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THE

SURGERY

OF THE

HEAD AND NECK

BY

LEVI COOPER LANE,
A. M., M. D. (Berol.), M. R. C. S. ENG., L L. D., PROFESSOR OF
SURGERY COOPER MEDICAL COLLEGE,
SAN FRANCISCO.

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It has been the custom of authors in separating from their books to say a parting word to them; this, by some, has been a dedication to a father, brother or friend, and in one case to the Author of Nature. Horace warns his of coming abuse and final neglect; Martial hints to his scroll that it may serve the base use of wrapping fish, or the worse one of becoming a flaming festoon to illuminate and torture the criminal; but Ovid, more ambitious and hopeful, announced in advance the salutations of immortality with which the coming years would greet his Metamorphoses; but the medical writer of to-day, warned by the fortune of his cotemporaries, may prudently contract the horizon of his expectation, and reckon on but a brief life for his book. He who thinks otherwise, reckons ill with Futurity. Thus warned, with limited hope, should a few years of existence be granted to the following pages, the writer's expectations will be fully realized.

LEVI COOPER LANE.

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CHAPTER I.

SURGERY OF THE SCALP.

HIPPOCRATES fully appreciated the gravity of affections of the head, and especially, of the wounds of the head. Several chapters of the works under his name which have reached us are devoted to wounds of the cranium, and create in the reader admiration of the progress and knowledge which had then been reached in this direction. In several editions of the DIVINE OLD MAN, as Hippocrates is often reverently named, this famous sentence occurs: "*Nullum vulnus capitis contemnendum est;*" or, as our tongue would have it, "No wound of the head is to be viewed as a trifling matter." If, as Littré thinks, this phrase is an interpolation by some later transcriber, yet there is so much practical wisdom couched in it that, rather than expunge, we should be grateful for the interpolation, for the practitioner of surgery can have no more valuable rule for his faithful observance and constant guidance than that every wound of the head should receive careful and thoughtful treatment. With this prefatory prelude, we will proceed to a brief study of the surgical anatomy of the scalp, necessary to a proper understanding of the diseases and injuries to which the scalp is subject.

SURGICAL ANATOMY OF THE SCALP.

Some knowledge of the parts that enter into the structure of the scalp is necessary to enable one to intelligently study morbid and traumatic conditions which occur here. As component elements of the minuter species, one finds squamous or flat epithelial cells, connective tissue and adipose cells, and muscular, fibrous, nervous, vascular, and lymphatic structures. Each of these components, whether cellular or structural, performs an important part in the attendant phenomena of the wounds of the scalp, especially the epithelial and connective tissue cells and the vessels. The scalp is divisible into stratified aggregated structures of larger order than the preceding ones mentioned. Com-

mencing outwards and passing inwards, these layers rest on each other in the following order, the cutaneo-adipose, the aponeurotic, and the periosteal. The outer one is constituted of the derm and fatty couch, and is especially important, since from it proceeds the hair, and in it are contained, also, the sebaceous and sudoriferous glands and the vessels.

This first layer is especially conspicuous as the ground in which the hair grows. In it the hair roots are planted, reaching often quite through the derm, and then resting on the subjacent fatty couch. This fatty layer, it may be remarked, is so closely adherent to the derm that it requires a forced dissection to separate the two. The fat is lodged in ovoidal compartments, the wall-like partitions being composed of dense fibrous tissue. It can only be removed from the skin by careful scraping, where the under surface of the derm will present a figured appearance. The roots do not penetrate vertically, but obliquely, so that the hairs, as a rule, tend to lie flatwise, with shafts diverging from, and roots converging towards, the so-called crown, or posterior fontanel, of the skull. This cutaneo-adipose layer increases in thickness as one passes from before backwards. With advancing years, the hair on the upper part of the scalp, through atrophy of the blastema, whence the individual hair grows, gradually falls. At the same time this portion of the scalp becomes attenuated through the vanishing of the adeps contained in the outer stratum. This senile attenuation has a bearing in surgical work. The traversing scalpel creaks as it goes, and demands greater effort to open its path than is the case in the structures of the younger subject.

The cutaneo-adipose layer is remarkable for its richness in vessels, which are found here in greater multitude than on any other part of the surface of the body, except that of the surface of the ends of the toes and fingers; and, as on the ends of the fingers, the vessels in the skin of the scalp lie very superficial. As Tillaux has specially pointed out, the vessels of the scalp lie in the skin and fatty stratum, and not beneath it, as is the arrangement elsewhere: for the usual anatomical disposition is that vessels near the periphery lie in the subcutaneous fascia. In the scalp, however, they are quite external to this structure.

In the cutaneo-adipose layer are numerous sebaceous and sudoriferous glands. The occlusion of the outlets of the sebaceous glands gives rise to the atheromatous or sebaceous cysts often found in the scalp.

The second important stratum is the so-called aponeurosis or musculo-fibrous layer, which, like an arched bridge, rests on the cranial vault, from before backwards. In the frontal and parietal regions it is reënforced by muscular fibres, the whole of these forming the occipito-frontalis muscle. From its firm, dense, and protective character arose the name galea capitis, or helmet of the head. In the lateral regions of the head this aponeurosis becomes attenuated to a layer of less thickness, corresponding more to subcutaneous fascia elsewhere.

This aponeurosis of musculo-fibrous structure is so closely adherent to the cutaneo-adipose layer outside that they can only be separated by a forced dissection. From it spring the fibrous partitions which separate and inclose the fat cellules, and then fuse with the external derm. In its vascularity this stratum presents, in an unusual degree, a numerical superiority of the venules over their corresponding arterioles. The consequent slackening of the circulation resulting from this disposition throws some light on morbid conditions which occur here. This musculo-fibrous stratum is closely adherent, as has been stated, to the layer external to it, but is very loosely connected to the periosteal stratum which lies inside of it, namely, there is an interval between it and the subjacent stratum, occupied only by loose connective tissue. The result is that the closely cohering first and second layers are readily movable on the third or innermost stratum, and, due to such laxity, the outer portion of the scalp can be moved backwards and forwards at will, by certain persons. This space external to the periosteum is of such a character that it is almost serous or bursal in structure, and it furnishes ready lodgment for pus, extravasated blood, and œdematous accumulations. As a consequence of the existence of this space the scalping knife, as well as that of the necropsist, can the more readily detach the scalp, and due to it the lacerated wound, also, may reach great dimensions.

The third layer, which must be reckoned as the innermost portion of the scalp, is the periosteum, named here, from its position, the pericranium. This pericranial layer is thicker than the periosteum elsewhere, and contains blood-vessels and nerves. The unusual number of nerves renders the membrane sentient and the seat of neuralgic trouble. The vascularity varies with age, becoming more limited in advancing years, yet in the young subject Hyrtl has found through injections that there is a direct connection between the intra-cranial vessels of the dura mater

and the pericranium. Material injected into the middle meningeal artery traverses the cranial wall of the child, and appears in the external periosteum. And in this way the encephalic engorgement of the child finds a medium for partial escape. But later in life osseous condensation obliterates these minute vessels. And as this obliteration proceeds, death of the bone can more readily occur. As a result of such vascularity, and the facility for afflux and efflux of blood, cranial necrosis is rare in the young subject.

The pericranium is adherent to the sutures of the cranium, and somewhat so to the frontal and parietal eminences; elsewhere the connection is slight, so that the membrane can easily be detached from the adjacent bone. The adherence of the pericranium to the skull is closer and firmer than is the adhesion of the pericranium to the overlying musculo-aponeurotic layer. Hence in the wound made for trephining, unless these conditions be well borne in mind, the uplifted flap will leave the periosteal layer behind.

The arteries of the scalp are derived from the external carotid, except those which are distributed to parts within the orbit, or which emerge from this cavity, as the supra-orbital, frontal and nasal, and also a few which traverse the cranial foramina: in all these excepted cases they emanate from vessels within the cranium, and chiefly from the internal carotid artery.

The arteries found in the scalp are the following: frontal, supra-orbital, temporal, auricular and occipital.

The frontal, which furnishes blood to the pedunculated flap taken from the forehead in rhinoplastic operations, done according to the Indian method, lies from a quarter to a third of an inch from the median line; hence, if the pedicle of the twisted flap have a breadth of a half inch, it will certainly contain one of the frontal arteries, and therefore its nutrition will be insured.

The temporal artery is the posterior one of the two branches into which the external carotid divides, when it has ascended into the upper part of the parotid gland. This division into the temporal and internal maxillary branches occurs in front of the tragus, and in the angle formed by the condyloid process of the lower jaw and the zygoma of the temporal bone. After rising nearly an inch above the zygoma, the temporal becomes superficial, and divides into two branches, the anterior and posterior temporal arteries. These vessels, quite visible to the eye, become tortuous with age. Just previous to the division of the primary

trunk, it gives off a branch named the deep or middle temporal, which dips down through the superficial fascia to the bone, and thence lying in a furrow on the squamous portion of the temporal bone, it ascends nearly straight upwards towards the summit of the skull; the course of this deep temporal artery corresponds pretty nearly to a line drawn vertically upwards from the external auditory meatus, as may be verified by one unwittingly opening it, as once occurred to the author in lancing an abscess in this region. In front of the middle temporal lies the posterior superficial branch, which mounts upwards to near the summit of the head. The anterior superficial branch is distributed to the integument on the side of the forehead. The branches of the temporal artery are often the subjects of wounds, and in former times when arteriotomy was resorted to for disease of the eye, these arteries were often attacked. The service of the lance here has been superseded by that of the suction-cupping cylinder, and other improved methods of the oculist.

Another artery deserving attention is the posterior auricular, which in its origin lies under the edge of the parotid gland. It soon reaches and lies in the sulcus between the pinna and the mastoid portion of the temporal bone. Yet abscess, which often appears here, lifts the vessel from its deep sub-aponeurotic site, so that it becomes (as Tillaux says) interested in the lancing of such abscess. From dissections made by the author, the vessel in the normal state of the parts lies deep on the bone, so that in plastic work done to reconstruct the adjacent part of the ear, a flap may be uplifted without risk of wounding the posterior auricular vessel.

The disposition and situation of the lymphatic vessels and glands of the scalp merit more attention than is commonly given them. These vessels, from their minuteness and want of color, often pass unnoticed, or are mistaken by the dissector for connective tissue. As channels for the metastatic transmission of septic or infectious material, these parts are of extreme importance. The glands, when swollen, point unmistakably backward to some infected point along the course of their different vessels, and then become important aids in diagnosis.

The lymphatics commence by a close network of fine vessels along the median or sagittal plane of the scalp. This capillary network, discoverable by injection in the young child, lies very superficial in the skin. From it depart toward each side groups of vessels, which, according to their destination, may be named

frontal, parietal, and occipital lymphatics. These vessels quickly abandon their superficial situation, and penetrate so deeply into the skin that, unlike what occurs elsewhere, when they become inflamed they cannot be seen as red lines.

The frontal, or anterior series, passes downwards and backwards and enters two or three glands which lie in or on the parotis, near to the condyle of the lower jaw. Lymphatics of the parotidean region enter these glands; hence swelling of the glands, though it may point to disease on the forehead, might also indicate disease or lesion on the side of the face or eyelids. These glands have also connection with others which lie below, near the angle of the lower jaw.

The second, or parietal group of lymphatics are of larger volume than the frontal, pursuing a downward course, almost straight in direction, to two or three glands which lie on the origin of the sterno-cleido-mastoid muscle, over the mastoid process; and from these glands efferent lymphatics proceed to the superficial and deep cervical glands.

The third group named, occipital, pass downwards and backwards to the occipital glands, one or two in number, which lie on the origin of the trapezius muscle.

The parietal and occipital lymphatics so interlace and intercommunicate that they may be regarded almost as one system. In consequence of such inosculation, it is probable that when one or more branches become obstructed, their contents may find escape through contiguous branches.

The glands which as a broken chaplet clasp the posterior part of the head near its base, are so often affected in secondary syphilis that Ricord proposes to feel, in the back of the neck, the pulse of the syphilitic subject. More properly, however, these glands are like signs which point back and indicate the course of the afferent lymphatics.

The nerves of the scalp, functionally considered, are of three kinds: Motor, from the facial, few in number; purely sensory, from the fifth pair; and also those of mixed functions. Of these three, the purely sensory nerves are those which require notice here; for as these are the site of neuralgic pains, along with others of their order, they sometimes become the subjects of operation.

From the ophthalmic branch of the fifth pair proceeds, within the orbit, the frontal nerve, which, lying close to the upper wall of the orbit, escapes with a small artery through the

supra-orbital notch, and passes thence upwards on the forehead. Within the orbit there are given off some small branches, an important one of which is a small twig which penetrates and ascends within the frontal bone, and it ends or escapes at the frontal eminence; this filament, escaping neurotomy or neurectomy of the frontal nerve, explains the continuance of pain after these operations.

After this preliminary consideration of the structures of the scalp that especially fall within the province of surgery, we will now proceed to a study of the surgical diseases of this region.

CHAPTER II.

GENERAL CLASSIFICATION OF THE AFFECTIONS OF THE SCALP, FOLLOWED BY A CONSIDERATION OF INFLAMMATION AND OTHER MATTERS WITHIN THE SPHERE OF GENERAL SURGICAL PATHOLOGY.

THE interminable variety of diseases, to which additions are being made by the legitimate progress of medicine, and especially by the ambition of those who are desirous of fame as contributors to nomenclature, is perplexing to both teacher and learner. To lessen the labor of mastering such detail, considerate writers seek to epitomize and to clearly generalize, and thus to lessen, as much as possible, by mnemonic aids the tasks of their readers. With such purpose the following categories and groups of disease which are met within the cranial integuments are presented:—

1. Inflammation, traumatic or specific, as seen in erysipelas; or in a furuncle, abscess, carbuncle, diffused phlegmon, or ulcer; or in the more simple forms of skin disease, as acne, eczema, etc.
2. Gangrene, ulcers and fistula.
3. Syphilitic, scrofulous and tubercular disease in their local manifestations.
4. Injuries, in which are comprised the various forms of wounds, viz., incised and flap wounds; penetrating, lacerated and contused wounds, wounds caused by gunshot and the diverse missiles used in war.
5. Burns and injury from contact of acids and caustic alkalies.
6. Hypertrophy and atrophy.
7. Tumors, benign and malignant.
8. Aneurism.
9. Arterio-venous enlargement and varix.
10. Oedema.
11. Emphysema.
12. Neuralgia.

It is the plan of this work to intermingle the subjects of surgical anatomy, special and general surgery, in such a manner

that each may add to the interest of the other; by following out such a course it is hoped to maintain an enlivening variety of matter, and thus, as far as possible, to avoid tedious monotony. And though in following such a plan the rigidly scientific method may be the loser, yet it is expected that the reader will be the gainer.

If precedent be sought for such deviation, the writer finds one in the example of Joseph Hyrtl, in whose admirable work on "Topographical Anatomy" one finds a violation of the prescribed rules of treating this subject; yet Hyrtl's transgression, though chastised by German critics, has given medicine a work of which each page interests the reader, and clings to his memory; should these pages, though they violate wonted method, awaken a tithe of such interest the writer's task will be well rewarded.

INFLAMMATION.

The subject of inflammation, which, as above mentioned, is present in some of the affections of the scalp, demands an early and important page. And this importance is augmented when it is considered that this subject is shared equally by surgery and internal medicine. It has engaged the study of a Billroth, a Weber, a Chauvel in surgery quite as much as a John Simon and Virchow in internal medicine. This list of names (in which many others might have been included), represents some of the best intellects which by their labors have advanced medicine in modern times. The subject has become, as it were, a scientific arena in which cultivated minds have worked ambitiously, hoping to win laurels by solving some difficult problem, or by making some new discovery. Until within recent years, the student of inflammation confined his researches to the laboratory of his brain. The modern investigator has chosen the inductive method of vivisection; and in this latter work, the frog, guinea pig, pigeon, dog, and other animals have become important coadjutors.

The Latin tongue, which long prior to our civilization passed from the rude and concrete stage to the abstract, has left us a treasure in the writings of Celsus; and to the lovers of classic literature, no more charming work can be commended for study than that of this old author. And, though it remains a matter of controversy whether Celsus ever practiced medicine, yet every one of his readers becomes quickly convinced of the practical value of his teaching. Celsus has left us a definition of inflam-

mation that is remarkable for brevity, as well as wide range of meaning. The four words of this definition, *redness, swelling, heat,* and *pain,* have been named the Celsian quadrangle; and, although these corner stones were laid eighteen hundred years ago, they endure until to-day; and on them the modern builders yet build. As proof of this, the following definitions of inflammation given in recent times are presented. Says Otto Weber, an eminent German student of surgical pathology, "Inflammation is a local disturbance of nutrition caused by an irritant; this disturbance commences with augmented formative action and is attended by an increased afflux of nutritive material to the part, as well as by increased disintegration." Stricker, another medical authority of eminence, defines it to be "a wound, disturbance of circulation, exudation of fluid and solid matter, disturbed nutrition, and new growth." The author ventures to offer a kindred one: in inflammation there is an increased afflux of blood or plasma to a part as agents of ascending metamorphosis; also an increased efflux of elements resulting from disintegration, as the result of retrograde metamorphosis, the whole originating from a local irritant. Sée, a French writer, says that "inflammation consists of tumultuous acts, nutritive and innutritive; it is an image of nutrition in which equilibrium is broken."

According to Heurtaux, a diligent student of this subject, inflammation is a disturbance of nutrition inducing a reversion to the embryonic type of tissue, and a production of plastic material, and sometimes of pus; the resulting lesions are transient and leave no trace; or they are destructive; or they may aid in the formation of connective tissue; of the eventualities here enumerated, one or more may be absent. And this inconstancy depends on the fact that the process may stop and retrograde.

Now if the leading points of these definitions be noted, we are able, by a slight interpretation, to discover in them that of Celsus; we have a resemblance to a palimpsest, or old manuscript, in which the first writer's text can be re-read through the lines of the second one. The modifications in nutrition which inflammation induces in a part are the chief phenomena which eighteen centuries have added to our knowledge. And even the processes concerned in nutrition are so far from being clearly known that the term itself is more a name than a thing clearly understood. If to the Celsian definition we add the term *modified function* then it becomes supplemented with about the only important addition that modern research has given us. Our Celsian

definition being thus completed, we will proceed now to an elucidation of its component factors, and will begin with that of *rubor*, or redness.

When a part of the body is irritated, the vessels which traverse it momentarily contract and then they dilate and remain swollen; but if the part be non-vascular, as cartilaginous or corneal structure, then the contiguous or circumambient vessels undergo like changes, the result in both cases being that the redness of the parts is increased as soon as the second act, or swelling of the vessels, has ensued. As causes of the consecutive contraction and dilation of the vessels, investigators differ; one class invokes an occult intervention on the part of the nerves; another class locates the action exclusively in the muscular tunic of the capillaries, which, for an instant, contract and then expand through exhaustion. The only act usually visible is the widening, manifested by the redness of the part. The tegument of the affected part has some influence on the degree of redness; when thin, as in the cuticle of the skin when attenuated, or in the covering of the mucous membrane of the mouth, the redness is increased. But when the epidermis is thick, as on the soles of the feet, then the inflamed condition of the underlying structures may not be apparent on the surface. Again, the presence of redness in a part of the living or dead body may be due to physical causes; for example, it may be dependent on gravitation or obstruction to the escape of blood from the part, and thus the observer can be misled. A notable example of this may be cited to serve as a warning against falling into such error. Broussais, of the Parisian school of medicine, distinguished for both frailty and brilliancy of intellect, announced that he had discovered the pathological key to many diseases in an inflammation of the coats of the stomach. This doctrine was founded on the fact that he found in all the autopsies which he made or observed, redness of the mucous lining of the stomach. The position of the portal system of vessels, so intercalated between the vessels and arterial capillaries of the systemic vessels as to permit congestion as the cardiac force is lessening, was overlooked by this author, and this theory, which led the medical world captive for a generation, like the fallacy of Phrenology, in which Broussais likewise believed, has vanished before the light of more careful observation. And this example should warn the observer from asserting that an inflammation exists when no other evidence of it is present than that of redness.

Swelling (*tumor*) results from the stasis or accumulation of an unusual quantity of blood in the part, likewise from the presence of leucocytes or white blood cells, which, through the researches of Cohnheim and others, have been shown to emigrate from the blood vessels into the adjoining tissues during the inflammatory act; and, lastly, should the inflammation be prolonged, then the swelling is further increased by a development of new cells which spring from the connective tissue and endothelial elements composing the part. The density or laxity of the tissue which is inflamed has a direct influence on the amount of the swelling. In parts which are naturally hard and dense, the swelling is often scarcely perceptible, but in those which are loose and yielding, the swelling is much greater. Examples of the latter are seen in the great swelling met with in the scrotum, eyelids, and lips when these parts are inflamed. The redness and swelling of parts tend to recede under the action of the inherent elasticity of the parts. Inflammatory tumefaction should not be confounded with œdema or dropsical swelling; in the latter condition pressure readily displaces the accumulated fluid.

Heat (*calor*) was viewed as so important an element in inflammation by the early fathers in medicine that in both the Latin and Greek tongues it gave name to the process. The heat and redness of flame, and pain from too near approach to the latter, were eminently suggestive of inflammation as manifested in the human body. Yet the improved methods of modern times employed to estimate heat in inflamed structures have, curiously enough, led to discordant results. John Hunter, the earliest student in the field, was the first to use the thermometer. In a scrotum the seat of a hydrocele, though heat was created by inflammation, yet the temperature found was less than that of the blood of the body. Later, many others, and among them Billroth, continued this investigation, and as long as the heat was measured by the thermometer, the results in the main were negative. Subsequently the testing was done by means of thermo-electric instruments, first by Becquerel and Breschet, and afterwards by the English pathologist, John Simon. The method used by Simon was to solder an iron and platina needle together at one end and to thrust their divergent shafts into the part to be examined. These needles were connected with a copper wire which encircled an astatic polar needle or galvanometer. By such an ingeniously contrived thermo-electric appa-

ratus the degree of heat of the part explored was accurately measured by the deflection of the needle. The discordant results obtained by the thermometer were now rectified, and it was clearly shown that the temperature of the inflamed parts is greater than that of the blood of the body. Otto Weber, who carefully repeated the experiments of Simon, obtained the following results from the examination of inflamed and non-inflamed parts, as well as of blood which is entering and departing from inflamed structures:—

1. An inflamed part is warmer than the corresponding uninflamed part.

2. The arterial blood entering an inflamed part is less warm than the inflamed part itself.

3. The venous blood departing from an inflamed part is less warm than the inflamed part, yet it is warmer than the arterial blood which is approaching.

4. The departing venous blood is warmer than the blood in the veins of the corresponding non-inflamed part of the body.

Hence, it is demonstrated that there is heat produced in the inflamed part; and the amount of this is probably considerably more than can be accurately estimated, since the cooler arterial blood which is constantly entering the part must reduce its temperature. In connection with the heat of inflamed structures when at the surface, Gierse has determined that heat is more easily given off than from parts in normal state. This circumstance makes the observer exaggerate the temperature of the part which he is examining; and when this is combined with the additional fact that the patient's sensation over-estimates the heat, we have an explanation of the unanimity of the old observers that there is an increase of heat.

The heat generated in an inflamed part is constantly being dispersed through the effluent venous blood and added to the general temperature of the body; and in this way we can account, to some extent, for the general rise of heat in one whose body is the site of some inflammation. The locally inflamed part must not be considered as the entire source of heat in inflammatory fever; the generally increased temperature must be accounted for chiefly as the result of dead elements of disintegrated tissue entering the general circulation. And having entered the blood these functionless elements become the subjects, as well as the promoters, of chemical change in which heat is generated.

The three properties of inflammation which have been con-

sidered are of an objective nature, susceptible of verification; pain (*dolor*), the next one to be considered, is more of a subjective character, and escapes the usual tests of observation. The instrument, which might be named an odynomometer, which can detect and measure pain, has not been invented. But science is continually adding to our knowledge and extending our foresight; and art is ever enlarging our power and sphere of action;* with these faithful and fearless guides, it may yet be possible to penetrate the inmost recesses of life, and with scale and indicating pendulum, to measure sensation in its various phases. And until such metrical device has been invented, there can be no quantitative estimate of the pain which is present in an inflamed part. And, though so intangible that it eludes the scrutiny of the five senses of the observer, yet it is manifest enough to the unfortunate subject of it, by whom it is announced by interjections or sounds recognized by any ear, for pain phrases itself in a universal language which needs not to be learned.

Pain is not an unerring sign of inflammation, since it may be present from an abnormal accumulation of blood in a part which is not inflamed. The degree of pain in an inflamed part depends on several conditions; the chief of these is an ample supply of sensory nerves of either the part affected, or of the parts contiguous to the latter.

The immediate cause of pain lies in changes which may be induced in nerves by pressure, mechanical lesion, structural disintegration, or cell growth either in the nerve or its sheath. In very many cases the pain present is due to swelling and the resultant pressure on the nerves. An unyielding texture of the affected structure intensifies pain. As illustrations may be cited the violent pain in a whitlow, in the fang of a diseased tooth, and in the case of an inflamed nerve traversing an unyielding osseous foramen or canal.

By means of propagation through reflex routes pain may be felt quite beyond the primarily affected part. Examples of this occur in the hand, in which an affected filament of the median or ulnar nerve may awaken pain in the whole hand and arm; and an affected branch of the trifacial nerve may awaken pain in other parts of the face which are supplied by the nerve. Inattention to this circumstance has led to errors in diagnosis. For instance, disease in the kidney or bladder may be denoted

*Compte's "Positive Philosophy," article "Biology."

only by pain about the external outlet of the urethra, and not unfrequently pain in the knee (as yet ill explained) has diverted the attention of the physician and misled him in regard to the true seat of the disease in the hip joint. And through the interlacing and intercommunication of the radical fibers of nerves in their centers of origin, pain awakened in one part of the periphery, as on the neck or arm, may be felt at some distant point in the lower part of the trunk.

These examples of pain, which tax the anatomist to explain them, find their analogue in these cases in which the pain, instead of reappearing as sensation, awakens motion. Thus an inflamed cornea causes spasmodic closure of the lids; inflammation of the mucous membrane of the pharynx and larynx awakens muscular movements of these parts; urethral inflammation may induce contraction of the sphincters of the bladder, and consequent retention of urine; inflammation of encephalic structure can cause the muscles to contract which are concerned in vomiting; and lastly, an inflamed peritoneum is primarily indicated by retching and vomiting.

Antecedent to the appearance of pain, there may be detected by cautious palpation increased sensitiveness of the part in which the inflammation is developing; this condition sometimes assists in the discovery of approaching disease which is deep seated; yet for its detection there is required a touch which has become erudite by much experience and careful training, for if by rough manipulation we rudely question the parts, the latter on their part may return us a rude and misleading answer, for violent pressure may awaken pain in parts where it does not really exist.

Though pain is commonly a prominent feature of inflammation, yet it may be absent in palsied parts which are inflamed. And such inflamed part through strangulation or pressure may become gangrenous without the patient's knowledge; as examples of this, which should awaken prudent foresight on the part of the surgeon, are decubital sloughs which occur through lesions of the spinal cord, or from luxation or fracture of the spine. And in an inflamed part, especially in structures which are œdematous, the element of pressure may be so excessive that it finally extinguishes sensation; and this, too, is a timely warning that death of the part is impending.

Inflammation is the peculiar prerogative of living tissue; whether these be lax or dense, highly vascular or non-vascular, abounding in or destitute of nerves, all living parts whatsoever

may become inflamed. Earliest youth and extreme old age have no immunity from it. But many circumstances, and among these are comprised those just enumerated, modify and stamp it with special characteristics. For example, it may be so mild as to run its course quite unperceived, or it may be so violent in its action that it soon extinguishes the life of its subject; and between these exist many intermediate varieties. As a general grouping founded on these facts, we have *acute*, *subacute*, and *chronic* inflammations.

If the phenomena which precede, accompany, and follow an inflammation, be studied in their logical connection as an articulated series of actions, there will always be found a causal agency from which the inflammation originated, and which determines the grade and intensity as indicated by the foregoing division. The old writers, Van Helmont and Stahl, familiar, perhaps, with the effects of a penetrating thorn, named such cause a *spina*, or thorn; the writers of recent time name it an irritant; and the initial stage as that of irritation. This causal agency may be classified under the headings of mechanical, physical, chemical, and toxic, the toxic being closely cognate to the chemical. Examples of the mechanical are wounds due to violence from some instrument; an instance of physical cause is the burn; one from chemical agency is that from a concentrated acid or alkali; and, lastly, toxic action is represented by the so-called poison, which acts probably in some undetermined chemical way, dependent probably on the respective molecular composition of the agent and the structure acted on.

In their descriptions of inflammation, writers mention a species which they name idiopathic; this occurs oftenest in works on internal medicine. The term idiopathic is a word coined to veil ignorance; such ignorance, however, were better acknowledged than concealed by the subterfuge of obscure verbiage. Every effect or result is linked to some antecedent causal agency. In medicine, as in other branches of knowledge, words sometimes acquire too much importance and become the counterfeit exponents of what are fancied to be facts. Thus paraphrased an idiopathic or causeless inflammation cannot rationally be conceived of. The class of idiopathic diseases is constantly lessening before the advancing tide of observant investigation.

Another agency claimed as causal is ascribed to certain parasites discoverable only by the microscope; there are many varieties of these microphytes, or microbes, as some name them; the

one, however, which has received the greatest credit as an agent of inflammation is the genus bacterium, which has lent its name to a new section of medicine, viz., Bacteriology. The work which has been done in this field, and what has been written on the subject, constitute one of the most brilliant chapters in modern medical science. The agent of disease which had so long eluded detection, now seems, in many cases, to be discovered. The sanguine minded are sure of this; the prudent, with certain reservations, accept it; the cautious are hopeful that it is so, and before full acceptance of it, are waiting for further confirmation. Another class of men, however, who are valuable as aids in the search for truth in this, that they earnestly work as irrepressible contestants, are the skeptics. This class, whose minds find more pleasure in contemplating the vibrating scales of doubt than in accepting established truths, is found here on the side of denial. Skepticism finds an ally in age, whose stereotyped immutability scoffs at any new thing. The writer has fully accepted this new doctrine. The evidences in favor of its truthfulness have so accumulated that it can no longer be rejected, except by those who, Cato-like, are only happy when steering against the opinion of their fellows. The writer will not attempt to explain how the microbe awakens an imflammation, nor will he deny that instead of being the antecedent it may finally be demonstrated to be the concomitant, or even the subsequent of inflammation; still the two entities are indissolubly connected.

Pathology has traversed four stages of development. Among the ancients it existed in the most rudimentary state. As proof of this may be cited Celsus, who was unfriendly to the examination of the dead body. He believed that the changes produced by death are such that no true idea could be learned from the examination of dead bodies of their real condition in life. It was only with Vesalius that an epoch of accuracy began. Vesalius won for himself the title of Reformer in Anatomy, because he corrected the inaccuracies of Galen, who is said to have studied the subject wholly from the dissection of monkeys—a statement with difficulty credited by any student of Galen. Accurate knowledge of the form, site, and aspect of the parts composing the human body made it possible to discover and discriminate the changes produced by disease; and the labors of Vesalius completing this work, mark the initial era of Pathology.

The second important epoch of advance in this matter was ushered in by Bichat. Amidst the excitement of the French

Revolution, which gave the world so much that was good and bad, this remarkable genius appeared, and at the early age of thirty-one years, when most men have scarcely learned to think maturely, Bichat gave to the world his wonderful works on "The Tissues" and on "Life and Death." His researches led observation, which had hitherto only contemplated the rude macroscopical aspects left by disease in the structures of the dead body, to a study of the minuter changes and perversions which disease impresses on the component tissues. Bichat's classification of tissues, though inaccurate in points, was a positive advance in knowledge, and was the pioneer work in constructing the way along which others were enabled to march to the final site of refuge of disease, which lies within the sphere of the infinitely little,* which the microscope has opened to us.

To this interesting field a number of eminent investigators was attracted in Germany, France and England. Among these investigators were Virchow, Henle, Hasse, Cornil, Waller and Wharton Jones. The pathologist was engrossed in the study of cell-life, cell-form and cell-change; for in this field, really so narrow, but which became so broad under the microscope, lay a great number of treasures awaiting disclosure. The leader in this work was Rudolf Virchow, whose discoveries were so numerous and important that they have added a new section to medicine, viz., Cellular Pathology.

The pages of this work are less poetical than those of the genius who wrote "La Vie et la Mort," yet those of the former constantly delight and instruct, as the writer depicts the eventful acts of the cell in its nutritive and innutritive changes, in the phenomena of life and death.

The tracing of the ever-changing life of the cell from its birth to its death, in health and disease, has rendered equal service to both surgery and internal medicine; in surgery it has illustrated the inflammatory processes awakened by the wound or other irritant; it has revealed the initial conditions of both benign and malignant tumors, placing those conditions under the observer's eye, as it were, at the very moment of their conception; and finally, this investigation of the cell has wrested from nutrition much of its mystery. Such has been the service which Virchow has rendered to medical science; and as Bichat has been immortalized by a prominent place among the figures which emblazon the

*Pascal, "Les Pensées."

frontispiece of the Pantheon, so when death closes the door of envy, Virchow will have perhaps a more conspicuous place among those whom grateful posterity will honor with enduring remembrance.

The fourth, and probably the final stage of advance in the search for the factor of disease, is to the concomitant entity so often found associated with the cell, viz., the microbe before mentioned; this is now thought to be the solving term in the explanation of morbid action. Passionate controversy on this subject has scarcely yet arrived at the period when a dispassionate review can be made. The pioneer work in this field of the truly infinitely little was done by Pasteur in his researches on fermentation and putrefaction. The writer heard Pasteur read some of his papers on these subjects at the French Institute in 1860, and confesses that he foresaw quite as little their bearing on the future of medicine and surgery as probably did Pasteur himself. These observations then announced by Pasteur were the first lines in the volume of "Bacteriology," which has since been given to the world; and at this time engrosses so much attention. The microphyte in its various forms and diverse habitats has become the object of study on the part of both amateurs as well as earnest students, and many species have been assigned special places as ætiological agents of disease. And what is yet more important, the thing which has been assigned the part of causal agency, may, it seems under certain management, furnish immunity against the disease which it originates. And when this hope is realized, which Bacteriology is promising in several directions, the accomplished task will remain a supreme benefaction to humanity.

In recent pathological investigation there has been a tendency to overlook past methods, and to underrate past acquisitions; the bacterium with a special fascination has so nearly engrossed all inquiry, that the cell, the tissue, and the crude anatomical masses, have been almost neglected. This is an error, and it were well if more attention were given to the appearances of parts revealed by necropsy, such as engrossed the attention of Morgagni and Hunter, and in the pursuit of which they made many additions to our knowledge. The knowledge gathered by these men through work done in the cheerless dead-house is lasting, and will bear comparison with the best work done with the microscope. And the cell also, recently nearly overlooked, or divested

of much of its former importance, should be permitted to return from partial exile to its former place.

After this pathological excursion, we will resume the narrative of inflammation, and in so doing will consider some of its results. The most important of these is the rapid appearance of a number of cell-like elements. Some of these elements have a definite form or outline; others are irregular in shape, and some again are dissimilar in size, and are wholly irregular in form. Those of regular outline are usually round, oval, or elongated in figure; the round or round-like form is the predominant one; deviations from this are probably due to pressure. These forms are only discernible by the aid of a microscope, and, when examined with this instrument, these cells, or corpuscles, as they sometimes are named, are seen to have one or more dark points, named nuclei, as occupants of the cell. A portion of these corpuscles are white blood cells which have forsaken their containing capillaries by escaping through interstices in their walls. Another portion originates from preëxistent elements composing the inflamed tissues. The two modes of origin here mentioned have been verified by actual observation. Cohnheim has seen the white cells in the act of traversing the walls of the minute vessels in their passage towards the inflamed tissue; and this may be named development by cell immigration. And on the other hand Otto Weber and Billroth have seen cells in different stages of development arising from inflamed structures; and this development has been named, according to the stage of growth in which the corpuscles are observed, nucleation and cellulation, nucleation being the initial period, while cellulation represents a more advanced stage of development.

The cellular elements mentioned, both the formless and the definitely shapen, are similar in appearance to those which compose the embryonic being in its early stages of growth, and are named by histologists, especially by Charcot and others of the French school, embryonic elements. When such elements become organized, the resultant tissue in its inchoate stage is named embryonic or granular tissue. Charcot and Ranvier have formulated as the result of their observations of the action of inflammation that it tends to reduce the affected structure to its primordial embryonic stage. The transformation is the same whether the inflammation has attacked the organs of the thorax, abdomen, or surface of the body.

The future destiny of these simple granular elements depends

on the grade, slowness or vehemence, and special character of the inflammation which generated them.

The inflammatory process may be constructive or destructive in its course; constructive in this, that lost structures, to a limited extent, may be reproduced similar to the original one. This is true of vessels, nerves, and, in a slight degree, of muscular tissue; the new-formed vessels seem to be offshoots from contiguous vessels, and the nerves appear to arise from the extension of preëxisting nerve filaments. Again, the process may be destructive in its action, and then the cellular and granular elements remaining in their nascent or embryonic state die before they reach the stage of organization; or, if they reach organization, this is of a very rudimentary character. Examples of destructive action are seen in diptheritis and the rapidly perishing products of hospital gangrene. The explanation of such early death of the newly-produced elements is that the development of cells has outstripped the growth of vessels. The cells die through lack of nutritious material, and in their death they involve the underlying adjacent capillaries. In military phrase, the army is lost through leaving its commissariat too far behind. Recent investigation makes it very probable that certain forms of bacteria are active adjuvants in the work of destruction.

Through changes which occur in the future destiny of the cellular and granular elements which have been produced in the inflamed tissues, inflammation may have the following endings or events:—

1. *Dispersion immediate or retarded.*—In a case of immediate dispersion, the inflammation is transient in duration; the redness and swelling quickly disappear, and the elemental products, few in number, are soon removed from the affected part. Or, instead of being immediate, the dispersion may be retarded and take place at a somewhat later period, and in both cases the inflammation is so completely innocuous in action, and the restoration to normal type is so entire, that hardly any vestige remains of what has occurred. It should be mentioned that this ending is known also by the name discussion; it is often seen in slight wounds, and not unfrequently in larger ones, through the improved methods which have recently been introduced in the treatment of wounds. Certain anatomical conditions favor such ending; for example, an ample supply of blood-vessels, and especially of lymphatics, favors this rapid or immediate restitution to integrity.

2. *Condensation.*—Inflammation may end in condensation or hardening of the affected part, and this event may present itself in two forms, which are the opposites of each other, viz., enlargement, or hypertrophy, or in diminution, called also atrophy. In the condition of enlargement, the swelling depends on increased afflux of blood to the dilated capillaries, and likewise on the increased number of cells and granules which appear in an inflamed tissue. Here the conditions are such as to offer an obstruction to the escape of both fluid and solid contents. Consecutive to such enlargement, a diminution of volume may occur through escape of the fluid contents from the part, and contraction of the remaining solid elements. The actual state in both enlargement and diminution is induration of the structure; and the induration is especially present in the case of atrophic or diminished volume.

3. *Adhesion.*—Inflammation has, as a frequent event, adhesion of the affected structures; such adhesion is seen in the lessened mobility of subcutaneous parts; thus muscles may become bound together in such a way that their separate, individual movements are interfered with, and consequently, their function is lost or impaired. Such adhesion may occur between tendons and their containing canals, and thus the movements of the hands and fingers are impaired and hampered. Vessels also may become adherent to adjacent parts, their caliber may be diminished, and thus the supply of blood to parts be lessened. Such adhesion or close tethering of vessels to adjacent structures near to luxated joints favors atrophy, and exposes the vessels to danger of rupture in the work done to reduce the luxation, especially in cases in which reduction has long been delayed. Through adhesion of other tubular canals to the parts inclosing them, or through coherence of folded sections of their walls, their permeability may be impaired through lessening of caliber; hence stricture originates from previous inflammatory action. This is seen in the urethra, in the alimentary canal, and in other tube-like passages. Adhesion arises in inflamed serous membranes and produces agglutination and fusion together of the opposite surfaces; thus the serous surface of the lung may become attached to the costal pleura, and the pleural cavity be partly or wholly obliterated. The heart may thus contract attachment to the pericardium. Within the abdomen, under the action of peritonitis, the serous surfaces of the intestinal coils may cohere, and the peristaltic mobility of the

intestine be fatally interfered with. On the other hand, adhesion sometimes becomes eminently conservative in its action; thus a perforated bowel through adhesion of parts around has been prevented from pouring its contents into the abdominal cavity. Also, in case of abscess about the cœcum, or in the spleen, or liver, through adhesion of the wall of the abscess with the abdominal wall, a way is prepared by which the pus may safely escape externally. I have seen a gall bladder laden with many calculi thus get rid of its deleterious burden, many months being occupied in the work. Alongside of these cases in which adhesion acts preservatively, may be cited a few others in which its result is deleterious. An instance of this kind is the palpebral space, which, through adhesion of the lid to the globe of the eye, may be almost obliterated, and the motions of the parts greatly obstructed. Also, inflammatory action within the mouth can cause union of the cheek to the inferior maxilla, so that the action of the jaw is hampered, and mastication rendered difficult. The phimosed prepuce may become adherent to the glans so that the two become one continuous structure. Also in case of burns in which the parts have been denuded of dermal integument, such parts readily cohere, if their raw surfaces remain in contact; the webbing of fingers after a burn is a familiar example. The art of the surgeon is severely taxed in preventing adhesion in the cases referred to, and where it has already occurred, the task is yet more difficult to restore the parts to normal condition.

4. *Suppuration.*—The event most familiar to both the professional and the non-professional eye, is suppuration. In this eventual phase of inflammation there presents itself a remarkable product, technically called *pus.* The layman, from whose early experience and primitive contact with rude nature the nude germs of all language originated, has adopted as symbol to denote this thing the most important word in his forcible vocabulary, viz., *matter.*

To the unaided eye, pus is semi-fluid; it is of a white or yellowish cream-like color; to the touch it yields the slimy feel of mucus, and tested by the sense of smell, its odor varies according to its source, or the part of the body in which it has arisen. It was deemed by Hunter to be a secretion from the tissues, and, like a secretion, it is composed of corpuscles of varying form floating in liquid. In this it is analogous to milk, saliva, mucus, and other secretions, for in them one has varying form-elements

suspended in a separable fluid. It may be compared to an imperfect emulsion, in which the suspended materials tend to sink downwards when left in repose, for if pus be allowed to remain quiescent for a time, such a precipitation of the solid elements does occur. The thickness of the deposited stratum varies in different cases, and depends on the nature of the structures whence it emanates; also, the age of the pus has an influence on its density. For example, when the pus has long been pent up in a cavity of which the containing walls favor absorption, then the liquid contents will be found to have disappeared, and a solid cheese-like content only remains. Instances of this are seen in the chronic abscess, and so complete is the solidification sometimes, that there is only found a fossilized cretaceous mass. Where the containing wall is unfavorable to absorption, as in the pleura that has become dense and thickened through chronic inflammation, then the purulent content may remain liquid for an indefinite period. Such pus in which the corpuscular elements are in lessened amount, and the containing fluid is in excess, is that derived from an ulcerated surface of long standing; the product here is closely allied to serum; it is almost transparent. A similar pus is derived from the chronic fistula, from a surface covered with exuberant granulations, and from an eye the surfaces of which are the site of a chronic inflammation. This species of pus, characterized by its barrenness in form-elements, when emanating from a mucous surface, is with difficulty distinguished from the normal mucus produced by the surface. Examples of this are the catarrhal sequelae which attend chronic inflammation of the various mucous membranes, and particularly that of the urethra. The interminable sero-purulent discharges from such affected surface often remain, despite the best efforts made for their relief.

Having considered the qualities of pus, primary and acquired, which unaided vision perceives, we will next consider what the microscope reveals.

If a drop of recently-formed pus be placed in the field of a microscope which magnifies five hundred times, it will be seen to consist of a fluid in which form-elements are floating. The fluid portion nearly resembles water. The solid content consists of bodies of varying figure; many have a rounded outline, and are opaque, or, at least, they are dark in appearance. If water be added, then these bodies become more transparent, and the transparency is further increased, if acetic acid be added. This clear-

ing up is due to the reagent clearing up the granular content of the corpuscle, and then one or more nuclei are brought to view. This body, which we will name the pus-corpuscle, when magnified five hundred times will be about two lines in diameter. In its appearance and behavior under the different tests to which the microscope subjects it, it is identical with the white blood-cell. Besides these rounded bodies there are other elements less regular in form, indeed, many are shapeless.

The rounded corpuscles when derived from recent pus present certain remarkable phenomena, which indicate that they are possessed of vitality. For example, in many, one sees movements of the molecules within the corpuscles, also from its surface one sees that processes are projected outwards, and at another point, retraction takes place. The motions are such as enable the corpuscle to change its place, and are the same as those manifested by the Amœba, a minute organism familiar to the naturalist. This faculty of motion enables the pus-corpuscle to move from one place to another, and as the normal tissues of the body abound with numerous lymph-passages and spaces between the elements of connective tissue, it is easily conceivable that pus when external may pass inwards, or when inclosed, that it may penetrate surrounding parts.

The number of pus-corpuscles present is very variable. In some specimens the containing serum greatly predominates. Also the number of cells endowed with mobility may be small, or quite absent; for example, none are found in pus which is old. In pus which is the product of gangrenous tissue few or no regular corpuscles can be found, and the elements which are seen present no movement.

Besides pus of light or yellow color, examples have been seen in which it was of a blue color. This hue has been referred to the presence of vibriones; others again, claim that the color is due to some compound of iron. Pétrequin says that it is caused by the sulphuret of iron. The writer has seen a case in which the pus was of a purplish color with a faint trace of blue. Such discolored pus (whether blue or purplish) has no ill import so far as observed in the writer's experience; though a lurid omen to the patient, yet it does not interfere with the healing of his wound. It is probable that it sometimes arises from a chemical change in some ingredient in the bandage through contact with pus. Other hues of pus have been seen: black in that derived from bone; yellow in the jaundiced patient, and red when it contains hæmetine, or an admixture of blood.

The pus-corpuscle has the power of incorporating in itself foreign material in molecular form, thus carmine, blood, bile, and other material of a color that can contrast with the content of the pus-corpuscle become incorporated with the latter. The conclusion arrived at from these facts is that the corpuscle is not a true cell, it has no containing wall, its component molecules are held together by an attraction akin to that which holds together the constituent parts of the living body. The thoughtful student of animal life and plant life finds many examples of such cohesive force. No more remarkable instance can be cited than that of the fixation of the tendon in a bone; though seemingly a union of the simplest order, yet the parts are almost inseparable. And so an attractive affinity holds together, arranged in a spheroidal form, the constituent elements of the pus corpuscle with an amount of force which permits of motion.

The law of biological development that every cell refers its maternity to a preceding one, finds no exception in the origin of the pus corpuscle; each one arises from a kindred element in the inflamed tissues. As before said, one of the later acts of inflammation is the production of a substance similar to that constituting the embryo, and hence named embryonic tissue. Nature here, as in her other acts which have the purpose of continuing species, makes provision with a liberal hand; the elements of repair are furnished in excess, and those not needed are cast off, and in effluent fluid they are carried outside of the organism, and share the fate of other excreta. Or, dropping the figurative for pathological terms, pus is the direct product of an inflamed tissue; the elemental forms contained in it are the offspring of similar elements in the generating structure, and in an open or closed wound, they are nearly identical with those which repair the breach. Every normal structure can generate pus, and the same law applies to every abnormal growth; carcinoma, sarcoma, lipoma, fibroma, chondroma, etc., can each produce a pus of which the elements correspond to those of the maternal structure. And in the case of a tumor of which the development is rapid, as in the encephaloid growth, if a breach be made in the surface of the same, there will be an unusually abundant production of pus. Here the work of organization does not keep pace with that of cell-production, and the unemployed portion of the latter appears as purulent material. In the newly-organized structure numerous fragile vessels appear as the predominant component; from these vessels emanate the fluid in which the corpuscles float.

This fluid may very properly be named serum, since it is similar to the serum of the blood.

Pus, then, is so nearly allied to the structure generating it that Boerhaave but slightly erred when he named it dissolved tissue. In composition it is nearly allied to blood which a French physiologist has named flowing flesh (chair coulante). Blood is one of the most costly products of the animal organism; and the near kindred of pus to blood gives the former almost equal rank. Its production on a large scale is an exhausting drain on the vital resources. The exhausting action from a profuse suppuration is nearly equal to that of hemorrhage. An important thing to be borne in mind is, that besides the loss to the organism incurred through chronic suppuration, it induces disease in parts often remote from the affected part; thus a joint or bone the seat of long-continued suppuration causes renal, splenic, hepatic, or intestinal degeneration of amyloid type; and the life of the subject may thus be imperiled through innutrition.

When pus is imprisoned, or has only imperfect outlet for escape, its elements undergo disintegration; and pus thus changed is capable of being partly absorbed; certainly, the pus-serum, molecular elements, and bacterial forms may be absorbed and become intermingled with the blood. Virchow denies that pus corpuscles enter the body except through open veins; the lessened volume of retained pus clearly shows that partial absorption of it is possible. And the absorbed purulent elements through chemical action cause fever; and, probably, through traversing or lodging in the kidneys, cause renal disease. The conclusion here come to is justified by the results of experiments made on animals, in which pus has been injected into the blood vessels.

5. *Ulceration.*—Another result of inflammation occasionally seen is ulceration. This is present in an open, unhealing wound. Similar conditions often exist in the boundary of an abscess, which tends to enlarge rather than remain in fixed limits. It is also present in a modified form in purulent infiltration, where pus disseminates itself, and breaks down tissues contiguous to it; in this instance, the inflammation present is of an acute and highly active character, but in the others cited it is of a subacute or mild character. An analagous process is seen in the malignant growth which has opened, and whence pus-like fluid is eliminated. Ulceration on an enormous scale is often present in the mammary cancer in its last stages. In the several cases of

ulceration cited, there is a slow breaking down of tissues, whether these be normal or neoplastic. And if the conditions present be studied and briefly defined, ulceration is found to be *molecular structural disintegration combined with suppuration.* It occurs on the skin, on the mucous membranes, in the serous surface of the joints, in glands, muscles, and even in bones, in which it is named caries, the rule being that structures which suppurate also readily become the site of ulceration. Ulceration proceeds more rapidly in lax parts than in those which are solid or hard.

The causes of ulceration are general and local.

The general cause, which may also be named predisposing, lies in some peculiarity or constitutional tendency of the subject. Scrofula, tuberculosis, scorbutus, and syphilis, each in its way, favors ulceration in its victim, and each modifies and gives an impress to the ulcer arising, so that from an inspection of the local breach one gets diagnostic proof of the constitutional tendency of the subject. There may also be a predisposition less general than the cases just given; for example, a diseased condition of an artery through calcification of its coats, may so impair nutrition in the part to which it is distributed, that ulceration on a large scale may there occur. Illustrations of this have been seen in the leg, arm, and other extensive districts of the body. Also, interruption of the normal routes of circulation through amputation, furnishes a condition favoring ulceration in the stump, especially, if the latter is the offspring of poor mechanical work. And cognate to the instances here cited are those of lost or impaired innervation, as seen in the palsied limbs of the hemiplegic subject from fracture of the spinal cord. Here a slight injury, or even continued pressure, can awaken a low form of inflammation ending in ulceration of the affected parts.

A general predisposition to ulceration exists in persons who have been the subjects of exposure, hunger, and overwork, through which the blood has been impoverished and the strength of the body greatly reduced. Examples of the kind the author had an opportunity of seeing, some years ago, in Costa Rica among the soldiers who had followed the Filibuster General Walker, in his attempted conquest of Nicaragua. After his defeat, a number of these soldiers were left for a time in the country in great destitution. They were emaciated, anæmic, bronzed in complexion, and, as prisoners, living on the smallest pittance which would sustain life. Many of them had wounds, caused in most cases, not by bullet or sabre, but by thorns which had torn the skin in their

march through the almost impassable forests of the tropics. The trailing vines which cling to shrub or tree are armed, as a rule, with sharp thorns; a prick from these, slightly wounding the skin of these men, had caused ulcers of a remarkable character. The surface of these was occupied by a pouting fungoid substance of a dirty yellowish color; and from this a discolored watery fluid was exuding. This spongy ulcerating mass, often some inches in breadth, rose considerably above the surrounding skin. It was painless, and resembled the pale exuberant masses which spring from an open encephaloid tumor. These cases showed how, under unusual circumstances, ulceration may deviate from its usual course; in fact, the ulcers might easily have been mistaken for malignant growths.

Ulceration can also arise from local causes, many of which permit of a mechanical interpretation. It may also proceed from some irritant of chemical or animal origin. Cases which can be explained mechanically are ulcers in the lower limbs. The veins here, during standing, are greatly swollen, and the blood in these tubes, in accordance with the law of hydrostatics, transmits its weight to the parts on and against which it rests. And pressure is increased by further widening of the vessels. The continued pressure lowers nutrition until ulceration commences, and the ulcer is only healed by treatment adapted to lessen or counteract the pressure.

Chemical agents which abstract water from the tissues, or which coagulate their albuminoid content, disturb the nutrition of parts and may cause ulceration. And this property when duly managed and regulated is often utilized for curative purposes by the physician and surgeon.

Ulceration may be caused by contact of some animal poison. Instances of this are seen in glanders and in the action of serpents' poison. And akin to this are the ecthymatous ulcers sometimes seen by the surgeon as the embarrassing attendant on some wound or operation, especially in operations on the neck of the scrofulous subject. The discharge from such ulcers infects the skin around, in which appear minute vesicular eruptions, which soon enlarge, pass into a purulent state, and then open, and the affected part remains as an extending ulcer, unless arrested by some local remedy.

Scars, from their low vital endowment, are disposed when wounded, or even slightly irritated, to inflame and ulcerate. The inherent quality of cicatricial tissue to contract, may proceed

to such an extent that from a slight cause a rupture of surface occurs in it, which remains as an unhealing ulcer; examples of this are seen in the scars from large burns.

Where the skin rests on a prominent ridge or crest of bone, and from the absence of subjacent soft structure it is the subject of pressure from within and exposed to violence from without, there we have a strong local predisposition to ulceration, and ulcers occurring at such points are very intractable to treatment.

6. *Mortification.*—The final and most fatal event which can proceed from inflammation is mortification or death of the affected structure. Gangrene, mortification and sphacelus, names nearly synonymous, are used to designate dissolution or death of tissue. Though some writers attempt differentiation of the early, advanced, or ending stages of the process by these several terms, yet their efforts to do so seem only to have obscured the subject. The English and American writers, as a rule, have preferred the terms gangrene and mortification, the latter having precedence; the French writers use the term gangrene.

Says John Hunter, "Inflammation often produces mortification or death in the part inflamed. This commonly takes place in old people that are very much debilitated, and chiefly in the lower extremities." And from Hunter to the present period most English and American writers, in treating of inflammation, mention mortification as one of its terminations.

Mortification presents itself in two forms, moist and dry. In the moist species the dead structure is saturated with ichorous fluid; this fluid consists of decomposed blood intermingled with the detritus of dead tissue. This humid form, as it is sometimes named, is seen in cases in which the death of the structure was rapid and had been preceded by swelling and local congestion. Examples of the moist form are seen in carbuncle, in the destructive action of the cattle poison, in the localized gangrene which sometimes attacks the fingers and hand, in scrotal sloughing, in the gangrenous form of syphilis and sloughing from erysipelas. A bandage improperly applied has fatally strangulated a limb and furnished a striking example of moist gangrene. In nearly all of the cases cited, there is present some inflammatory action through which there have been a profuse cell production and exudation of fluid within the affected part; this newly introduced material, by pressure on the vessels, interrupts circulation, when death soon ensues. Nutrition is prevented by excess of plastic or building material. The parts die surfeited by materials, which

under more favorable conditions might have been valuable elements of repair.

The dry form, as Hunter says, occurs in the old and feeble, and especially in those in whom the arteries are diseased through atheroma or calcification; and hence the parts supplied by them are imperfectly nourished. From its occurring chiefly in the aged, this species is named senile gangrene; and in the old it often commences from a slight injury of a toe. Contiguous to the part in which the mortification has begun, there will be found an abnormal condition of the structures; they are swollen, painful, and of a dusky red color. And this unusual condition seems to be an accompaniment of the advancing mortification, and in reality, to be the result of it. The district of dead structure awakens a low grade of inflammation in the parts adjoining, so that the gangrene is both cause and result of the inflammation. Certain French writers claim that the arteries being inflamed are the cause of senile gangrene.

In parts of Europe where rye is used as an article of food, and where formerly care was not taken to isolate spurred rye (ergot) from the sound grain, the rye flour thus adulterated caused, in persons of all ages, a mortification similar to senile gangrene. That ergot was the morbific cause was proven by experiments on animals. The picture of the disease as left us by eye-witnesses is deplorable; its subjects often made pilgrimages to distant shrines, where they unsuccessfully sought relief for their dying limbs, a relief which was found later at the shrine of Æsculapius. Intelligent medicine here, as in many other cases, plucked the mystery from the matter, found in food the cause of ergotism, as this form of mortification is called, and the peasant was taught to save his limbs by improving his bread.

There are many cases of mortification which arise from mechanical closure of the nutrient vessels by means of emboli or plugging clots. Instead of inflammation, thrombosis and embolism, as demonstratively shown by the studies of Virchow, must be regarded as the causal agency. In this way a small district, or an entire limb, may, by deprivation of circulating blood, quickly die from inanition.

Having considered the several terminations of inflammation, viz., resolution, adhesion, suppuration, ulceration, and mortification, there remain to be noticed certain anomalous endings which sometimes follow inflammation so closely that they must be considered as products of it. Under this head the simplest forms

which can be cited are the fibroid and keloid growths, which are often merely transformed scars, the product of a recent inflammation. And finally must be mentioned cases of carcinoma, in which, though the origin is recondite and obscure, still experience fully justifies the conclusion that there often exists the relation of cause and effect between inflammation and carcinoma. Examples confirmatory of this statement are familiar to those occupied with the treatment of malignant growths. It is seen in the malignant growths which arise in the mammary gland, the lip, the tongue, throat, and points of the alimentary canal, which are the sites of frequent irritation or slight inflammatory action.

Erysipelas.—After this review of the phenomena of inflammation, which was necessary for a proper comprehension of what follows, we return again to our original subject, and resume the study of the surgical diseases of the scalp. A form of inflammatory action frequently seen here is erysipelas, which we will now proceed to consider.

The name is from the Greek, and respecting its origin the etymologists disagree. One class claims that it is derived from *eruein*, to draw, and *pelas*, the skin; but a more probable derivation is from *eruthros*, red, and *pelas*, skin, literally meaning red skin. The disease is mentioned by Hippocrates in his book on "Epidemics," and he seeks for the cause of erysipelas in some state or constitution of the air, viz., at the beginning of spring, erysipelas arises from some accidental cause in very ordinary lesions and slight wounds, no matter where they may be located, and particularly in persons who are above sixty years of age, and the wound is in the head. In some cases the disease arises when treatment has been neglected, and in others it appears during some treatment. In the majority of cases, the disease ends in suppuration, and the muscles, tendons, and bones are destroyed on a large scale. The fluid which escapes does not resemble pus, but it is an ichor-like fluid.

Celsus states that in what the Greeks named erysipelas, there is "inflammation, redness, ulceration, and pain." "And this, which is named erysipelas, not only supervenes on a wound, but it can originate without a wound, and in each case it is very dangerous, especially, if it attack the neck or head." Celsus associates it with cancer and gangrene.

From the statements of Hippocrates and Celsus, it is clear that the ancients had observed a causal connection between wounds and erysipelas. That the connection was obscure and

involved in mystery, is evident from the circumstance that, at an early period, the disease was called *sacer ignis*, or the sacred fire. Cælius Aurelianus designated it by this name in his reference to it as an accompaniment of diseases of the throat.

Though these ancient references to erysipelas are historically interesting, yet they give us but vague notions of the affection, for in many particulars an accurate description of it must be sought for in the modern writer.

By erysipelas is meant a disease which manifests itself by general as well as by local symptoms. The general or constitutional manifestations are the initial ones. The first one is a severe chill, in which the muscles tremble, the teeth chatter, the entire body is irregularly shaken. Nausea, and finally vomiting of bilious matter, supervene. The pulse is hastened and irregular in action. The mouth is dry, the tongue is coated, and there is intense thirst. There is pain in the back, and a feeling of general fatigue. The temperature of the body is elevated three or four degrees. There is often delirium, usually of a mild character, sometimes amounting to merely a mental clouding. This delirium is less during the day than at night, and is oftenest present in erysipelas of the scalp. These general conditions continue from three to six hours, when a careful inspection of the body will discover in some parts of the body a larger or smaller district of redness in which coexist the additional characteristics of inflammation, viz., heat, pain, and tumefaction. The heat is sensible to the patient and the physician. The pain is slight, still it is always present, and assists in the detection of the disease, especially in the scalp, before there are any visible manifestations of it. Pain can often be awakened by pressure on the lymphatic glands, beneath or contiguous to the affected part; and thus pressure awakening pain in the glands enables the physician to herald the coming disease. Redness is modified by the natural tint of the skin; where this is very fair, the redness is more conspicuous, but where the skin is dark, the redness may be nearly absent. This is the case in the African and other colored races. And on the scalp the dark pigment of the hair roots may so disguise the surface that the hue of erysipelas can scarcely be perceived. The swelling depends on the nature of the tissues; where these are loose or lax, the swelling is greater; this is seen in the scrotum and eyelids, which swell enormously when the site of erysipelas. The swelling here is of the nature of œdema, and is due to the transudation of serum from the swollen vessels.

The enormous serous content present renders the part pale, rather than red.

Erysipelas may remain stationary, and then it is named *fixed;* and in this case the disease is confined to a limited part of the body, and is the most favorable form with which we have to deal. In another form the affection spreads and occupies a more extended surface, and from this circumstance it is named *migrating.* The affected part is always somewhat higher than the adjacent sound surface; and the transition from the higher to the lower surface is sudden and abrupt, so that it can readily be felt by the observer, and this bounding line or crest of the advancing erysipelas wave is sinuous or serpiginous in direction. This elevation of the affected parts may be taken as a measure of the grade or intensity of the disease, for the disease presents itself in varying degrees of violence from that which is mild to that which is severe. The mildest grade is limited to the superficial part of the skin, being merely a simple dermatitis; while the more severe form occupies the entire skin and subcutaneous structures; in the latter form there is much more swelling than in the former. The grade of violence is influenced by the constitutional characteristics and hygienic surroundings of the patient. The author has observed in the otherwise robust and healthy child, that erysipelas, though migrating, assumes the form of a mild dermatitis, in which, after the lapse of two or three days, the general health of the patient is not seriously deranged.

The disease occasionally runs a very irregular course. After migrating over a large surface, and the patient meanwhile being pleased with the hope that he has reached the end of his disease, the latter retraces its steps, and reoccupies the surface of regions over which it has just passed. And this reappearance may occur at isolated points, contemporaneously. In these acts of recurrence the disease is less violent than its primary invasion; the pain, swelling, and redness are less. In this recurrent form the disease may last for a number of weeks. In one case seen by the author, in which the disease attacked the head, and especially the region about one ear, the affection lasted some months, recurring, and again recurring a number of times. And in the latter part of the course, the patient suffered so little that he yielded with reluctance to hospital discipline. In an ordinary case unmarked by irregularities, the disease runs its course in a period varying from ten to fifteen days; then the concurrent concomitants vanish, the redness fades, the epidermis falls by piece-meal, and in parts cov-

ered by hair, the latter falls. The epidermal detachment is due to a serous exudation in the meshes of the true skin; and Volkmann finds such exudation most abundant in the lower stratum of the cutis. The hair may not fall in mild cases, yet in severe ones it does, and this is caused, as Haight has shown, by the exudation of serum between the roots of the hair and its containing sheath. Again, where the disease attains to a high grade of intensity, the exudation is so profuse that the epidermis is uplifted by the fluid in a manner resembling the action of a vesicant. And in cases of the greatest severity, the disease forsakes its accustomed bounds, the inflammation then terminates in extensive suppuration, which may be in isolated foci; or there may be phlegmonous destruction, in which there may be structural death on a large scale.

From the earliest times, as already mentioned, erysipelas was thought to have a dual origin, viz., from a wound often slight in character, and from some epidemic influence or peculiar constitution of the air. This notion of its connection with some peculiar state of the air, which is held by many cotemporaries, originated with Hippocrates, who sought for the origin of many diseases from some state of the atmosphere. The obscurity in which the matter was veiled in the terms constitution and epidemic influence, was not materially lessened by the substitution of miasm, by which the occult agency has been designated, especially by the French in modern times. But the miasmatic agent, hitherto an intangible entity, has lately assumed more definite shape in a microbe discovered and announced in 1884–85 by Fehleisen, a German, and which, it is claimed, is the veritable cause of erysipelas.

The parasitic origin of erysipelas announced in Germany, was studied by Denucé, in Paris, in 1886. In nineteen cases of the disease, Denucé found the erysipelas coccus of Fehleisen in the diseased tissue subjected to examination; and besides this microbe, Denucé found others in two cases. From the microbe of Fehleisen he made cultures with which he inoculated animals, viz., dogs and rabbits, and erysipelas was developed in them. Denucé did not try to inoculate in man, though Fehleisen did in seven cases, and Janicke did it in one man. Where the erysipelas is phlegmonous in character, besides the coccus mentioned, Denucé found the staphlococcus aureus. The parasitic origin of erysipelas was accepted by Verneuil and others in 1885. Verneuil thinks the microbe retains its vitality, even if situated in the hair, ear pas-

sages, mucous membrane of the nose, throat, or that of the bowels. And situated at any of these points it readily enters a breach of the surface and develops the disease. In this way, Verneuil explains the disposition to relapse and recurrence after subsidence of the disease. The microbe commonly remains in the tissue, where it can be found for three or four days, yet this period may be greater and reach even to fourteen days.

The parasitic origin of erysipelas explains the ready transition of the disease from place to place, viz., the passage of the affection from the skin to the mucous surfaces, and reversely. Thus it has been seen to pass into the rectum and thence up to the colon, and also to enter the urethra and travel to the bladder, and, finally, in the puerperal patient it may attack the vagina and uterus. It may pass from the pharynx to the middle ear, and from the external ear it may migrate to the tympanum and there awaken sounds subjectively. A physician once thus affected, told me that he heard the "singing of a thousand grasshoppers." The disease may pass from the eyelids to the bulb and there attack the cornea and iris; it may detach the retina and induce atrophy of the choroid tunic and optic nerve. In the days when sepsis trod quickly in the footsteps of the surgeon, I witnessed the removal of a tumor from near the eye; an erysipelas supervened, which attacked the structures of the adjacent eye, and, in a few days, permanently destroyed vision.

Both Fehleisen and Denucé failed to find the microbe in the capillaries, except in those of the lungs and kidneys. The kidneys eliminate the parasites through the urine, and these organs may become diseased in this way.

This history of the mode of migration of erysipelas, or its irregularities in progress and regress, in which it marches and counter-marches, strongly supports, even without the aid of the microscope, the theory of microphytic origin; for the phenomena are those which might be caused by the purposeless and erratic movements of an independent organism.

Ponfick, in his studies of erysipelas in 1867, announced that he found the inner lining of the blood vessels affected, and from this originate the thrombi and emboli found in the vessels.

Few physicians and still fewer surgeons deny that the causal agent requires a wound or breach through which it can gain admission into the human organism. Accurate search rarely fails to find such a breach, though sometimes it may be so minute as to elude discovery. Certain sites and conditions of those sites

favor erysipelatous development, for example, it commences most often at the angle of the mouth, angle of the nose, and angle of the eye, also in the hair-covered scalp. At the corners of the mouth, nose, and eye, a condition favoring development is that at these transition points from derm to mucous membrane, lesion from mechanical or chemical cause often occurs, and this may be a mere fissure or slight abrasion. This is irritated and inflamed by the decomposing detritus from the adjacent outlet. The conditions of the scalp, studded as it is with glands and hair roots, which are the centers of exuberant organization and disorganization, are qualities favoring erysipelas. The virulent microbe transplanted in any of the parts mentioned, finds ample field for its nutrition and multiplication.

Wounds with certain peculiarities favor the evolution of erysipelas; among such are wounds which have continued for some time, and which are nearly healed. After an amputation in which ligatures are left hanging from the wound, as was the former custom, erysipelas sometimes appeared around the fistulous opening. And the same is the case with the metallic suture employed to secure union in pseudarthrosis, for in the wound around the wire, if it be left projecting, the disease is wont to appear in the recurrent form. Wounds made for plastic purposes when nearly healed, and the site of slight suppuration, may become attacked with the disease. The silken sutures used for the closure of superficial wounds, if not removed early, often become points of erysipelatous infection. Any small wound, whether from suture or other traumatic cause, especially on the head and face, which, while healing by suppuration, becomes covered by a crust or scab impeding the exit of pus, is often the starting point of erysipelas; and the early detachment of the scab and careful removal of the pus will prevent the development. And besides those of traumatic origin, any ulcerating wound, whether of tubercular, scrofulous, syphilitic or vaccine origin, if the exit of pus be prevented by dried pus, or an impervious dressing, an erysipelas can easily arise there. And most favorable conditions for the evolution of the disease exist in the scrofulous, tubercular or syphilitic subject, in whom dead bone is being detached, and where an existing outlet for the necrosed material is suddenly closed. This is often seen in the necrosis of the frontal and nasal bones in tertiary syphilis.

From the several cases cited the induction follows that erysipelas tends to appear at some wounded point in which an inflam-

mation has not a free outlet for its purulent product; and these conditions are more favorable in a small, than in a large wound, since the extent of the latter guarantees the escape of pus.

As a rule, the diagnosis of erysipelas is readily made; the incipient chills, gastric derangement, increase of heat, dry tongue, and intense thirst, and redness commencing at some point and traveling thence continuously, are unmistakable marks by which erysipelas announces its presence. With these there is commonly associated some trivial lesion, the point of departure of the dermal affection; exceptionally the starting-point may be from the border of some large open wound, in which the escaping purulent matter drying prevents the escape of pus. The migratory tendency of the redness distinguishes it from a counterfeit form of the disease, in which redness due to a subjacent collection of pus is stationary, and instead of ending at an abrupt border, it fades insensibly into the color of the surrounding parts. A neglect to note these characteristics, or ignorance of their significance, has led the unwary practitioner to accept and treat a case for genuine erysipelas, which was merely a counterfeit form of the disease.

The prognosis of erysipelas is favorable: few among the physicians of the younger generation have seen deaths from it, and this arises from the improved hygienic conditions which surround the sick, whether rich or poor, learned or unlearned, soldier or civilian. But where the opposite conditions exist, as prevailed in the boasted past, in which the patient was the subject of filth, foul air, and vitiated food, then the disease assumes a graver form; and instead of recovery with slight epidermal exfoliation, the affected structures, particularly the subcutaneous tissues, are destroyed on a large scale, and death often occurs from pyæmia, or general exhaustion. And if regions be compared as to their relative peril when the site of erysipelas, the danger is greatest when the disease penetrates deeply into the orbit; also when it attacks the deeper structures of the throat; in such cases, despite the best sanitary surroundings and ablest treatment, death commonly claims the victim.

Treatment.—As erysipelas is a dual compound of general and local morbid conditions, so the treatment must have two objects in view; and hence the remedies used must embrace both general and local means. Inasmuch as the local symptoms are more conspicuous than the constitutional manifestations, so the former have absorbed chief attention from both writer and physician; and this has proved of detriment to the patient.

The strength or weakness of the patient should be carefully considered, and the treatment made to conform to the conditions found. The weak subject should be sustained by nourishing food, and by tonic and stimulant remedies. Meats and their extracts, wines, and alcoholic stimulants are likewise indicated. Where the debility is extreme, tea or coffee mingled with brandy should be given. While the nutrition is thus being admitted through the upper portion of the alimentary canal, the lower part must be relieved of its excremental accumulations by simple enemata: but in the strong, in whom there is an amplitude or excess of the vital forces, then the treatment may be more energetic.

Some excellent surgical authorities, as Gosselin, in cases of plethora, favor bleeding. The author would prefer indirect depletion through the great excremental routes of the skin, kidneys and bowels, through the use of sudorific, diuretic, and purgative agents. As purgative, Dr. Rush's combination of calomel and jalap, ten grains each, has no superior. And if there is nausea and much gastric disturbance, an emetic of ipecacuanha should be administered. Besides emptying the stomach of its catarrhal content, the mechanical action of vomiting has been proven by experience to combat the tendency to pyæmic development. To reduce the fever an antipyretic may be given; and for this, for two days in succession, ten grains of quinine may be given twice daily; this agent does double duty as antipyretic and germicide. In the debilitated subject, quinine may be seconded by some form of iron, as the chloride or acetate, given in minimum doses. The large doses sometimes thoughtlessly given, of both iron and quinine, are a reckless perversion of medicine; and whether in this or other kindred ailments, instead of opponents, they become allies of disease. They are like valueless freight taken aboard of a vessel already well laden, which is on the eve of a hazardous voyage.

The remedies which, from time to time, have been heralded with praise for the cure of the disease have accumulated to so great a list that the inexperienced beginner in medicine is certain that nothing will be easier than to cure a case of erysipelas. But to his chagrin he soon discovers that the law in force, that numbers carry strength, does not hold true here; and in time he learns that the opposite canon obtains, viz., the multitude of medicines advised is a certain exponent of their inefficiency and uncertainty. An attempt to collect the local remedies in groups offers the following classification:—

1. *Those Which Are Absolutely Inert.*—Among these may be mentioned starch, flour, the seeds of lycopodium, also the bland ointments, as Unguentum Cetacei, Ceratum simplex, Oleum Amygdalæ, Adeps, and, lastly, water. These remedies do not limit the extension of the disease, yet they have considerable virtue in allaying the itching and burning of the affected skin. The desiccating powders mentioned are of less value than the unguents. The hpdropathist claims much for his panacea locally used. The remedies of this list, though inert, have the virtue of being harmless.

2. *Agents Which Constrict.*—As such are collodion and the properly adjusted constricting bandage. Collodion has been used and praised by Brainard, Cooper, and other American surgeons. Its constrictive power, when collodion is applied and let dry on the affected parts and surfaces bounding the latter, lessens the supply of blood to the part, and this combats the leading element in the inflammation. This action reduces the erysipelas to a low grade; and thus it controls, but it does not remove, the disease. In a child the subject of the disease, though collodion was applied by the author with watchful diligence, still the disease was only ameliorated; and it passed from the head to the feet, and would plainly have proceeded further had there been room for extension. The constricting bandage, where the parts admit of its use, acts in a similar and more effectual manner than collodion; but, like collodion, as every practical surgeon has witnessed, it lessens but does not arrest the progress of the disease; the eruption glides onwards beneath the bandage.

3. *Astringents.*—Under this head may be mentioned alum, acetate of lead, and the sulphate and chloride of iron. These medicines when dissolved in water and applied to the affected parts represent, in a slight degree, the part of mechanical constringents, and in their action, lessen the afflux of blood. According to the writer's experience, if these weapons be permitted to rest in their armory, the patient will suffer no loss; for they exercise no curative action against erysipelas.

4. *Disintegrants.*—Examples of these are the preparations of iodine and mercury, of which the action is to cause molecular solution of the animal tissues. And the property of disintegration explains their beneficial action in other diseases. In the medical mind hitherto no article of faith has been more firmly rooted than that iodine is a remedy against erysipelas. But an

extended series of trials in which iodine was tried and found to have no remedial agency, led the author long ago to abandon its use externally in erysipelas. It burns, irritates, vesicates, and discolors the skin; meantime, the disease, undiminished by this action, moves onwards. Mercury applied in the form of ointment has no more efficacy than iodine, and brings along the additional peril of salivating the patient. Hence the group of disintegrants may well be dropped in the treatment of erysipelas.

5. *Escharotics.*—Of these the nitrate of silver has been much used, applied in solution, or in full strength. The immediate action is to form a superficial eschar on the skin. The observation that such action does not arrest the disease in the least degree, soon led to the abandonment of nitrate of silver, especially when it was found that the treatment entailed a discoloration of the skin which lasted much longer than the disease.

6. *Vesication.*—Somewhat akin to escharotic treatment is that by cantharidal vesication. When Dupuytren held reign in the surgical world, his advocacy of blistering in erysipelas, rendered the method generally popular. Blisters were directly applied on the affected parts. But experience, than which nothing aids more in the art of healing,* did not confirm what was proclaimed of vesication; and to-day the blister is almost forgotten.

7. *Scarification.*—A new mode of treatment was announced a few years ago by Schützenberger of Strassburg, of a more heroic character than most of those already mentioned; this consists in making slight scarifications of the affected surface. For this purpose slight cuts parallel to each other are made with intervening intervals of about a quarter of an inch. The surface is slightly rubbed so as to promote the escape of blood from the incisions; and this blood is to be spread over the surface and allowed to dry as a slightly protective film. In this way the introducer of this treatment claims that the surface is covered, and the inflammation lessened by the withdrawal of blood. Like other plans of treatment, this one seems to have done more for its inventor than for any one else; it has been abandoned except in cases in which the inflammation assumes a high grade, and destruction of the parts is threatened; in such, impending gangrene may be averted by emptying the capillaries in which the blood has ceased to move.

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* Celsus.

8. *Superficial Germicidal Treatment.*—Agents for this purpose are turpentine, alcohol, carbolic acid, and others of the antiseptic list, which has so increased during the last few years. Turpentine has especially been praised by Lücke, who, having mixed it with oil, covers the surface with it. Trials of this agent made by the author have not given very satisfactory results. Its disposition to spread and diffuse itself on the surface, renders its use difficult near the eye, ear, nose, or mouth. But as these agents only penetrate the surface very superficially, it is evident that as germicides they can have but an imperfect action; to be effective they must be used as described in the following paragraph:—

9. *Parenchymatous Germicidal Treatment.*—Germicidal remedies injected into the tissues in front of the advancing erysipelas will arrest its progress. This has been verified by the author in two cases, in one of which the agent used was a three per cent solution of carbolic acid, and in the other the compound tincture of iodine was employed. The work was done cautiously, only a small quantity of the remedies being injected. The result obtained was that in no case did the disease travel through the structures thus treated. Yet through the intermediate uninjected portions the disease untrammeled continued its normal course. From the experience of the writer he is convinced that where the disease is limited to a small space, by the injection of some germicidal agent around it at short distances, the disease might be effectually isolated and extinguished. The amount to be injected, for example, of the tincture of iodine, should be from one to two drops of the ordinary Pravaz hypodermic syringe. If this amount be not exceeded, then the injecting may be done at numerous points. Thus done at an early stage the disease may be completely circumvallated and caused to expire through isolation.

Herewith is concluded an epitomized summary of the various modes of treatment employed against erysipelas. Nearly all of them bring some relief and ameliorate the patient's condition; but in none is the hope of a cure realized except by the subdermal method last given. But when the disease has already full mastery of the field by having occupied a large surface, even this plan could not safely be pursued; then we should select some inert agent for local use, such as almond oil, simple cerate, or a desiccating powder. Besides this, the general condition of the patient must be attentively considered; and according as exuberant strength or debility is present, or, as the old Methodists would put it, according as constriction or laxity predominates, so should the constitutional medication be shapen.

CHAPTER III.

WOUNDS OF THE SCALP.

WOUNDS of the scalp next claim attention, but before considering them it is well to study the general characteristics of wounds. The wound gave birth to surgery, of which the nascent field was furnished by war. Where violence ran riot, and the soil drank and became enriched with libations of human blood, there grew the seminal germs of surgery close beside the equally precious ones of civil and religious liberty. The growth was slow, very slow, like all things, which, through inherent value, endure. The observation of wounds, and some knowledge of their treatment, antedate all written record. Machaon and Podalirius treated wounds before the deeds of olden times were sung in epic verse, and Homeric hexameter, long before Hippocrates, tells us that a physician is worth a legion of common men.

The ancients assigned a place to Æsculapius among the Olympian Celestials, thus giving medicine its representative in the divine hierarchy, and this honor was probably assigned to Æsculapius on account of his treatment of wounds, for it was only to these that his sons above mentioned gave attention. Wounds and diseases held places widely asunder in the mind of early antiquity. Diseases were then regarded as penal entities, sent by some offended god on a mission of vengeance, and this need not lessen our estimate of the intellect of olden times when we recall what absolute ignorance then obtained in regard to the cause and nature of maladies which were intrenched deep within the invisible regions of the body. Coming from the unknown, and going to the unknown after it had destroyed, or perhaps left no footprint on its subject, disease easily became an object of awe and religious fear, and for relief it was natural that the remedy was sought in some appeasing sacrifice. In this matter the hand of cunning priesthood is too plainly discernible.

The origin of the wound was involved in no such uncertainty; its causal agency was plainly apparent, since it could be traced to

man himself, or to some violent natural force. The division of the healing art into Surgery and Internal Medicine was most natural, since such division was founded in the marked contrast between the wound and disease, the one telling its own story plainly, while the other concealed its story in mute mystery. Bleeding and gaping, the leading features of the wound, were manifest and unmistakable, and needed no interpreter; but internal disease, in order to be divested of its abstruse obscurity and to have complete interpretation, required all past time and much of the future. Disease in its recondite complexities has challenged and exhausted the efforts of the best intellect; the wound is known and comprehended by the unthinking child. Over twenty centuries has been occupied in reaching a treatment of wounds which is now nearly perfect. The day is yet remote when the same will be reached in Internal Medicine.

John Hunter, in some philosophic lines, seeks to present the difference between disease and wounds. His language, a model of clearness and directness when he details his remarkable experiments, becomes complex and obscure when he attempts to formulate principles in deductive method; this is apparent when he says: "I may observe that all alterations in the natural dispositions of a body are the result either of injury or disease, and that all deviations from its natural actions arise from a new disposition being formed. Injury is commonly simple; disease is more complicated. The dispositions arising from these are of three kinds; the first is the disposition of restoration in consequence of some immediate mischief, and is the most simple. The second is the disposition arising from necessity, as, for instance, that which produces the action of thickening parts, of ulceration, etc. This is a little more complicated than the former, as it may arise both from accident and disease, and therefore becomes a compound of the two. The third is the disposition in consequence of disease, which is more complicated than either, as diseases are infinite.

A disease is a wrong action of the living parts; the restoration to health must first consist in stopping the diseased dispositions and actions, and then in a retrograde motion towards health. The operations of restorations arise naturally out of the accident itself, for when there is only a mechanical alteration in the structure, the stimulus of imperfection taking place immediately, calls forth the actions of restoration. But this is contrary to what happens in disease, for disease is a disposition producing a wrong action, and it must continue this wrong action till the disposition is stopped, or wears itself out."

As a distinction between the two, the following is offered: Disease involves a large part, or the whole of the body; a wound is primarily local, and it may remain so, or it can become a starting point for general diseased action. In both the wound and disease there is a spontaneous effort towards restoration to previous integrity; unaided nature will often accomplish this work, but that desirable end is greatly insured by the coöperation of intelligent art. Nature here may be compared to a blind workman, who often needs a hand to guide him. With pain one often sees in the retrospective history of medicine that the guiding hand was also blind.

The modern definition of a wound is a *solution of continuity*, a sonorous pedantic phrase to ears unaccustomed to it, but through use it has lost much of that quality. Stripped of a part of its Latin dress, with which classic language has invested it, the wound might be more plainly defined to be a breach of structure caused by some external violence; in a few exceptions the violence may be caused by muscular action within the body. The wound is open or closed according as the skin is ruptured or not. And this condition of being open or closed figures greatly in the gravity of the wound; in fact, its future destiny depends on this circumstance, the closed wound pursuing a painless course towards recovery, unless, as sometimes occurs, the closed wound becomes changed to an open one.

Wounds may be classified as incised, lacerated, contused, punctured, and those caused by gunshot and other projected missiles. The burn, though not classified among wounds, is nearly allied to them; for modern physics reckons heat to be a form of rapid motion in the thing heated.

Incised Wounds.—These are produced by the blow or contact of some instrument having a sharp edge; and variety in wounds is determined by the sharpness or bluntness of the cutting edge. If the edge of a cutting instrument be examined microscopically, it will be found to be notched or serrated; and under a highly magnifying power, it is very irregular; the edge of the sharpest instrument appears to be unevenly notched. Now if the instrument have a fine edge, the margins of the resulting wound will be sharply angular; but the margins are blunter and more irregular, according to the dullness of the instrument. These minute points, though seemingly unimportant minutiæ, are not so, since they have a practical bearing on the healing of the wound. For time is saved, pain lessened, and scarring diminished in propor-

tion to the sharpness of the instrument making the incision. And especially is this the case when the wound assumes the cleft or flap form; for such flap when only connected to the rest of the body by a small pedicle, lives or dies, according to the sharpness or dullness of the instrument causing it. The thin, sharp blade, free from foreign material, and moving rapidly, inflicts a wound which, though on a large scale, soon heals. Such an instrument merely separates the tissues, and but slightly injures their molecular integrity. No particles of structure destroyed at the time, or afterwards dying, are present to interfere with immediate agglutination. Milton's fertile fancy had a conception of such traumatic characteristics in wounds in those given and received by the combatants in the celestial battle which he has depicted.

The instrument of dull edge lacerates; and besides, fatally injuring some elements, it displaces others, so that exact coaptation of corresponding parts is impossible. But in cases in which the wound has smooth surfaces, kindred or similar elements can again be joined, and immediate healing secured. By her varying action in these different conditions, nature gives an intelligible wink to the surgeon for guidance in his cutting operations; his instruments should be as sharp as sharp can be, and when used they should move hastingly and thoughtfully, not restingly and loiteringly in their work. Thus operating, the surgeon conforms to the three rules of the classic trilogy, *tuto, cito et jucunde;* his cunning knife almost effaces its own pathway, or only insignificant stigmata remain to mark it. The cry* of the bistoury as it traverses the scalp announces a dull instrument rather than unusual density of structure.

The form and minute characteristics of wounds sometimes become the matters of study in Forensic Medicine, inasmuch as they have a bearing in criminal investigation in which it is sought to determine whether the wound was self-inflicted, or done by another's hand, or was the result of accident. In case of the purely incised wound, its location and direction will usually determine whether it was self-inflicted or not. But in case the wound has irregular edges, the question sometimes arises, By what instrument was it caused? was it a knife, club or missile? or did it originate in a fall against a body having a sharp projection or cutting border? A solution of these problems is frequently the unenviable task of legal medicine. Few eyes see and few ears

* Richet.

hear all that they might, through discipline, learn to see and hear. But an eye trained and skilled to detect exact outline, and, if need be, aided by the microscope, will be able to satisfactorily solve the problem here referred to.

The cardinal conditions which are present in structures the site of an incised wound are *opening, bleeding, and pain;* as inflammation is sketched by four lines, named the Celsian quadrangle, so the gaping breach, the escaping blood, and the pain awakened, represent what may be named the traumatic triangle. The surgeon's care in the treatment of the incised wound is comprised in attention to each of these parts.

The opening is due to lesion of muscular tissue. Both striated and non-striated muscular structure contracts when it is wounded; and hence, when severed, each part retracts and leaves an intervening gap. This phenomenon of retraction is doubtless due to reflex influence emanating from the lesion of peripheral nerves. The central ending of nerves has been diligently studied; who knows but that their peripheral terminations may have quite as important functions? Besides this, it is probable that the containing tegument of the animal body is normally in a state of contracted tension. Thus change of volume of the parts contained within is permitted. Valentin, the Swiss physiologist, by a series of experiments many years ago, determined this extensile property of the animal tissues, and especially of the skin. Hyrtl has made some similar ones with the peritoneum, in which the resisting power and strength of this membrane were tested. Farabeuf in his work on ligations and amputations has made some valuable contributions on this subject. In the mechanical calculations which should precede and accompany all operative surgical work, the extensile and retractile property of the parts operated on must be taken carefully into the account; ignorance or neglect of this matter is a common cause of faulty result. From inattention to the influence of these inherent properties of the animal structures, a beautiful piece of plastic surgery has often perished and proved a bitter disappointment to both patient and operator. And in no case is neglect of the retractile property of tissues attended with more unfortunate results than in the work of amputation; thence can result the painful and conical stump, an ill requital for the perils which the patient assumes. At risk of life, a useless limb has been exchanged for a useless fragment of one; and all this is due to the fact that the surgeon forgot the simplest and most familiar fact of daily experience.

viz., that the incised wound opens, its lips being pulled asunder by the inherent retractility of the tissues. And in the case of the flap wound, or where the subjacent connecting tissue is so loose as to easily permit displacement, then the flap or loosened structure, as experiment and observation have verified, retracts one-third its length. Retractility should also receive proper attention in the work of closing open wounds which penetrate deeply. If the closure be merely superficial, then there will remain underneath open spaces (dead room), in which traumatic excreta may be imprisoned, act as poison, and delay the healing.

The second important result of an incised wound is hæmorrhage, which may be slight or profuse, according to the vessels which are wounded. The vessels opened are arteries, veins, and lymphatics. The lymph vessels require no surgical attention; the arteries demand prompt and thoughtful care, and so do the veins when those of large caliber are wounded. And here the character of the cutting instrument performs an important part; the sharper the edge the more profuse is the bleeding, but the dull blade contuses the opened vessels, and thus arrest of hæmorrhage is favored, for here partial torsion is caused. The jetting of arterial blood distinguishes it from the purling flow from the wounded vein; the crimson blood from the artery distinguishes it from the darker blood of the vein. But where the heart and lungs are acting feebly, these differences are less, the arterial blood scarcely bounds from the wound, and from imperfect pulmonary action it is of dark hue. And though in checking bleeding the wounded arteries should receive the first attention, yet the wounded veins should not be neglected, since the blood escaping proximally and peripherally from the vein can equal that escaping only proximally from the artery. The slow oozing of venous blood may mislead as to the quantity lost. The experience of the practical surgeon soon teaches him not to neglect such bleeding, for the vein doing its work at tortoise pace, often outstrips the leaping artery in fatal hæmorrhage.

In several parts of the body, the direction of the incised wound has an important bearing on the quantity of blood lost. As a rule, vessels, and it may be added nerves too, lie in intermuscular interstices, and parallel to the adjacent muscles. This is especially true in the limbs, in which the course of the muscles and nerves corresponds to the long axis of the limbs. The most of the vessels that lie in the superficial structures of the head and neck lie in lines converging towards the summit. The conse-

quence of such anatomical disposition is that on the limbs and head transverse cuts wound more vessels than do longitudinal wounds. By utilizing these facts, long incisions may be made on the limbs, and head, and neck, with but moderate loss of blood. It is only from the practice of continually dissecting that this guiding knowledge is retained; thus, and only thus, the scalpel becomes an intelligent instrument and ceases to wander from conservative lines.

The side of the traumatic triangle which remains to be considered is pain. This depends on lesion of nerves which lie in the track of the incising agent. The pain of the wound is most acute in those parts which are abundantly supplied with nerves. Examples are the labial and anal structures, those of the outlets of the genito-urinary organs, the integument of the fingers and toes, the mucous membrane of the nose and of the eyelids, and the structure of the auditory meatus. In the parts enumerated, incised or other wounds are very painful, even careless manipulation in which no lesion is produced, causes pain. Wounds in the dorsal region of the trunk are less painful than those of the anterior surface; in fact, every surgeon has frequently seen with what stoical composure extensive incised wounds on the back are borne, for example, such as are made for the removal of fatty tumors, in patients who decline an anæsthetic. As a rule, wounds of the surface of the body are more painful than those made in parts deep seated. In the evolution of the animal body, nature, in her conservative work, has placed pain as a faithful sentry at every outpost of the living organism, and where danger oftenest menaces, this sentry, though usually slumbering, is easily awakened to duty. It has been found that transverse wounds in dividing many vessels cause much bleeding; for like reason, through the division of many nerve filaments, they cause much pain. These facts may be advantageously used in operating. In the removal of tumors and similar work, if the first incision be made on the proximal side nearest the heart, then subsequent incisions will cause but slight hæmorrhage; thus proceeding the surgeon economizes blood, and also pain, if the patient be conscious.

The incised wound, except when made by the surgeon's knife, is less often seen in the scalp than in the extremities and trunk. From the dense structure of the scalp favoring laceration with abrupt edges, a wound similar to the incised one may arise from a fall, or blow of a blunt instrument.

Preparatory to the treatment of incised or other wounds of the scalp, the usual custom (though not always necessary) is first to remove the hair around, and if this be done by shaving, care must afterwards be taken to wash off all fragments of hair; this being done, attention must first be directed to controlling the hemorrhage. This is accomplished in most cases by catching and pinching, or by pinching and twisting the wounded vessel. Both arteries and veins are to be treated in this way, though as a rule, the wounded veins here cease to bleed spontaneously. It is often requisite to patiently repeat the compressive pinching. Where torsion must be combined with the pinching, then a slight circumscribing incision must be made around the end of the vessel so that it can be seized by the twisting instrument. The common small forceps may be used for this work. Should this modified torsion fail to arrest the bleeding, then the ligature in some form must be resorted to. The author prefers alcoholized silk, made by immersing strong silken thread in a fifty per cent solution of alcohol. A few hours of immersion serves to make the silk free from irritating qualities. Retention in the diluted alcohol will preserve the thread aseptic and ready for immediate use. Immersion of the silk in a five per cent solution of carbolic acid will serve the same purpose as alcohol, yet the carbolized silk is more irritating. In the use of the ligature in the scalp, the peculiar relation of the artery to the parts in which it is lodged, must be attended to. The vessel is so adherent to the fibro-adipose structure, that when severed it can neither contract nor retract, as is its wonted act when wounded. In a wound of smooth surface the opened artery continues to bleed much longer than a wounded vessel of similar caliber elsewhere would bleed. And these anatomical conditions render accurate ligation very difficult, and before it can be ligated, the artery must be made accessible. This is done by isolating the vessel by slight incisions made around it, whereupon the ligation can be done. Instead of the ligature, Tillaux prefers compression to arrest the bleeding in wounds of the scalp; this is to be done by means of a properly-compressing bandage. Doubtless a bandage applied by an experienced hand might do the work, yet such continuous pressure soon becomes irksome to the patient.

Another mode to check bleeding, which has often been successfully employed by the writer, is that in which the efferent vessel is tied in mass, or by what is known as percutaneous circumscription. For this purpose a well-curved needle, armed with

a strong, aseptic, silken thread, is caused to traverse the tissues and pass underneath the vessel; next, a small compress formed of folded paper is laid over the vessel, and the circumscribing thread is next tied tightly on the paper compress. This circumscribing ligature should be removed at the end of forty-eight hours; if allowed to remain longer, it can cause suppuration. The thread should be removed with care lest the included vessel be disturbed and caused to bleed. This circumscriptive compression is best adapted to controlling hæmorrhage in wounds of the temporal artery, and here it may be necessary to do it on both the hither and distal sides of the wound. Besides these methods, bleeding may be arrested coincidently with the work of closing the wounded scalp. To do this, let the sutures so transfix the lips of the wound near the vessel that when the sutures are tied, they will compress and close the wound. In no structure is this plan so readily followed as in the scalp, since the arteries there lie in the skin. Where the vessels are situated deeper, this method, to be successful, requires deep sutures, for superficial and even deep sutures inaccurately used for this purpose would allow the blood to escape within the tissues. Some years ago there was reported a case of death from this cause. In the removal of an angioma from the scalp of a child, though the wound was closed, yet hæmorrhage continued subcutaneously, the blood entering the loose space between the scalp and the pericranium, and was only arrested by the attachments of the occipito-frontalis muscle. This can more readily occur in the child's scalp than in that of the adult, since the former is less closely fastened to the skull.

The hæmorrhage having been controlled, should there be much pain, an anodyne may be given; as a rule, this will not be required, yet should it be, then morphia in doses from a quarter to a third of a grain may be given an adult every four hours until the pain is relieved.

Before the closure of the wound, this must be carefully cleansed; this work is done by irrigating with a continuous stream of water which has been boiled. Another agent for irrigating is a solution of corrosive sublimate, viz., one part of the salt to two thousand of water; or, in the absence of this, a twenty-five per cent solution of alcohol may be used. All clots which loiteringly cling to the wound should be removed.

The work of cleansing being thus done, the wound is to be closed, and this may be effected by adhesive plaster, suture or by

tying the unshaven hair across the wound. The old method of shaving off the hair for some distance around the wound, and then approximating the lips by adhesive plaster, may be characterized as very *unsurgical*, and has become nearly obsolete. The re-growing hair soon lifts the plaster so that it stands bridge-like over the widening gap beneath. Until recent years the scalp was intangible to the suture. For in the teaching and practice of fifty years ago the suture was allowed no place in the treatment of the wounds of the scalp. This doctrine was firmly planted in the student's mind as a truism intended to remain there undisturbed by question or criticism, and rightly, too, for its violation was followed by certain punishment in the form of an erysipelatous inflammation, which started at, and proceeded from, the points of suture. A disease was thus awakened which in gravity far outweighed the simple wound of the scalp. For in the olden days which antedate the antiseptic reformation, the needle and its following thread often became instruments of virulent inoculation. Infecting elements abound in the scalp. It is an excellent lurking place for parasites; the civilized man has eliminated those visible to his eye, but those of microscopic minuteness are not so easily banished, for the epidermal and furfuraceous elements, decomposing sebaceous matter and the retained excreta of the hair follicles are admirable habitats for morbific microphytes. The suturing needle opened the way and the following thread drew and lodged these elements of disease within the canal, where they multiplied. Some were probably contained within the meshes of the thread, so that when the field is viewed with the light of modern knowledge, it is a wonder that erysipelas did not develop in every wound of the hair-clad scalp. But since Lister has taught surgeons cleanliness and given them germicidal weapons, the scalp tolerates the suture as well as other parts. The old rule may be fearlessly disobeyed, or perhaps expunged from the surgical code. But in doing so, both scalp and suture must be freed from every species of infecting material.

The best suture is metallic, which may be of silver or of copper which has been heavily plated or gilded. Copper wire, from its strength and flexibility, is an excellent material for suture. This wire should be washed in dilute alcohol; the sublimated solution is unsuited, since it will tarnish the wire. Chloroform may be used for the disinfection of the suture, as the author has verified in his experience. A well-curved needle should be chosen, and its flattened end not so sharp as to cut the fingers which use it.

The wire passed an inch through the eye should be squarely bent over the head of the needle, and so twisted as to form a uniform thread. Thus arranged, the needle and wire can enter a quarter of an inch from the edge of the wound, and pass through the lower part of the fibro-adipose stratum and emerge at the same distance from the wound on the other side. The wire may now be cut with ordinary scissors, so that one end, an inch long, will remain on each side of the wound. These ends may next be united by twisting, and this twisting should be done, not over, but on one side of the wound. The twisting may also be done before the wire has been cut, and in this way the wire may be used more economically. The work of suturing should be commenced at one end and proceed thence to the other. The stitches should be about three-quarters of an inch asunder. And should the coaptation be incomplete at any point, a superficial suture may be introduced there. In some cases it is more convenient to introduce the first stitch at the middle of the wound, and to proceed thence to each end. Where the parts have been well cleansed, one need not shave the hair; but then care must be taken not to include the hair in the lips of the wound.

The projecting ends of the metallic sutures should be bent down; and to prevent their being entangled in the superjacent dressing, the author advises to ensheath the ends in a piece of drainage tube of small caliber. The closure being completed to this stage, some dressing is next to be applied. A good one is lint saturated with compound tincture of benzoin, known also as Friar's balsam in former times, when the priest was the minister of both religion and medicine to his people. By this dressing the wound is hermetically occluded and excluded from the air, with the result that it inflames in but a minimum degree, and a union almost scarless is often obtained. At the end of two days the metallic suture should be removed, and if there be some retractile tension of the sutured parts, the removal may be postponed a day or two longer. In the withdrawal of the suture, some care is required not to reopen the wound. The benzoated lint must first be removed, by being uplifted from each side of the wound, then the end of the wire being seized with forceps, it is so drawn upon that it can be cut off in the part which had been buried; then the divided suture is to be loosened at its other point of emergence, and from this side, viz., the one opposite to where it has been divided, traction is to be made, and thus the wire is easily removed. During this work the parts adjacent

should be pressed on with the fingers, so as to immobilize these parts and the uniting wound contained in them. The union will now often be found complete; yet should there be seen any indications of suppuration, then vaseline (petroleum gelatum) containing four per cent of carbolic acid, should be used as dressing; thus an outlet will be furnished for any purulent material. If proper care has been taken in the work, in most cases union will be found complete at the first dressing when the sutures are removed, viz., on the third or fourth day. The site of the wound should afterwards be protected from violence or irregular movement for a few days; otherwise it might be reopened.

Besides closure by wire, the work may also be done with catgut suture, which has the advantage that it vanishes by absorption, and does not require extraction, as must be done with wire; yet absorption sometimes occurs before firm union is established, and then some gaping occurs. Catgut should be used where there is no tension of the parts.

Another method of closing wounds situated in the hairy scalp is by means of the hair itself. The advantage of this plan is that healing is accomplished without shaving the hair, and one avoids the conspicuous mark resulting from such shaving. To close the wound in this way, commence at one end of it by placing a thread in or alongside of the wound, and then isolate a lock of hair on each side and lay this over the thread across the wound. Next the locks held accurately are included in a half knot, each lock is next to be turned back towards its own side, when the two are to be held in place by completing the knot. The work is to be continued by a series of knotted loops, so as to wholly close the wound. The wound being thus united, the part should be washed with undiluted alcohol, and then covered with dry lint or cotton wadding. This plan of closing wounds was practiced by Dr. Garwood, formerly physician to the City and County Hospital of San Francisco. The striking advantages of it are that no sutures are used, and the tied hair may remain undisturbed until the healing of the wound is wholly completed; and when this has occurred, then the threads may be cut and removed, and scarcely any trace of the previous injury will be visible.

Lacerated Wounds.—Lacerated wounds of the scalp are next to be considered. These injuries may originate in two ways: in the one case, they may arise from blows from some blunt object; and then, if the causal instrument be but slightly blunt, the wound

will resemble the incised wound before described. The lacerated wound can arise in a second way by the subject falling with his head obliquely against the ground, or some object having a blunt surface. The edges of this wound are ragged, uneven, and often very irregular. The wound may run in any direction; it may be straight or curved, it may consist of a single breach, or have one or more branches running from the main opening. Vessels are opened, yet in such a way that, as a rule, they bleed but slightly; for the violence in severing the vessels closes the latter either completely or incompletely.

Lacerated wounds present themselves in two classes; in one, there is no lateral detachment; in the other, there is lateral separation of the soft parts, on one or both sides of the wound. In the second form the separation may comprise the entire thickness of the scalp, the pericranium being included; this is rarer than the other form, in which the separation is through the stratum of lax tissue which has previously been described, as connecting the pericranium to the superjacent structures.

The treatment of the lacerated wound without lateral detachment, if the margins be even and untorn, is similar to that of the incised wound. But if the edges be torn and crushed, they must be trimmed off; that is, the breach is to be converted, as nearly as possible, into the form of the incised wound, when it must be treated similarly to the latter, by suture, or tying the hair across it, as above described.

The cleansing of these wounds prior to closing them, should be done with scrupulous care, more so, if possible, than in the simply incised wound, since in the origin of the lacerated wound some foreign matter is liable to be forced into, and remain incorporated in, the structures. After closure has been done by one of the plans mentioned, the further dressing may be done with the compound tincture of benzoin or alcohol. An agent recently brought into use, and of which the excellence has been established by much experience, is iodoform. Iodoform tends to maintain the parts aseptic; it is used pure, in the form of a finely levigated powder, sprinkled over the wound and parts immediately contiguous; the dressing is ended by complete occlusion under cotton wadding. Since the above cases, as well as all other forms of lacerated wounds, are unfavorably constituted for primary union, during healing they should be watched lest pus form and, being retained, lead to ill consequences.

In the second group of lacerated wounds there is uplifting of

one or both sides of the soft parts, and this detachment may include the pericranium, though, as a rule, this is left intact. The pericranium is oftener uplifted in the young subject, more rarely in the adult or old subject. The detachment may be slight, or it may be on a most extensive scale, so as to constitute a large flap. Such flap at the time of injury may be so displaced as to expose the subjacent skull. The flap when large bears resemblance to one-half of a bivalve shell.

The lacerated wound of flat valve-shape is one of the injuries of the scalp demanding serious attention; for careless or improper treatment of it may perilously compromise, and even end the patient's life. The dangers here referred to are seldom directly from the wound, but more commonly they are secondary complications, or results of it.

The lacerated wound with detachment of the scalp may, as just stated, be on a large or small scale; the detachment may be so slight as to demand no attention; again, it may be so large as to comprise a large portion of the scalp. Hyrtl mentions a case in which the entire scalp was detached and left hanging by a pedicle. As a rule, the anatomical conditions are such that there exists no doubt about the maintenance of the vitality of the uplifted part. The free and abundant vascular anastomosis within the scalp is favorable to maintenance of its life. The position of the pedicle or base of the flap, and also the breadth of the same, have an important bearing in this matter; a narrow base of attachment is unfavorable; also, when the attachment is downwards the chances of maintaining vitality are most favorable; but these chances are less when the foot stalk or base is directed towards the summit of the cranium.

An effort should always be made to save the flap, no matter how narrow its pedicle of attachment may be; even if it should be wholly detached, the surgeon should endeavor to save the part, provided the patient be seen soon after the receipt of the injury. In the restoration of the separated part to its original site, the conditions for reunion are very favorable, so much so that an attempt to save the part should be made, even though a considerable time has elapsed since the detachment.

The preliminary and principal work, in the treatment of the lacerated flap wound, is careful cleansing of the space or cavity underneath it; and this is best done by irrigation with a dilute alcoholic or sublimated solution, of the strength before given. Continue this subcutaneous cleansing until all blood clots and

other foreign materials are removed. A syringe may be used in order to carry the cleansing fluid to the bottom of the sinuous pockets. This work is often hastily or imperfectly done; and, in consequence, pus forms and prevents the reunion of the separated parts; and, what is worse, it may, by burrowing, increase the detachment of the scalp. Besides the removal of the clots, any hanging shreds which can be found should be removed by trimming or twisting off, and if any bleeding follows this, arrest it by pinching or torsion.

The edges of the wound are now to be trimmed; and this should be so done that the opposite faces can be accurately fitted to each other, when they are to be united by suture or tying of the hair. In case the scalp be detached to a great extent, then the parts after closure must be carefully watched, lest in the blind pockets fluids may be poured out, and by their intervention prevent union, or perhaps lead to suppuration. Should this danger menace at the time of dressing, then one or more drainage tubes should be introduced; or should signs of such accumulation present themselves later, then a counter-opening should be made through the flap at such point as will insure the escape of the liquid material. If, at the time the wound is dressed, external pressure be judiciously made by means of a bandage, it would tend to prevent such effusion of fluid. If pus presents itself in the drainage tubes, or it collect after closure, then open and let the cavity of the wound be cleansed daily by syringing it with an antiseptic fluid. This work should be done with a flexible rubber syringe, and the fluid thrown in as gently as possible. And since forcible injection is apt to separate the surfaces which are uniting, hence, as soon as the fluid has been put in motion through the instrument, the latter should be curved into the shape of a siphon, when the fluid will move by atmospheric pressure, and not in jets as occurs in simple syringing; and the pressure in siphoning may be augmented by lifting the receiving end of the syringe. This work may be done by means of an irrigator, which may be made by fixing a rubber tube to an opening in the vessel which contains the cleansing fluid. The common rubber syringe with which propulsion is done by compressing a bulb, may easily be converted into a siphon or irrigator. Whatever way may be selected for cleansing the wound, the work should be continued until all traces of pus disappear. Neglect in this matter, through which pus is overlooked and allowed to be retained, sometimes becomes the cause of erysipelas; thus not

unfrequently, the genuine or migrating form of this affection has arisen, and as a complication has been more serious than the wound itself. A spurious form of the disease, simulating true erysipelas, has occasionally been seen as the result of retained pus. This spurious affection is indicated by a purplish or dark red hue of the integument over and around the retained pus. If this pus be early liberated by incising and washing out the pocket, then the surgeon is pleased to find that his suspicions of commencing erysipelas were erroneous, since the red flush soon vanishes.

Sometimes the flap remains attached to the adjacent scalp by a very narrow pedicle; in such case one must try to save it; and to do this, cleanse and trim off hanging shreds, and replace the flap in its original site and fix there by sutures. These sutures should be as few as will suffice to retain the flap in place; too many will interfere with the blood supply required to maintain the flap alive. All tension and traction on it must be avoided, especially so where the flap is scarcely large enough to fill the breach. If an attempt be made to fill the opening by stretching the flap, such traction has the effect of elongating and narrowing the vessels in the pedicle, and thus greatly lessening the passage of blood through them in accordance with the laws governing the transmission of liquids through tubes of different caliber. For example, if a tube be doubled in length, the quantity of fluid passing through it will be diminished one-half; and if with the elongation the diameter be diminished one-half, then the quantity of fluid which can pass through it in a given time will be reduced to one-sixteenth part of that which would pass through the tube before elongation and narrowing. This offers an explanation of the tendency to slough in parts which are subjected to traction in the work of closing wounds; especially in wounds made by the surgeon in operating. Severe lateral traction is often fatal to the vitality of the part. Subjacent or eccentric pressure, which stretches overlying structures, as well as extensive swelling from any cause, may, in like manner, cause death through elongation and narrowing of the nutrient vessels.

In the attempt made to revivify a flap, and thus to close the wound with it, the bandage and dressing should be such as to thoroughly protect it; and the dressing, which may consist of lint and iodoform, should not be disturbed for two or three days; the sutures also should not be removed for a much longer time; and on the removal of the sutures, when wire has been used, it should be done with care so as not to loosen the flap. It often happens

that but a part of the flap is found alive, perhaps islets here and there; these are valuable aids in closure. These living islets lie in dead structure, which must be permitted to loosen and detach itself. An effort to prematurely remove the sloughing tissue always endangers the living points; and though there be a strong temptation on the surgeon's part to aid Nature, yet as a rule she will do better when left unassisted; for if these islets be once loosened from the subjacent nutrient ground, they will perish. Even irrigation violently done may break their attachment. Some two or three weeks' time will be required for the dead structures to detach themselves; a few threads of fibrous tissue, owing to their immunity from disintegration, often maintain the connection much longer than the period here mentioned. The detachment of the sloughs will be favored and perhaps hastened by moist warmth. For this purpose cataplasms of ground flaxseed or bark of the slippery elm were formerly used. An objection to these agents is that they soon ferment, and hence they require frequent renewal. Instead of these materials, soft linen or cotton cloth, wet in aseptic water, may be used, the cloths being covered with oil silk. If the water be made alkaline with carbonate of soda or potash, the disintegration will proceed more rapidly. This depends on the property which alkalies have of dissolving the albuminoid compounds. After the complete removal of the sloughs, the remaining wound should be dressed with some bland ointment by which the raw surface will be protected. The use of such ointment, though no better than water, entails less attention; it need not be renewed so often. For this purpose one may select Unguentum Cetacei, which, smeared on lint, is applied to the wound, and need not be changed oftener than twice a day. An excellent ointment, which the writer has used, is made by adding enough prepared chalk to Linimentum Calcis to convert the latter into an ointment. The important quality of the ointment is that it should be unirritating. This mode of dressing should be continued until the healing is completed; for this, some weeks' time is often required.

Contusion of the Scalp.—The contusion results from a blow with some blunt object; or it may originate from a fall in which the head strikes some blunt object or surface. Its causation is similar to that of the lacerated wound. According to the degree of violence, so the wound may vary from one of trivial degree to one of extreme severity. The striking characteristic is swelling, which occurs quickly after the receipt of the violence, and this

is due to lacerated vessels. In the contusion, even of mild grade, there is a subcutaneous breach of the structures, the more fragile tissues suffering the most. In this lesion the vessels are crushed; minute ones, and, in case of greater violence, large veins and arteries, may be opened. Thence results effusion of blood into the adjacent torn structures, causing swelling. The effusion of blood is termed extravasation or ecchymosis.

The extravasated blood may be of capillary, venous or arterial origin. Capillary extravasation is that occurring in the mildest form of contusion. The effused blood then permeates the affected tissues without definite limitation. The contused part is somewhat swollen, and to the touch and scalpel it is denser than normal tissue. The covering integument, at first normal, soon becomes discolored; this discoloration, which originates in the breaking up of the red cells and the dispersion of their coloring matter, remains often after the other phenomena of the contusion have vanished. This simple form of contusion (or bruise, in our vernacular) is nearly painless; there is felt by the subject merely an unnatural tightness and tension in it. It requires but little treatment; at the time of the injury, pressure will arrest most of the effusion of blood and so prevent swelling. But if seen after the contusion has reached its final limit of swelling, then the recovery may be facilitated through friction with some mildly stimulating liniment, such as soap liniment or diluted Linimentum Ammoniæ; still, if such cases of mild contusion be committed solely to the fostering hand of Nature, restitution to health will occur nearly as soon as where there has been surgical intervention.

As the antithesis of the mild form is that where the violence has been so great as to lead to immediate or later destruction of the integument implicated; here the elementary tissues have been so acted on by the casual violence that their component molecules are so displaced or altered as to wholly lose their function; and hence gangrene soon appears in the part. Such gangrene is indicated by a livid discoloration. The treatment in this case is to be directed to the separation of the dead structure and, afterwards, to a closure of the remaining breach. If it be apparent that only the outer stratum is destroyed, then the treatment will consist in favoring the drying of this part; for this purpose paint it with the compound tincture of benzoin or tincture of iodine; thus the dead part is converted into an occluding eschar similar to a scab, beneath which the wound heals. The dried eschar

should be let remain in place until it becomes loose and falls off. But if the destruction extend through the whole thickness of the scalp, then this desiccation cannot be obtained; the detachment of the gangrenous part must be favored by moist warmth; the warm alkaline water before mentioned may be used to accelerate the separation of the slough. After the detachment, one of the best dressings is that of water containing two per cent of alcohol, applied by means of surgeon's lint. The processes of granulation and repair are thus favored. Repair, however, ensues often very slowly, due perhaps, as Hunter says, to the remoteness of the part from the heart; the tardiness of repair is also due to the bony substratum on which rest the soft parts; for it is a matter of common observation that open wounds of large extent situated near the surface of broad bones are slow to heal; examples of this are seen on the cranium, scapula, and the front of the tibia. The slowness in cicatrizing over such parts is due to the absence or paucity of blood-supply from beneath; the material for repair must be derived from the marginal, or surrounding vessels. In consequence of this disposition, cicatrization may occur at normal rate in the peripheral parts of the wound, while centrally, the process proceeds slowly or is at a standstill. After a long period the wound may wholly heal; the remaining cicatrized surface is dry, hard, immovable, glossy and hairless. Its sensibility is perverted; it may be almost destitute of feeling; or it may be the site of pain, in consequence of compression of the nerves which have developed in the scar, or which have reached to it and been arrested there by the hard texture of the cicatrix. Two such cases have fallen under the writer's observation, in which extensive scars had followed lacerated wounds of the scalp. The large scars remaining after healing, especially in one case, were painful; or, at least, were the seat of disagreeable sensations, which the patient could not clearly describe, yet they were the source of constant torment. It should, also, be remarked that the patients, having such painful cicatrix, manifested some psychical peculiarity bordering on insanity; and it was not improbable that along with the injury of the scalp there also occurred slight cerebral concussion, sufficient to cause change of mental character. Since such patients localize their trouble in the scar, it is justifiable to remove the latter, and replace it by sound structure borrowed from the adjacent parts. As preliminary to such operative work, one should examine and study the parts around in reference to their capability of lending tissue for replacement; and in this

matter an important point is that the replacing tissues be easily movable, so that the wound made in them can be closed. It being decided where it is best to obtain the structure, one traces off a portion somewhat greater in extent, if possible, than the vacant place. Since this replacing flap must be twisted in order to reach and occupy the breach, it should be so chosen and situated that its base shall be twisted as little as possible; and this is accomplished by incising the flap from alongside of the vacant breach. The breach must now be prepared by the removal of the cicatrized structure; and if the surface is yet unhealed, then the indolent granulations should be pared off, and when bleeding has ceased, the replacing flap should be brought into its destined site; and having been pressed well against the subjacent surface, the free end of the flap must be fastened to the contiguous border by metallic sutures. Should the flap not readily reach to the opposite border, still let it be fixed in place by an elongated suture; and thus, if the flap be not brought in contact with the adjacent margin, at least it is so fixed on the subjacent parts that it becomes united to them. The wound left whence the flap was uplifted must next be closed by lateral approximation; to do this use metallic suture, inserted and passing a half inch from each margin. When this amount of structure is included in the suture, it will bear much traction without arresting the circulation through it; and such suture will maintain apposition of the margins until they have cohered. The wounded parts must be dressed daily if suppuration appears; the best agent for dressing is iodoform, which should be dusted freely over the surface.

In case the breach is so extensive that it cannot be wholly covered in the manner just described, then let the restoring material be carried across the middle of the breach; for, done in this way, the remaining uncovered portions will be reduced to minimum proportions in the subsequent healing process. Through this plastic procedure the painful scar is removed, the breach partly or wholly covered and, through the growth of the hair, the patient is relieved of an unsightly mark. Should the operation fail to wholly close the breach by hair-covered flaps, then the latter may be supplemented by cuticular flaps according to the method lately introduced by Thiersch.

A form of contusion next to be considered is that in which there is subjacent separation of a portion of the scalp, or injury in which there has been lesion of structure without external opening. In these cases vessels are supposed to be opened from

which blood is extravasated into the subcutaneous breach; and this effused blood is the phenomenon which distinguishes this form of contusion, and which claims chief attention in treatment. The form of such wound is rounded, both in its free surface and its boundaries; and its content of blood may vary from a small quantity to that of several ounces. The dimensions, though they can be estimated with the eye, can be more accurately determined through touch, by which the consistence of the swollen part is learned.

The contusion with ecchymosis of blood is often seen on the head of the new-born child; sometimes it is of very great size. There are two kinds: one in which there is a distinct cavity filled with blood; and a second form, in which the blood enters and is disseminated through the tissues of a portion of the scalp. In the first case there is a well-defined sac of blood, usually liquid, and which has arisen from subcutaneous laceration and loosening of the pericranium, in which vessels are torn and their blood poured into the sac-like cavity which has thus accidentally arisen. This form of extravasation, named cephalhæmatoma, in the opinion of trustworthy students of parturition, arises from the passage of the child's head through a rigid, unyielding os uteri, which displaces and so slides the scalp on the cranium that the vessels are torn and empty their blood into the loosened space. That this is the way that such extravasation is created is proven by the fact that it has been seen in births in which the fœtus presented by its feet or breech. The contained blood is dark, grumous, and not coagulated. This tumor is often so large as to deform the head of the child. The tumor is compressible, slightly movable, and its liquid content evident to the touch. As John Hunter mentions, the pulsation of a subjacent fontanel may be transmitted to, and through, such tumor, and give the semblance of an aneurism. Where an artery of some size has been opened and communicates with the tumor, the case is very analogous to a false aneurism; however, the pulsation in such tumor usually soon disappears. The best treatment of such tumor when small is slight compression, and should the blood not disappear after some days, then a slight incision may be made in the dependent part of the tumor, and the blood be squeezed out, and the wound closed under an iodoform dressing. As a rule, however, non-interference is the safer plan, since, if the tumor be opened, suppuration is apt to appear in the sac, and then the healing becomes prolonged and tedious. The author

has found that painting such tumor with the tincture of iodine accelerates the absorption of its contents. As before said, an accompaniment of the tumor is that the pericranium is often detached to some extent; and where this detachment continues long through the non-removal of the effused blood, then there arises a slight growth of bone which, wall like, marks the former site of the cephalhæmatoma. This osteophyte or bone growth is so slight in amount that it gives no trouble.

A second form of contusion, occurring in the fœtal scalp, presents itself in those cases of cephalic presentation in which, after the rupture of the membranes, the child's head is forced for many hours against the uterine mouth; in this delayed delivery a portion of the scalp is pushed through and constricted, cord-like, by the unyielding os uteri. The final result of such constriction is that the blood is extravasated and disseminated through the part, so that after birth there is present a large tumor, well marked off from the adjacent scalp. This tumor, slightly elastic and compressible, differs in consistence from the preceding form, in which the content was grumous blood; for though the swelling is due to effused blood, yet the latter is not contained in a sac or common cavity. This more solid form of contusion of the fœtal scalp is seen in the majority of new-born infants as an inevitable incident of birth, yet it is seldom sufficiently grave to demand attention; on the contrary, however, the lesion is sometimes so severe that the vitality of the part is nearly or quite destroyed, and then suppuration or sloughing follows. Where conditions are present which portend this, an attempt must be made to prevent such ill events. For this purpose gentle friction should be daily made over the part; or, as Hunter teaches, "the best stimulus is pressure, which if urged beyond the point of ease, sets the absorbents of the part to work." Such pressure may be made by means of an elastic bandage, but it should be slight, lest the absorbing vessels be occluded or retarded in their work. As a general rule, however, the contusions met with in the scalp of the new-born rarely demand any treatment; the superabundant forces stored up in the nursling are adequate to the vanquishing of most of the accidents which accompany its birth.

Besides the wounds in the infant just described, contusion with concealed extravasation of blood is met with in subjects of any age, as the result of violence. In similar contusion met with in other parts of the body, the ecchymosed blood is partly or wholly

clotted; yet in such injury in the scalp, the effused blood, similar to what occurs in the child, does not coagulate, but remains semi-fluid or grumous in character. The coagulation of blood, according to Hunter, is due to its being alive; and non-coagulation, to the blood being dead. Bruecke refers fluidity to some influence emanating from the coats of the containing vessels; while Richardson referred the fluidity of the blood to ammonia, which he claims is present in the circulating blood. Richardson received a premium for the solution of a problem yet unsolved. Hunter was probably not far from the truth; since, as he observed, such liquid blood is often attended by inflammation and suppuration, such as might arise from a foreign body.

Another important fact to be noted in connection with such injury is that it often deceives the touch, and is mistaken for a fracture with depression of bone. The deception arises from the sinking of the part under pressure, and from the hardened tissues which, as an abrupt wall, surround and separate the ecchymosed blood from the adjacent parts. The careful observer learns to distinguish such contusion from depressed fracture by the circumstance that the bounding margin in fracture is more sharply defined than in mere contusion; and in the latter the boundary is inclined toward the cavity. To avoid error, in some cases, much tactile experience is demanded. In the case of fracture the causal violence is greater than in uncomplicated contusion, and the patient's condition is such, in most cases, that some grave injury may be inferred; but in contusion there is rarely any enduring encephalic complication; if anything, it is merely a transient concussion of the brain.

Where the effused blood is small in quantity, no special treatment is required; slight compression of the part is sufficient; such compression is especially indicated on the forehead, where it has appeared to the writer that the effused blood coagulates and becomes organized oftener than in the hairy scalp; and in such case, though the clot be somewhat reduced in amount by compression, yet as a rule, some of it remains as a discernible deformity. As just said, in slight cases little or no treatment is needed, but if a large amount of blood be effused, and which remains liquid, then it is proper to consider this as a foreign body which should be removed. This work of removal should be done with much care; and for this purpose, first cleanse the part carefully, and then, at some point best situated for the evacuation, make a valvular incision and, having forced out the blood

close the wound made with iodoform dressing. In forcing out the blood, let this be so done as not to disturb the torn vessels and cause new bleeding in the cavity. If the blood removed has become putrid, a suppuration is sure to arise, and then it is necessary to open the cavity freely, scrape off and cleanse its walls, dust these with iodoform and close again; thus doing, it is sometimes possible to obtain healing with but slight suppuration.

A matter of importance to the patient in the several cases of contusion considered, is whether the hair will be lost over the site of injury; in nearly all cases he can be assured that no such loss will occur; only where there has been suppuration and destruction of tissue is there loss of hair in the part.

Occasionally the coagulated blood remains and becomes the starting-point of a fibrous growth; such growth is oftenest seen on the forehead, and may so interfere with the head-dress as to require attention. A contusion may occlude the outlet of sebaceous glands, which are numerous in the scalp, and thence an atheromatous tumor can arise. Again, where the content is non-coagulated blood, the containing cavity may remain and be transformed into a cyst. Such cyst rarely attains to great dimensions; and hence will not require surgical interference unless it interfere with the subject's dress; in that case it may be removed. The same advice may be given in regard to the fibrous growth mentioned above. If such benign development, whether fluid or solid, remain undisturbed, it will continue without pain, or increase or decrease in volume, for an indefinite period. The continued tranquillity of such formation is often disturbed by the patient's solicitude and desire that his figure should conform to that sketched by his vanity; and especially is the existence of such development menaced by the knife of some new recruit to the ranks of surgery; and though the removal is an easy matter, the recovery is not always so; for through some untoward circumstance, the healing may be long and vexatious, and the finality of an attempt to improve a feature may disappoint both subject and surgeon.

Gunshot Wounds; General Remarks.—Human civilization often boasts of its advancement, and with much satisfaction prides itself on a near approach towards perfection; yet when one regards the sanguinary battle-fields of modern years, on which life was wantonly sacrificed, it is evident that many vestiges of the worst barbarism of the untamed era of our race still remain. And even should the optimistic hope be entertained that humanity

will sometime reach a stage of reason in which war shall cease its deadly work, yet it is more than probable that even in peace the fatal firearm will continue in use as an agent with which the human body will voluntarily or involuntarily be mutilated; and hence that hereafter, as heretofore, gunshot wounds will constitute an important chapter in surgery. The human body is vulnerable to the missile projected by gunpowder, from the scalp to the sole of the foot; among modern men there is no one who has acquired immunity through armor or Stygian water; a Charles the Twelfth, if in range of a musket ball, falls a victim; the sentry Destiny, whom the king fancied to be his constant guardian, on one occasion slumbered at his post, and the royal hero, as readily as a pawn, was swept from the chessboard of battles, on which he had played the intangible victor so many times.

The gunshot wound is caused by a missile discnarged by an instrument known as a gun or firearm; of such instruments there are many kinds, which vary in form and size from that which is very small to that which is of stupendous proportions, and intermediately there are many gradations. Also, there is an infinite variety of missiles corresponding to the projecting instrument. The gun may have a smooth caliber, or the inner surface may be rifled with spiral furrows; these furrows are designed to impart a whirling movement to the ball, so that the latter, planet-like, while moving in its course, likewise revolves about its center. Thus moving, the ball acquires a double endowment of doing violence. Gunshot missiles vary in form, volume and in component material. The form may be round, which was the only one in use until recently; in modern times a ball of elongated and oval form has been introduced. The best type of this is the minie ball, which is egg-shapen. The ball of this shape acts somewhat as a wedge, and thus by splitting the structure of the body on which it strikes, it acts more destructively. The wedge-like smaller end of such ball striking a long bone may split it from end to end, but a ball of rounded form causes a more localized fracture with numerous fragments. The conical ball traversing rapidly the soft parts leaves a wound similar to an incision, but the round one leaves a more circular track. As to component material, the gunshot missile may be of lead, copper, or some mixed metal; the leaden ball is the most usual kind. The gun may be loaded with powder alone, and the violence done by the firing will depend on the condition whether the powder has been rammed down or only lies loose in the gun barrel, for when forced

well down, firing at short range may cause much violence; a charge of powder fired at a short distance into the abdomen of a man caused immediate death. Dupuytren, who saw the case, records that a large opening was made through the abdominal wall, the intestines were wounded and the wadding of the powder was lodged in the abdominal cavity. Where no wadding is used, the discharged powder, says Dupuytren, wounds the skin severely. The suicide in his haste and desperation has sometimes, luckily for his life, forgotten to place the ball in his weapon, and there resulted only a severe powder wound of his face or mouth.

Besides the missile's form, its magnitude and velocity coöperate as important factors in the amount and character of the violence done by it. For example, if a small and a large ball move with equal propulsive force at a long distance, the small one will do much more injury than the large one; at a great distance the small ball will penetrate, or even pass through a human body, while the larger may fall as a spent ball on the hither side of the target. Again, a ball moving at a slow rate of motion injures more than one moving rapidly, and in case the two sever tissues, the one moving rapidly makes its way rather by cutting than by tearing; but the one moving slowly does so by tearing rather than by cutting; in the former case, the wound made resembles an incised one, while the latter resembles a lacerated one. The Swiss government, in equipping its military forces with guns which can do work of violence at a great distance, has utilized these facts; their guns carry small balls.

John Hunter, who had opportunities for the study of gunshot wounds while holding the position of staff-surgeon in the British army, says that the wound produced by the bullet is a contused one. He remarks that from "such contusion there is most commonly a part of the solids surrounding the wound deadened, as the projecting body (bullet) forced its way through the solids, which (tissue) is afterwards thrown off in the form of a slough, and which prevents such wounds from healing by the first intention, from which circumstance the most of them must be allowed to suppurate." Yet he observes that the amount of contusion differs, the difference arising from the variety in the velocity of the projectiles. Instead of the velocity, it is rather the momentum, which is a component of the velocity and the weight of the missile, that figures in the work done by the missile; for the weight of the ball has an important bearing on the injury inflicted. To illustrate this, a large pistol ball impelled by a

small charge of powder and striking the trunk of a man would cause him to fall, though the injury done to his body was only slight, but with the same charge of powder a small ball would penetrate and probably pass through the body; in the former case the subject would be stunned and disabled for a short time, while in the latter he might be killed. Those selling arms are familiar with these facts, and advise their purchaser to buy this or that piece according to the purpose intended. To such refinement have the agents of destruction been brought!

Gunshot Wounds of the Scalp and Skull.—The victim of a gunshot wound of the head is fortunate if the lesion is limited to the scalp, but in the case of large balls, or the fragment of a bomb causing the wound, then the injury commonly extends to more important parts which are adjacent, viz., the cranium and the encephalon. But where the injury has arisen from a small ball which did not pass deeper than the structures of the scalp, the wound, in nearly all cases, is an unimportant one.

The varieties in the form of the wound produced by a ball are here, as well as elsewhere, the following:—

1. An open wound caused by the missile merely impinging against the surface in its passage and dividing the tissues to a greater or smaller extent, and owing to the convex form of the head, this wound must necessarily be short, seldom equaling, and almost never exceeding, two inches in length.

2. The ball may enter and escape, the intermediate passage, canal-like, lying beneath the surface. Such tubular wound, as a rule, is not more than two inches long; an exception is where the ball passes deeper, and striking the surface of the skull, it is deflected from a straight course, and in this case the point of emergence may be at any distance from that of entrance. Though the ball has escaped from the canal, yet not unfrequently it carries along with it and leaves some foreign material detached from the head-dress or covering of the scalp. The walls of this wound are in contact, so much so that fluid injected into one end would with difficulty escape from the other end, especially if the missile be small.

3. The ball may not escape, but remain imbedded in the scalp, and then the ball lies at the bottom of a blind canal, and with it may be detritus from the head-dress. Another species of blind ending shot-canal is that in which the missile rebounds and escapes where it entered; contact with the skull might cause such rebound of the missile.

4. Finally, there is a variety in which there is no external wound, nevertheless, the structures underneath the skin are severely, perhaps totally, killed; the integument may also be destroyed. Such injury on the head would necessarily involve parts deeper than the scalp; the skull might be injured as well as the brain itself. The explanation of the manner in which this wound is produced has been a matter of much study among those who have studied gunshot wounds. As no mark on the surface remains to indicate the contact of the projectile, the wound has been referred to the action of the suddenly displaced air, and thence arose the name of windshot. Another explanation offered by Rust, quite the opposite of this, is that the ball passing near the surface causes a vacuum towards which the structures are so violently displaced as to wound them. Neither of these explanations is deemed satisfactory. The one now accepted is that the ball actually strikes the surface in a glancing way, and in so doing communicates a part of its momentum to the parts which thereby become wounded.

The projectile in its passage through the air describes a uniform curve in accordance with laws so unvarying and so well known to the mathematician that the final end or stopping point of the ball can be definitely estimated and determined. Yet in the human body, constituted as it is of materials of such varying consistence and density, the ball, striking some hard structure, is caused to stray from its previous direction; and should such impact be repeated, then the course of the ball is composed of broken lines, of which mathematics find no analogue in the sections of the cone, straight or curved line. The ball glancing from point to point leaves a path vague, erratic and incalculable. Thus it has followed the convex surface of the skull, and then emerging has reëntered the trunk and continued its wandering there. A ball has struck the chest wall, and, without entering it, has passed quite around the thorax, its path lying just under the skin. And not alone has such wandering followed convex surfaces, it has followed concave ones; this has occurred within the cranial and thoracic cavities; thus a bullet having entered the thorax has confined its course to the inner surface of the ribs, and left the adjacent lung intact. The deflection of a ball from a straight course occurs when it passes from a rarer to a denser medium; this is well illustrated on the water when a ball is so projected as to bound from point to point (ricochet) on the water. The varying structures of the human body do not

permit any regular rebounding as occurs in the ricochet of the naval gunner; for the latter is so nearly master of it that he can utilize it in his destructive work. In the human body, like many things familiar to our observation of humanity, though it may start straight, yet it may end very crookedly.

The form of the entrance opening and that of the exit, where this exists, will here be considered. As a rule the edges of the entrance opening are turned inwards; if, however, the ball were moving with great speed, then the edges might be cut so abruptly as not to turn inwards. Where the ball does not emerge from the body, its course often becomes a difficult problem to solve. In such cases the position and direction in which the inverted edges lie are indices of the direction in which the ball started. Besides the eversion of the exit opening, it is larger than that of the entrance, and this is caused by the missile carrying along with it foreign material caught outside of the body; or such enlarging material may be derived from the tissues through which the missile passes; for the shot-canal, especially when the ball moves with great speed, is not caused by misplacement alone of the parts traversed, but the structures are likewise severed. The opening of escape may also be enlarged, or rendered irregular, through the ball having been altered in its form, through contact with some bone or tendon. From such contact the ball might also be split and the fragments escape at different points; or one fragment only escaping, the exit point might be smaller than that of the entrance. The entrance point may be distinguished sometimes by marks of powder; and such marks would indicate, also, proximity of the discharging weapon.

From the facts and circumstances already detailed, the diagnosis of the gunshot wound can readily be made out in most cases; in cases of obscurity the history of the accident will usually remove any doubt from the mind of the diagnostician.

The prognosis of the gunshot wound will depend somewhat on the extent of the injury, but more on the situation and nature of the parts wounded; certain regions of the body may be traversed by a gunshot wound, and but slight injury occur to the subject; should the ball leave foreign matter in its track, then the wound becomes much more grave. But if parts necessary to life are injured, the wound becomes a perilous one, the peril depending, in case the head and chest be the site, more on the foreign matter carried into the tissues, than on the wound made in them. In the abdomen, besides the foreign matter which the missile

may introduce, a wound of the bowel may lead to the effusion of intestinal content, and these invisible contingencies add greatly to the wound; and though modern surgery would expose them to sight by exploratory incision, yet, thus far, the danger of such injury has only been but partially diminished.

The wanderings which the ball may indulge in, and the impossibility often of deciding what structures have been wounded, render it impossible in many cases to predetermine the final result of a gunshot wound; so that when the ball has entered the head, chest, or abdomen, the first few days, and sometimes the first few hours, are pregnant with momentous issue to the unfortunate victim. And the prophetic art of the attending surgeon on such occasion is often most successfully exercised if his prognostic utterances are couched in the phrase of the Delphic oracle, which admits of opposite interpretations; for the medical seer when he casts his prognostic horoscope very often descries no absolute certainties; when, however, the field is limited to that of the simple gunshot wound of the scalp, there is rarely any occasion for ominous foreboding, for recovery may always be expected.

Treatment.—In considering the treatment of gunshot wounds of the scalp, we commence with the simplest form, viz., the open shot canal, which is a furrow in the surface of the scalp. The depth of this may vary from that of a mere abrasion to a wound involving the whole thickness of the parts, but in every case the surgeon has the advantage of being able to inspect the wound, whether it is smoothly cut or lacerated, and he also sees whether the surface is free or not from foreign impurities. If impurities be present, they should be removed by irrigation with an antiseptic fluid; and if the edges be irregularly torn or fimbriated, they should be rendered smooth by trimming. This work being done, if the edges can be approximated by sutures without much tension, this should be done; the part is next to be sprinkled with iodoform, and lastly covered with lint. In this case the wound has been converted into a simple, incised one, and the healing should be immediate and leave but a slight trace in the form of a linear scar. In case the wound is so broad that it cannot thus be closed, partial closure should be made, either by suture or by tying the hair across the breach, as already described; and then dress with iodoform and occluding lint; thus treated, the least possible scarring will remain.

In the second form of wound, viz., tubular and open at both ends, when it is superficial, the subjacent track will be indicated

by some discoloration of the skin; also, if pressure be made along this track a crepitant or emphysematous sensation will often be perceived, and becomes a diagnostic aid. Besides this, the normal consistence of the parts may be altered. If it be probable that some foreign material has lodged in the canal, a careful search should be made for the same with a bullet sound, and if found, removed. The removal can be done by cutting down directly on the body, but the work can be done preferably in most cases by means of forceps introduced through the opening of the canal, viz., the end which is nearest the foreign object. After this, the canal, if sufficiently permeable, should be cleansed by injecting through it an antiseptic fluid. This injection must not be done too violently, lest the fluid forsake the canal and be forced into the adjacent tissues. This preliminary work being completed, the wounds are to be treated as any simple wound, and the whole to be covered with lint and a retaining bandage. The wounds will probably quickly heal, with only a slight serous discharge from the concealed canal. If there be indications of hæmorrhage in the canal at the time of the dressing, it would be improper in most cases to open the wound to find the opened vessel, since the bleeding could be arrested by a compressive bandage over the dressing. If later there occur signs of suppuration in the canal, which would be indicated by circumscribed swelling, the canal must be opened, and having been cleansed, it must be dressed daily with iodoform.

In the third or cæcal form, in which the canal ends blindly, at its bottom the missile may be expected to be found. In a case, however, of a gunshot wound of the chest seen by the author, no ball was found in the canal, and on examination it was discovered that the coat, vest and outer shirt had been pierced, but the undershirt was intact; the undershirt had escaped opening, and been forced into a canal two inches long, and then the missile had been dislodged by the retraction of the shirt. From this the lesson is forcibly taught, always to examine the clothing carefully, both with the view of learning whether it has been pierced, and if so, whether the ball has cut and carried with itself some of the dress. As a rule, the ball will lie at the bottom of the canal, and can be detected there by a sound; but if the wound will admit the finger, the latter is the best detective both of the ball or any adventitious matter. The ball having been removed, it should be examined as to its form, since from changes in this some information can be gained concerning injury which may

have been done to the skull. From studies of the change of the bullet's form, Bousquet, in 1885, announced the following: "When the point is flattened it denotes that the bullet struck and caused a depression, or, along with depression, the bone is also broken. When the bullet is depressed on one side and is cracked on the opposite side, this indicates that the bone impinged on was not broken. A lateral depression on the bullet means that the bone was touched and only depressed." Instructed by these facts, it is well to study any changes visible in a bullet which has been extracted. The ball being removed, dress the wound according to the methods already described.

In cases in which the ball lies concealed, and there would be great difficulty in removing it, the better course is to let it remain. Such practice, however, would not be proper where the ball lies anywhere on the cranial vault, since its removal there is easily effected; but when the missile is lodged in the structures at the base of the cranium, the case is otherwise. For example, in the occipital region, a ball might lie in the trapezius and complexus muscles, and be so deeply buried that it would be extremely hard to find it, and, if found, the attempt to remove it would cause great laceration and injury to the tissues. Also, if buried in the temporal fossa, the effort to extract the ball would be attended with much violence; hence, in gunshot wounds in these regions, non-interference is the better plan for the patient; yet it is too rarely followed, since the surgeon finds it difficult to withstand the popular clamor that the ball must be found. Yielding to such mischievous opportunity, the surgeon has too often forsaken the line of duty and engaged in adventurous work which has added little to his own reputation, and still less to the welfare of his patient. The probe, led by a blind guide, has often wandered far from the object of its search, and caused irreparable injury. In some cases, the ball which lies at the bottom of a blind canal, does as little harm in the body as it would outside of it. In all such cases abstention is urgently indicated. When the ball is allowed to remain in the tissues, if it be unaccompanied by any foreign material, it does not awaken much reaction in the parts contiguous; it is an aseptic agent which has been purified by its passage through fire. No more innocent intruder could make its ingress into the tissues of the body; its only offensive qualities are its weight and the slight pressure which it makes on the parts around. The resultant irritation awakens a formative action by which a cicatricial capsule is thrown about the ball; especially, if

it be lodged in the muscular tissue; but in more yielding structure, as the brain, the ball may sink by gravitation from its first place of lodgment. The same has occurred in the loose structures of the axilla.

The fourth form of gunshot wound, caused by the lateral or glancing contact of a large ball, is often a grave injury, since the parts thus wounded are often wholly destroyed; and, when on the scalp, the cranium may also be fractured. Such fracture conjoined to the lesion of the soft parts, is extremely perilous to life. Where the bone is probably not injured, as may be inferred where depression and crepitus are absent, then the treatment is directed to the use of means calculated to save or restore the life of the injured soft parts. For this purpose, shave the part and apply to it a paste composed of balsam of Peru and iodoform. This compound, should the injured parts die, resists putrefaction and aids in the disinfection and drying of the surface covered by the paste; and thus if the injury does not involve the entire thickness of the scalp, the outer desiccated layer acts the part of a scab, under which healing occurs. Such healing, however, is slow, and would rarely complete itself under the protective slough; and, therefore, it is better that the latter be removed, and the remaining injured surface treated as an open wound. If, however, at the first examination of such injury the surgeon is convinced that the parts are wholly killed, then any attempt to restore their vitality would be irrational; it is better to use means which would promote detachment of the dead structures; and for this use moist warmth, by means of cataplasms covered with oiled silk. And if ten per cent of alcohol be added to the liquid, and enough of carbonate of soda or potash to render it highly alkaline, then the maceration will be best effected. After the dead tissues have been removed, the remaining wound should be protected by moist dressings; and if the granulative action be tardy, a slightly stimulating dressing should be used, viz., a five per cent solution of alcohol. In case the surface to heal is so large that it cannot readily close by cicatrization, then the surgeon should lend assistance by some of the plastic artifices at his command; for this, adjacent tissue may be utilized, either by complete or incomplete approximation of opposite margins, or by taking a flap from the contiguous parts and placing it across the breach. Should these methods be impracticable, then the work of closure might be accomplished by means of skin-grafting; such grafting material may be procured from the subject, his friends, or from corpora viliora, as the frog or

dog: the dog, it is said, has repaired his master's scarred and hairless scalp with hair-covered derm. Transplanting grafts from the sheep has been advised, and, in fact, trial of the same has been reported; yet it is not probable that the appendage inseparable from such grafting would be satisfactory to many heads, though, as a humorous journalist once put it, it might be the "best thing that many heads could be put to." In this work of skin-grafting, where there has been loss of the entire thickness of the scalp, the anæmic condition of the surface to be repaired will be more apt to entail failure than success; should, however, the pericranium be intact, the peculiarly disposed vascularity of this membrane would insure the life of the grafts; for the numerical superiority of the veins over the arteries would favor congestion and insure an abundant supply of blood; and hence the presence or absence of the pericranium has no small bearing on the question of repair by the method of grafting. Instead of using the entire derm, Thiersch's epidermal grafts might be used.

Gangrene.—Gangrene or mortification of the structures of the scalp is seldom or never seen as a primary phenomenon; a fact due to the abundant supply of blood to these parts; in this respect the head contrasts with the inferior extremities, so often the seat of mortification. Besides the abundant supply of blood to the scalp, its position is unfavorable to stasis or congestion, which, in many cases, may be viewed as the proximate factor in the causation of gangrene: the crowded vessels in the lower limbs exert no inconsiderable pressure on the parts which they traverse, and the paradoxical condition is present of starvation in the presence of excessive nutrition; but in the scalp the forces of the heart, assisted by gravitation, avert stagnation of blood; and as result, if the structures on the head die, it is from actual anæmia due to some mechanical agency. As example of such case may be cited concussion, in which the violence done has immediately deprived the scalp of its vitality, and those in which the part has been rendered anæmic through pressure. The cases arising from sudden violence have been sufficiently considered; but as examples arising from lack of blood, may be cited those cases in which the patient, the subject of some debilitating disease, rests the head in one position for a long period; thus a patient in the later stages of typhoid fever has been found to have death of the scalp on the back of the head on which he has lain for a number of weeks. This tendency to death from pressure in any adynamic disease of long

duration, should be borne in mind, and suitable means used to avert it. As means to avoid such gangrene, let the head rest on an air-cushion, and besides having its position changed from time to time, let the exposed part be bathed with alcohol containing corrosive sublimate, in the proportion of one in a thousand. If, notwithstanding this, the part dies, then the detachment of the gangrenous structures should be favored by moist warmth, and the ulterior management of the case should conform to advice before given.

Again, fatal anæmia of the parts may be induced by the careless use of the ice-bladder, the use of which is so much in vogue in the treatment of injuries of the head. To avoid such ill results, the heavy fragments of ice should not be used, but instead, ice which has been finely crushed; or, if it could be obtained, snow might be used; and between the containing bladder and the head, a layer of flannel should be interposed; thus the excessive action of the cold will be prevented.

Gangrene of the scalp may arise from the subcutaneous ravages of phlegmonous erysipelas; thus from the suppuration in the lax tissue of the interspace beneath the scalp, the confined pus may burrow, and in its diffusive march, destroy the nutrient vessels of the overlying parts, and cause the death of parts so deprived of blood. Such mortification will not be uniform, but islands of dead tissue will be found interspersed in sections of living structure. The detachment of the sound from the unsound parts in such cases is very tedious. It need hardly be remarked that such cases are rarer now than formerly; yet the aseptic doctrine, like all great truths, will sometimes fall short of realization; and suppuration and erysipelas will continue, as hitherto, to occupy some portion of the domain of pathology.

In the cases of concealed suppuration mentioned, the sloughing may be lessened, or prevented, by incisions made early, so as to allow free escape of the pus. In making these incisions the vessels should be studiously avoided, for if cut, the consequent bleeding will almost defeat the purposes of the opening; if an artery by mischance should be opened, the vessels should be ligated. If such cuts be made in lines radiating from the summit towards the base of the head, then the risk of wounding vessels will be much lessened. Through the incisions made, the suppurating cavity should be washed out, and the dressing completed by the introduction of iodoform into the recesses of the cavity; thus doing, suppuration is lessened and healing is promoted; but, if

some structure is lost through gangrene, the case should be dealt with as heretofore detailed.

Remotely cognate to the subject just treated of are fistula and ulceration.

A fistula, technically considered, is a tubular ulcer; that is, a canal of which one or both extremities open on the surface, and the walls of which are lined with indolent granulative tissue. A sero-purulent fluid normally escapes from such a canal; and the latter is occasionally so situated that some excrementitial matter also escapes through it. The leading characteristic of the fistula is that it is non-healing; in some regions of the body the fistula is an unending source of inconvenience to its possessor. It does not heal because the materials which traverse it, separate the canal; in some cases, also, the healing is prevented by the frequent movement of the structures in which the fistula lies; but this latter condition does not exist in the case of fistula in the scalp, and hence in the treatment of fistula in that region, the immobility is favorable to healing.

Fistula of the scalp may arise from a phlegmonous inflammation, in which there occurs a latent burrowing in, or beneath, the structures of the scalp; the lost structure is not wholly restored, and one or more narrow passages remain. Fistula may remain as the sequel of scrofulous or syphilitic disease, in which the ulceration penetrates and traverses the structures, and leaves unhealing passages beneath the surface. And this condition is oftenest found where the bone is affected, and being in a carious or necrosed state, acts as a foreign body at the bottom of, or along the track of, the fistula. And, lastly, a fistula has arisen from the lodgment within the tissues of a gunshot missile; or any other foreign object penetrating and remaining in the scalp may leave an unhealing fistulous canal.

From the diversified causation of fistula in the scalp (and the same is the case wherever it may be found), some diagnostic acumen must be exercised to determine the origin of it; whether it be from phlegmon, scrofula, syphilis, a bullet, or other foreign body, will generally clearly appear from the history of the case. Besides, the sound is an aid which should not be neglected; and though it may not reveal the origin, it may reveal some important conditions of the fistula; thus, the presence or absence of a foreign body may be determined, and especially, whether the subjacent bone is implicated. To distinguish, however, between dead bone and a foreign body is not always easily done. And even contact

with the rough surface of sound bone has often misled the searcher. Dense fibrous or tendinous tissue has likewise often deceived the prober; great experience is requisite to guard one from error in arriving at a correct diagnosis in such cases.

The treatment of fistula, as may be inferred from what has preceded, may be wholly local in character, or both local and constitutional. Where the trouble is purely local, as from a foreign body, then the canal must be freely opened and the body removed; and this done, the track of the canal must be scraped or curretted, until it has been freed of its granulative investment, and the work concluded by dressing with iodoform and means before given. If, however, the disease depend on cranial caries or necrosis, then the affected bone must be wholly removed by gouge and chisel, and the further treatment correspond to that of simple fistula; and if thus treated the wound will close rapidly. But if foreign matter be inadvertently overlooked, or some diseased bone be left, the wound may close, but reopen again in a short time; in such a case, repeat, and do the work more thoroughly; especially, if the causal agency be diseased bone, must the removal of this be thorough; the excising chisel or forceps must only cease work when the instrument has passed into the contiguous sound bone; stopping short of this has often been followed by a return of the fistula.

Should some constitutional disease coëxist, and which must be reckoned as the cause of the fistula, then appropriate treatment must be directed to the general disease; such causal disease is commonly scrofula or syphilis; and as the fistula present will be the same in each case, the diagnosis of the causal affection must be definitely made out before appropriate treatment can be prescribed. Soon after the constitutional treatment has commenced, the fistula should be operated on and treated in the manner detailed in the preceding paragraph.

Ulceration.—By ulceration is meant that condition present in a part from which the skin or mucous membrane has been removed, and which remains as an open wound, with little or no tendency to heal. Such wound, called an ulcer, is usually bounded by a border regular in outline, and which is elevated above the ulcerated surface. This surface is constituted of imperfectly formed granulative tissue, which has been before referred to as embryonic tissue; and from this surface is thrown off a thin, pus-like fluid. The discharged fluid contains a few pus-cells along with elements of irregular form, which have, in part, arisen

from broken-down, decomposed pus cells. Some of the formless elements arise from the death and detachment of minute portions of the ulcerated tissue. Ulcers vary in color from red to a pale hue; this depends on their greater or lesser vascularity. Their limiting margins also differ in different cases; these may be steep and high, the margins may be inverted, and this indicates that the inverted edge is undetermined by the ulcer; and this state is one unfavorable to healing. When an ulcer is near bone, a diseased condition of the bone may be the origin of the ulceration. Contiguous vessels, muscles, and nerves may also become affected.

The immediate cause of ulceration is a disturbance of the vascular structures of the affected part; the venules, arterioles, and lymph-vessels are in an abnormal state, the blood does not come to, and go from, an ulcerated part, as it does in healthy structures. The function of the lymphatics is likewise interfered with; and this impediment to the movement of the blood and lymph exists both under and around the ulcerated structure. In order that the nutrition of a part be duly maintained, the nutrient material must be supplied to it at regular intervals, and be under a certain amount of pressure from the action of the heart; hence in the process of maintenance of the tissues, several factors occur; and without this regulated action and concurrence, the vital process ceases and death results; and when this death is on a large scale the event is gangrene, but when small particles or molecules only die, it is ulceration; death in the first case is macroscopic, and in the second it is microscopic. In gangrene the obstruction to nutrition is primarily in the large vessels; but in ulceration the impediment is in the capillaries. Gangrene involves both the superficial and the deeper structures; the action of ulceration is limited to the superficial ones. Ulceration does its work in detail; gangrene does it in mass; the former runs a more chronic course than gangrene does. The favorite site of the ulcer is on the inferior extremities, though not infrequently it occurs in the scalp.

Similar to fistula, ulceration in the scalp may be associated with, or be dependent on, scrofulous or syphilitic disease. The products of these diseases interfering with the nutrition of the parts adjacent, often cause atrophy or even death in these parts; thus the tubercular product of scrofula and the gumma of syphilis act destructively on parts adjoining. The nature of this accompanying disease must be accurately determined, since the treatment of scrofula would be very inappropriate for syphilis, and

vice versa, since the mercurial course so proper in syphilis would be detrimental in scrofula. Hence it is evident that in the treatment of ulcer on the scalp, as well as elsewhere, the varied causation must be studied.

When the ulcer is the result of loss of integument from uncomplicated traumatism, then local means may suffice for cure. The surface of the ulcer should be carefully noted, and if it be clad with exuberant granulations, these should be reduced by an escharotic. For this an excellent agent is the sulphate of zinc, which must be applied in crystal form. To do this, cover the part to be acted on with a stratum a half line deep of the crystals of the salt, cover these with dry lint and allow them to remain undisturbed for twenty-four hours; the surface will then be found quite charred to a depth equal to the thickness of the stratum of the salt that was used. This dead surface is to be removed by means of a macerating cataplasm. Three or four days will be required to separate the destroyed structure. The surface thus cleared off will heal rapidly, the cicatrization proceeding towards the center from the peripheral border. If skin grafting be resorted to at this period, and a few grafts be placed here and there on the raw surface, the healing will proceed much more rapidly than if allowed to proceed wholly from the circumference of the ulcer; or healing might be further hastened by covering the surface with epidermal grafts. The healing will also be promoted by the local use of a ten per cent solution of alcohol. The secret of success in the treatment of ulcers as well as that of many other diseases, local or general, is not to persevere too long in the use of any one method. Nature is whimsical and requires to be catered to by variety, and hence when one method ceases or fails to do what is wished of it, some other means must be resorted to. Change of plan often accomplishes what pertinaceous continuity is impotent to effect.

As a local application to the ulcer, iodoform may act well for a time. A better remedy than this is the sub-iodide of bismuth. This agent was announced in 1876 as an antiseptic agent. Dr. Reynolds and others reported good results from its use; its expensiveness is an objection to it. This remedy may be employed alone or combined with calomel or salicylic acid; for use, it is to be sprinkled once daily over the ulcerated surface, and the whole to be protected by a covering of adhesive plaster. If the ulcer is so situated as to render the use of the plaster difficult, then it may be covered with lint or a simple bandage. The author has often

seen an ulcerated surface speedily take on a healthy character, and cicatrization to commence under this management.

Should the prime causal factor be a constitutional disease, as before stated, this should be accurately determined and receive appropriate treatment. As topical means, one of the most effective is calomel combined with morphia, in case the patient has constitutional syphilis. The following is a recipe which, used locally, has acted well:—

℞. Hydrargyri Chloridi Mitis. ....ʒi
Morphinæ Sulphatis..... ....gr. j
Misce.

A portion of such a powder should be sprinkled over the ulcer once daily, and the part then covered with the cotton wadding. Meantime the patient, if feeble, should take internally the iodide of potassium in combination with the tincture of Peruvian bark. Should the patient, however, be a strong subject, then he may take a combination of mercury and iodine; and for this purpose the protiodide of mercury may be given. As additional local remedies may be mentioned the balsam of Peru and the compound tincture of benzoin; these remedies applied to ulcerated surfaces stimulate and promote healing. The fluid extract of ergot may also be used with benefit.

Hypertrophy.—The scalp is sometimes the site of abnormal thickening; and this hypertrophy may embrace a large extent of the scalp, or it may be of limited extent. Such increase of structure is the result of some prior derangement or disease of the part. The most usual cause is a chronic erysipelatous inflammation of a recurrent or continuous form. In such state, the affected structures, being constantly swollen with blood, receive an undue quantity of formative material, and the result is growth of the part beyond normal limits. Such thickened structure is painless, and except that it slightly deforms the head, it is the cause of no inconvenience to its possessor; and should this trouble be of sufficient moment to cause the subject to seek treatment, the best results may be obtained from compression with collodion, and also from the topical use of iodine. And these remedies may be used in combination, viz., first painting with tincture of iodine and then cover the painted surface with collodion; thus the absorbent action of the iodine and compression act conjointly. But if the hypertrophy be so great as to demand more active measures, then the knife may be resorted to; and wedge-shaped portions having been excised, the wounds must be closed with

sutures. It is seldom, however, that a recourse to cutting will be needed, or even any other treatment, since, after a lapse of time, a diminution of the structure may confidently be anticipated. For it is a rule that the bodily form, however modified by circumstance or contingency, tends to revert to the original model. Careful of the products of her work during uncounted years, Nature jealously guards them; her maternal watchfulness is ever diligent in their maintenance in permanent constancy in form and type, unperverted and unchanged; and if changed, as a rule, this is for the better. The tendency to the elimination of the hybrid or compound form in the domain of plant life finds its analogue in animal life; the products of cicatrization and hypertrophy often slowly vanish and leave but slight traces of their existence, and such, in most cases, is the final event of hypertrophy of the scalp when due to simple multiplication of the normal constituent elements.

Atrophy.—An opposite condition to that just considered is atrophy of the scalp, in which it is the subject of attenuation, of which there are varying grades from extreme thinness to that which is scarcely perceptible. This condition arises from imperfect nutrition of the part, and in the male is often associated with baldness; and the two are, doubtless, promoted by the irrational head-dress which obstructs the circulation of blood in the part, and of the air on its outside. The thinness of the scalp is likewise associated with attenuation of the adjacent cranial wall. In atrophy of the scalp the normal mobility of the part is limited, or quite lost; and the part so affected is dense, tense, and apparently bloodless. The innervation of the part is impaired, and in every respect its vitality is lessened. Such tissue, when wounded, is slow to heal; and, on this account, the surgeon should avoid it with his knife; especially so when it is the site of atheromatous or sebaceous tissue, not unfrequently seen on the head of old persons. Such atrophy is irremediable, and only exceptionally does it cause any inconvenience.

Tumors.—By the word "tumor" was meant, primarily, enlargement or swelling; including this idea, the word has acquired in pathology the additional meaning of a structure superadded to some part of the body, and the superadded structure may resemble and be nearly identical with the tissues in which it is contained, or from which it arises; or the tissues which compose it, and the course which the tumor takes in its development, may present radical and striking differences from the parent structure, whence

the tumor originates. In the former case, the tumor may continue as a harmless appendage for an indefinite period, and in many cases causing its subject little or no inconvenience; if there be any trouble, this is due to the pressure of the tumor on adjacent parts, and also to the deformity which it causes. The other form, in which the tumor consists of normal elements which are abnormally compounded, unlike the former type, sooner or later becomes a source of incalculable trouble. This species, like any organized being, has a definite life; it starts from an humble, usually unnoticed origin, thence grows to such size that the parts on which it rests are unable to furnish it with sufficient material for its maintenance; it then dies, and fatally involves in its death the parts about it. Such tumor, like an ingrate, finally ruins the organic household into which, inadvertently or unknowingly, it has been adopted. From their action and course, the former group is named benignant or benign, while the second group is named malignant.

In the scalp almost all forms of tumors occur, both benign and malignant; yet in our treatment of the subject we will only consider those of greatest frequency.

Tumors originate from the preëxistent constituents of the parent tissue, or that in which their growth is situated. In the scalp one finds as component elements the following: epidermal scales, epithelial cells, muscle of the striated and non-striated species, connective, fatty and fibrous tissue, and nervous, vascular and glandular structures. Though seemingly simple, the scalp is a complex compound and reducible to the proximate elements enumerated; and in any tumor growing in it, it will be found that one element is the sole or predominating constituent, and hence the tumor, elementarily and histologically considered, is simple in character; and this is true of both the benign and malignant.

The benign type is represented by the fibroma, cystoma, lipoma, and angioma; the representatives of the malignant type are sarcoma, epithelioma, and carcinoma.

The fibroma is seldom seen in the scalp except in the form of warts; these, however, contain so many elements besides fibrous tissue that, structurally considered, they can only be viewed as remotely cognate to the fibroma, which, in its simple form, is composed of fibrous tissue. For the pure fibroma the scalp does not furnish the conditions favorable for its development; space for growth is absent. The nearest representation to it which the

author has seen is the fibro-adipose tumor, in which the fibrous tissue is the chief constituent. Such tumor occurs on the sides of the head, where the scalp is thickened by the addition of fatty, muscular and tendinous structure. The starting point is generally a scar resulting from a severe contusion or open wound. And then in the work of repair the production of granulative tissue is continued beyond what is needed for restitution to normal form; and in the new growth, adipose elements are incorporated or entangled, since from the nature of its development, such growth is not definitely separated from contiguous parts, and the tumor passes insensibly into, and is intermingled with, neighboring structures. Such growth is elevated above the parts around, and thus it becomes a slight deformity through interrupting the even surface of the head. From its poverty in nervous structure there is obtuseness of sensibility, if such structure be pricked or wounded in any way; and yet through encroachment or pressure on peripheral nerves, it may become the source of pain; a neuralgia or sensation of uneasiness may thus be awakened, and cause no inconsiderable trouble to the patient, so much so that the surgeon's knife may be invoked for relief. And should the growth be painless, it should be regarded with some suspicion, as it can alter its type and become malignant; in this way sarcoma and carcinoma have originated. Hence, an additional motive for the removal of such fibroma. For this excision, let the tumor be circumscribed by a cut of such figure as to admit of the readiest closure of the wound; and this may be elliptical or triangular, for the wound in either of these forms remaining after the removal of a tumor of moderate dimensions can be closed by direct sliding or approximation of the opposite edges; this should be done with deep metallic sutures, which should be allowed to remain in place for not less than eight days. The wound should be washed with alcohol and then dressed with iodoform and cotton wadding. A cure can thus be accomplished in from ten to fourteen days.

Warts.—The wart is well known as a miniature growth originating in a hypertrophy of the papillary layers of the cutis of the hands; the primary cause is probably some continued local irritant, such as the hands are the subjects of, and also the feet of the barefoot boy; in the latter, the feet being as much exposed to injury as are his hands, one finds in him warts as often on the feet as the hands. The wart requires a free supply of blood, both for its origin and subsequent maintenance; and to this is

due the occasional occurrence of warts in the scalp. The wart here is concealed in the hair, and is a source of inconvenience in dressing the head, since in this work it is easily wounded; and from this cause, as from being an unsightly object when visible, its removal is commonly demanded. This may be done by escharotics or by excision. The escharotic may be applied externally, or injected into the wart. Numerous agents may be used for this purpose; among the best is nitric, sulphuric, carbolic, or chromic acid. Where the wart is small, the local use of any of these will accomplish the gradual destruction of the growth; yet the remedy will require to be applied a number of times, since each application destroys but a small portion of the wart. Sulphuric acid is best applied in the form of a paste made by mixing the acid with powdered charcoal; with this mixture cover the wart and let it dry, when an adherent crust is formed, which will fall off in a few days, carrying a small portion of the wart with it. Instead of the external use of these acids, each one may be used by inserting or thrusting a drop of the agent into the wart. To do this, trim a piece of oak or hickory wood into a small, sharp point, and, having saturated the point with nitric or chromic acid, thrust this through the base of the wart. The escharotic thus introduced will interrupt the circulation, and thus cause gradual atrophy or immediate death of the wart. Another method used by the author to destroy warts is to transfix and cauterize it with a long needle or pin such as is used in the twisted suture in harelip. For this purpose take a long cork and thrust the pin through it near one end, so that the other part of the cork may be used as a holder. Having thrust the needle well through the cork, next insert its point in the base of the wart, and then with a small lamp's flame heat the needle on the side of the cork nearest the holder; in this way the nutrient vessel of the wart can be closed and the wart caused to die and fall off. And finally, by the hypodermic method, an escharotic agent can be introduced into the base of the wart, and its destruction effected; the corrosion of the instrument renders this plan unsatisfactory.

The wart can be very successfully destroyed by directly excising it; for this work small curved scissors may be employed. To remove the wart in this way, let it be transfixed with a tenaculum so introduced as to lie parallel to, and in the same direction as, the cut to be made; the tenaculum is next lifted up so as to elevate the wart above the parts around, when the cutting can

readily be done with the scissors. This excision will be followed by considerable bleeding, which, if troublesome, may be controlled by some styptic; for example, by alum applied in solid form; and where the bleeding is not great, it is better to allow it to cease spontaneously, as thus a clot is formed, beneath which healing occurs rapidly and faultlessly, and more conveniently than by any other method, since no dressing is needed; for the encrusted blood forms a protective covering on the wound. This plan of healing under coagulated blood may be adopted in many minor operations on the head and face, and has the advantage of leaving only a slight scar. Such scar differs from that resulting from granulation, in which granulative closure is tedious and often leaves a scar, which is unsightly from its unevenness and elevation above the parts which surround it.

Cystoma.—The next form of growth to be considered is the cystoma, the generic name of a large class of benign tumors, of which the leading characteristics are that they possess a well formed and clearly defined boundary or wall; and they have a content which differs wholly from the containing wall. The containing wall may be indistinguishably fused with the adjacent parts, or it may differ wholly from them and be easily separable from them. This sac, or cyst, as it is ordinarily named, is usually wholly closed, though in a certain class one can, by inspection, often detect an opening in it. In constitution the wall consists of closely woven and compressed areolar or fibrous tissue. In some cases a thin filamentous wall lies between the content and the main wall. The main wall receives a supply of blood through one or more vessels which enter it; in some cases the vessels are so small that they are hardly distinguishable by the eye. The arrangement of the arteries and veins is such as to retard rather than hasten the circulation of the blood; and thus growth is favored.

The material contained in the cyst may be synovia, mucus, serum, sebum, dermoid material, or blood; and such cysts are named respectively, synovial, mucous, serous, sebaceous, dermoid and blood-cysts. In the case of most cysts their origin can be found in the retention of some secretion or excretion, which in some way does not have free escape through its natural outlet. The species of cysts found in the scalp are the serous, sebaceous, dermoid, and blood-cyst; for anatomical reasons, the synovial and mucous cysts do not occur here.

The cyst of purely serous content is infrequent in the scalp;

and in most cases it arises from extravasation of blood into the tissues, by which a cavity is formed in which principally blood is lodged; the tissues immediately adjacent undergo a change of structure; by condensation a wall is formed; meantime, the blood is absorbed and replaced by serous content. In other situations, as in the case of the scrotal hydrocele, the reverse may occur; serum may be the original content, yet through enlargement and rupture of vessels in the wall, blood may be mingled with the serum. Besides this, the serum may contain other organic material, such as detritus cast off from the wall, and also material may be precipitated from the serum itself, so that a purely serous content no longer exists, but instead, a turbid heterogeneous fluid.

The serous cyst in the scalp might be confounded with the dermoid; yet the briefer existence of the former, and the history of some accident, as a contusion, would indicate that the tumor was a serous and not a dermoid cyst. The dermoid tumor is nearly always found over or near the supra-orbital ridge, especially the outer part of this ridge. The serous cyst, if it is found in there, lies more superficial; the dermoid growth reaches deeper downwards, and from its subjacent attachment to the periosteum it admits of but little lateral movement. The serous cyst may increase in its volume, while the dermoid remains constant, neither diminishing nor increasing in size.

Unless the serous cyst be so located on the head as to be a visible deformity, it need not be interfered with; but should its removal be desirable, this may be done by compression, the external use of an absorbent, or, finally, the work may be done more radically by excision.

Simple compression by means of a bandage or adhesive plaster, continued for a time, has caused such tumor to vanish; and the same has been done by frequently painting with the tincture of iodine; and a more effective agent of this kind is iodized collodion prepared as follows:—

℞. Iodini puri .... gr. vi
Potassii Iodidi ..... gr. xij
Collodii .... ℥i
Misce.

This is to be applied in the same way as the tincture of iodine. A strong solution of muriate of ammonia, viz., fifteen per cent, or the pure powder of this salt, may be used. A cure may like-

wise be obtained by injecting into the sack tincture of iodine diluted with two parts of water. Such a solution having been injected is allowed to flow out again. When done in this manner the cyst soon refills, and then absorption slowly ensues, finally ending in the cure of the cyst. Should an injection fail to cure, the work may be repeated after a few weeks. Lastly, the tumor may be extirpated by making a straight incision through the overlying integument, and then having dissected out the sac, treat the case as a simple wound.

Of all the kinds of cysts which occur in the scalp, that of the sebaceous species is the most frequent. This has its origin in the sebaceous glands, of which one or two are contiguous to, and open into, each hair follicle, and have the function of furnishing an oil-like matter to the hair. The precarious destiny of the hair exposes its glandular satellite to frequent disturbance and accident; in the falling or plucking out of the hair, the outlet of the gland may become closed, and still the production of sebaceous material continues. The result is distension of the glandular cavity beyond its natural capacity; and thus distended it crowds on neighboring glands and involves these in its morbid condition. The final end is a cavity of greater or less capacity filled with abnormal sebaceous material, which, in its changed condition, approaches more nearly to the character of a solid substance than a liquid. Of the three elementary constituents of oil, viz., oleine, margarine, and stearine, the latter is the predominant one in the content of the sebaceous cyst. When the tumor has existed long, there will be found a countless number of crystals of cholesterin in the content. Also, irregular masses of calcareous matter are likewise present in the old cyst. In fact, the content having lost its hold on organic life, the processes of inorganized nature assume mastery, and, under the action of crystallization and calcification, the content becomes a lifeless fossil. The sebaceous cyst presents a well-formed containing wall of whitish or grayish color; and in this sac a small orifice or outlet can often be detected, which continues through the integument; and through this opening the content can be forced out—a procedure which Sir A. Cooper recommends as a method of curing such cysts. Between the proper wall of the cyst and that formed by condensation of the tissues in which the cyst is imbedded, there exists a thin stratum of filamentous or areolar tissue, which contains the nutrient vessels prior to their terminating in the proper cyst-wall. This intermediate layer is of such tenacity that it is liable to escape the attention of the operating surgeon.

The sebaceous cyst is known among German writers as the atheromatous cyst, from the resemblance of the content to material found in the semi-calcified tunic of the artery which is the site of senile or fatty degeneration.

The sebaceous cyst, in the primary period of its growth, is so small that for a time it escapes observation; it can, however, grow to great dimensions; and in the same scalp one finds sometimes a number in different grades of development, viz., from the size of a pea to that of a volume two or three inches in diameter. As the tumor augments in size, the overlying integument becomes thinner, and if this be the site of hair, the latter falls.

From pressure or violence of any kind, the cyst may inflame and then its content becomes darker in color and approaches more nearly to a liquid in consistence; and such inflamed cyst tends to open and discharge an ill-smelling, ichorous material; this consists chiefly of the sebaceous content which has undergone putrefactive change. If unaided by art, such opened cyst can continue discharging for several weeks or even months; for, though the content may soon escape, yet the proper cyst wall only slowly disintegrates, and during the time that it is breaking down it probably continues its perverted excretory action, thus becoming a persistent source of a discharge that is most offensive in character. And besides the offensiveness of the discharged material, the latter, not unfrequently, through its acrid nature attacks the structures with which it comes in contact and awakens an erysipelatous inflammation, which in its march may involve the scalp and face. This possible event in the course of a sebaceous cyst should be borne in mind, and when it seems impending, such unfavorable event should be forestalled by proper treatment.

The sebaceous cyst occurs in those who have reached the middle period of life, probably from the fact that the hair then begins to fall, and as a result the hair follicles become obstructed. The commencing baldness renders the growth conspicuous and especially offensive to its possessor. From its volume, and especially when multiple, this cyst may interfere with the head-dress, and on this account the surgeon's assistance is occasionally sought.

For the reasons given, and to rid the patient of a deformity, the removal of a sebaceous cyst is a proper procedure unless the patient be very old; in all cases advanced age is a most serious contraindication to surgical interference, and especially is this so in the region of the scalp, where advancing years induce

attenuation and degeneration of the tissues. In the ante-lysterian period, ere surgery had opened its eyes to the perils of sepsis, when operations were often done by the careless surgeon with instruments whose hilts and blades bore the microscopic remains of a score or two of operations, then the old man who submitted to the removal of a sebaceous cyst in his scalp, did so at the risk of his life. The writer recalls the case of an old man in whom the desire to be rid of such a deformity was paid for with his life.

After these words of caution, intended to emphasize the importance of careful action in the removal of the sebaceous cyst, and to give the matter a place in major rather than in minor surgery, we will consider the ways in which the removal may best be done; and as methods, two have been recommended and practiced, viz., one in which there is injection of some agent which will induce atrophy of the cyst, and in the other there is immediate extirpation of the tumor with the knife. The absorbent or atrophic plan was announced by a European surgeon a few years ago. The medicinal agent employed was a strong solution of tartar emetic; in this way it was claimed that the sac was caused to atrophy, and that the sebaceous content was reduced to a calcified fôssil. It is probable that this could be done, but afterwards the patient would not be entirely relieved, since an irregular nodule would remain and disfigure the scalp. This treatment is not advised by the author, and it is only mentioned here as a plan which might be tried in those knife-shy patients to whom nature has denied the endowment of courage. The proper treatment of the sebaceous cyst is to remove it with the scalpel. As preliminary to this is a careful preparation of the part to be operated on, which may be done with soap and water; and when these have been well used, alcohol should be poured over the part. To remove the large cyst a portion of the wall should be excised; this excised portion should be elliptical in outline, and should be removed as the first act in the work. As this part of the investing dermal wall is thin, the operator runs the risk in his dissection of opening the underlying wall of the cyst, which is likewise attenuated; in fact, it is often so thin and tense that a slight pressure suffices to rupture it; and should it be opened, the remainder of the removal becomes much more difficult; in fact, from the collapse of the cyst there is danger that some fragment of the wall may be left, and this will insure a regrowth of the tumor. The integument covering the lateral portions of the cyst is next to be uplifted on each side, and

retracted by means of blunt hooks or suitable retractors; thus held, the dissection can be continued until the tumor is uplifted and separated from its subjacent attachments. The elliptical portion of integument, which is removed in the case the cyst is large, must not be too large, lest the gap made will be so great that it cannot be easily closed. And should the operator fear that he cannot estimate correctly the portion to be excised, this work had better be deferred until the cyst has been removed, when such amount of the lateral valve-like flaps can be removed as will permit of perfect coaptation of the opposite edges of the divided integument. Should the error be committed of excising more than the superfluous portion, then the wound can only be imperfectly closed, on account of the absence of elasticity in the overlying wall; for the elastic or extensile property of the integument which covers a large sebaceous cyst is gradually extinguished by the constant pressure of the underlying growth; it cannot be elongated by drawing on it, nor does it retract or shorten to any great extent after the removal of the cyst; so that, where a large amount of the superfluous wall has been left, this remains afterwards for a long time, and perhaps always, as an irregularity in the surface. In the work of removal, the vascular filamentous stratum which lies next to the cyst must be carefully removed; and if any vessels be opened, the bleeding from them should be arrested by torsion; it is seldom that ligation is demanded. Should torsion be insufficient, then exposure to the air for a few minutes will suffice to contract the vessels and check bleeding. After washing the wound with dilute alcohol, sprinkle with iodoform and then cover with lint; also wet with dilute alcohol. In case the tumor be a small one, as soon as the cyst has been removed, the covering integument falls into and closes the vacant space; the closure is so complete that no pressure, suture, or tying of the hair is required. But where the tumor is a large one and the remaining valve-like flaps do not readily close the breach, then this should be accomplished by the aid of sutures; one or two will be sufficient; as a rule, however, no artificial aid will be needed, as the parts will, without aid, properly adjust themselves.

The case will occasionally offer itself for treatment in which the cyst has, through violence in some form, been opened, and remains as the source of a constant foul discharge; and such discharge often awakens an erysipelatous inflammation which may be perilous to life. Operative interference is here urgently

demanded, even though the erysipelas has commenced; the cyst must be freely opened and its contents removed with the curette. To check the erysipelas, inject into the infected structure a five per cent solution of carbolic acid. This injection should especially be done in parts where the disease is advancing. The wound should then be dressed with alcohol and iodoform. Instead of carbolic acid, tincture of iodine may be injected into the infected parts; as this must be done at several points, but a drop or two should be inserted at each point. The recession and vanishing of the redness of the affected structure is strikingly manifest soon after the injection. But where the neighboring parts are yet intact around the opened sebaceous cyst, the recovery under proper treatment is usually unimpeded and rapid.

In cases of multiple cysts, one need not hesitate to remove a number at once, especially where they are of small volume. In this work, if the patient possesses a fair share of courage, the work may be done without an anæsthetic, since the cutting through the overlying integument causes but slight pain. Where a number of cysts exist, however careful the operator may be in his work, some minute ones will probably not be found, and these, continuing to grow, will at some future time demand attention.

As a rule the sebaceous cyst is met with only in the adult of mature age; exceptionally, however, it may occur at a much earlier age. In fact, there is sometimes seen a peculiarity of constitution which may be denominated a sebaceous diathesis, in which a great number of these cysts appear; and these are not confined to the scalp, but they are found on the trunk, and especially on the limbs. The author has seen instances of the kind in which there were a great number of such tumors, of different sizes, on different parts of the body; yet they were the most numerous on the scalp. None of the tumors reached a great size; and several of them contained semi-fluid content which had, presumably, arisen from some violence to the cysts. In such a case, in which the cysts are so numerous, prudence would dictate abstention rather than surgical interference; and such interference, if decided on, should be limited to the removal of such tumors as give inconvenience to the subject; or to those which, through liquefaction, threaten to rupture.

Lipoma.—The lipoma is a tumor of which the predominant constituent is fatty tissue; and this may be modified by the addition of fibrous or vascular tissue; and thence arise the three forms of pure lipoma, fibro-lipoma and angio-lipoma.

Like the sebaceous cyst, the lipoma usually has a proper wall which closely invests the fatty tissue; through condensation of the structures which contain the tumor, another wall is formed; and these two walls are separated by a thin structure of web-like tissue in which the nutrient vessels lie previous to their distribution to the lipoma. And this is the usual disposition of the parts in the three classes mentioned, viz., in the pure, fibrous, and vascular lipoma; but there is a form of lipoma in which the tumor is not so separated from the parts around; in fact, it is so fused with the contiguous fatty structures that it cannot be distinguished from them; this form, named diffuse lipoma, is embarrassing to the operator, since he is puzzled to decide to what point the work of removal should reach; a part may easily be left from which the growth readily reappears.

Though the lipoma is so easily recognized in most cases, yet its diagnosis is not always an easy matter; indeed, there are few surgeons who have not been guilty of the error of mistaking a lipoma for an abscess, or an abscess for a lipoma. Such mistake is commonly due to inadvertance or haste, and might be avoided by attending to the following points: The lipoma in most cases can be laterally displaced, and as this is done, the covering skin will be retracted so as to present a quilted or figured surface; the lipoma appears tethered to the integument at certain points, so that if the skin be moved over the tumor, the former is depressed in regular lines. The abscess is more firmly imbedded in the structures, and cannot be so readily moved as the lipoma. There are, however, cases in which the lipoma and abscess are so nearly alike that they cannot be infallibly distinguished except by the use of the exploring needle of large caliber. A few drops of the pus of an abscess differ materially from the adipose matter which is withdrawn from a lipoma.

The lipoma when found on the head is oftenest in that part of the scalp which is adjacent to, and emerges into, the skin on the back of the neck. Yet the author has seen and removed this tumor from the region of the frontal tuberosity; in one case, the content was purely adipose; in others it was fibro-adipose. It is oftener seen in the strong and muscular subject and, from the author's observation, oftener in the male of short neck; and, in consequence of the peculiar conformation of the neck, the tumor may, for a time, escape observation. In this location the lipoma is often of a fibrous type, and is so hard and firm in consequence as to resemble a fibroma. Though situated under the occipital

portion of the scalp, this fibro-lipoma extends downwards on the neck, so that often it is quite as much an occupant of the neck as of the head; and the fibrous character of the tumor is also shared by the normal adipose structures situated here.

The lipoma of the head, similar to that in other parts of the body, is painless; so that its removal when undertaken is mainly done to gratify the patient, viz., to relieve him of a prominence which deforms the person and interferes with the dress. In its usual site on the occipital cervical region, it may attain such a volume that it interferes with the collar of the shirt, and causes tightness and an unpleasant constriction; and from the pressure of the dress the tumor is forced inwards, reaching, as the author has seen, quite down to the upper cervical vertebra. For these reasons the extirpation is undertaken, and should be done before the growth has become very voluminous. The work is done in a manner similar to that pursued in removing the sebaceous cyst; yet it will not be required to excise any of the covering integument, since the superfluous portion of this will afterwards vanish through spontaneous contraction. From the pressure to which the tumor has been subjected by the patient's dress, it will be found closely attached to the integument and subjacent parts; besides, the tumor is often of the diffused species, that is, its actual boundaries are indistinguishable. For these reasons the lipoma here located, in its removal, radically differs from that in other parts of the body; for in other situations the extirpation of the lipoma may be reckoned the easiest feat of the surgeon's knife, since, through one simple incision, the work of enucleation can be rapidly done. But in the case under consideration, the work is one of tedious dissection.

After a deep vertical incision through the thick and dense skin, the work of separation is to be continued until the lateral limits of the growth have been reached; thence the work is to be continued downwards and underneath until the lipoma is freed from the parts in which it lies imbedded. Usually one or more nutrient arteries will be found deep seated, entering the tumor, and which must be ligated; if this precaution be omitted, troublesome bleeding from the wound will occur, which, despite the closure and compression of the wound, will continue; hence these vessels should always be ligated or closed by torsion, and thus the operator will be saved the trouble of subsequently reopening the wound, and hunting for the vessels amidst difficulties which were not present in the primary work

of removal. Hence, a cardinal rule to be observed is to seek and tie all vessels as soon as they are opened. Even those of minute caliber should be controlled, either by torsion or tying, since they are certain to recommence bleeding, if neglected. The attempt to prevent such hæmorrhage by the use of a deep suture has, doubtless, disappointed many an operator.

The bleeding being controlled, the surface of the wound may be sprinkled with finely levigated iodoform. This done, the wound must be closed, and this should be done by means of a long curved needle; for this one can employ a handled needle, with its eye near the point, such as is used for the closure of the torn perineum. This instrument entering a half inch from the margin on one side, is to be passed down beneath the floor of the wound, and then to ascend and emerge at a like distance from the edge, and the point of emergence of the suture should be as nearly as possible opposite to that of entrance, in order that the apposition of the sides shall correspond to their normal position and situation before they were opened. But if the wound have much depth, as it may have in the robust subject, then there may be difficulty in obtaining exact apposition of the wound's walls. Where these conditions are present, by a plan used by the author, better coaptation can be gotten than is obtained by the common suture; this, which may be named the figure-of-eight suture, is to be introduced as follows: A needle of semicircular curve is to be threaded with aseptic silken thread, or flexible wire, and, being introduced into one wall of the wound at the middle point of its depth, the needle is carried downwards beneath the wound, and let emerge at the corresponding middle point of the opposite side; from this point the needle is carried and made to enter the point of commencement, and brought thence through the remainder of the wall, emerging through the skin a short distance from the edge of the opening; next the remaining loose end of the thread is to be armed with a needle and carried across and caused to pass through the remaining unincluded portion of the wall of the wound. The work thus described in words, like all descriptions of mechanical work, is not very clear, as Hippocrates remarks in his description of mechanism for dressing fractures; yet it is readily comprehended when it is stated that when closed the suture represents a figure of eight, of which the deeper portion is first introduced. When such a suture is closed, it cannot fail to bring the walls of the wound into apposition throughout their entire extent; no space is left in which blood or other material can

collect—a condition most necessary to obtain speedy union. This suture does not cramp the included structures into a circular form as the usual suture does. And it can be removed as readily when its work is done as the usual suture. The use of this suture, it need scarcely be mentioned, is applicable in the scalp only in the inferior part of the occipital region, since elsewhere the structures are not thick enough to demand its use.

Angioma.—By this term is meant a tumor of which the predominant constituent is vascular tissue; and these vessels are of different thickness, viz., they may vary from that of minute caliber, so small as to be unseen by the unaided eye, to that of vessels of considerable caliber. The angioma is capable of becoming turgid; and this property of temporarily swelling has given the angioma a place among the erectile structures of the body; yet it differs materially from those structures of which erection is a normal and physiological action; the turgid state occasionally occurring in the angioma is an accidental condition dependent on the circumstance, that blood under some movement of the body is forced from the heart towards the periphery; and this action is, in most cases, some phase of expiration, as in the acts of coughing, crying, screaming, and straining, acts in which the blood is forced towards the periphery and temporarily retained there. Hence these structures are not properly erectile, but through some contingency they become swollen. The property mentioned is often connected with the growth of the angioma. The angioma may consist of fine capillaries, or of large vessels which are remarkable for their involved and contorted disposition; and these vessels present irregular dilatation, which are called caverns; hence the two species of angioma have been respectively named capillary and cavernous.

The capillary angioma may vary in size from a mere point to that of a large surface; and it may be superficial or penetrate deeply. The caliber of the constituent vessels have an influence on these conditions. The most superficial variety is the red-wine mark, which arises from a dilatation and multiplication of the outermost dermal capillaries. Between the superficial species and the cavernous angioma, in which the vessels are dilated into irregular sacs, there are numerous gradations; as the development reaches inwards, the vessels are found more dilated and of greater caliber; the vessels reach such dimensions in the cavernous species that the pulsating arteries impart an impulse to the hand akin to that of an aneurism. When constituted of larger

vessels, the intervascular tissue increases in amount so that the normal volume of the affected part is more or less hypertrophied.

The color of the angioma varies from the bright red hue of the superficial wine-color mark, to that which does not differ from the normal hue of the skin. The color of the deep-seated species is often blue, and has given rise to the opinion that such growth is composed chiefly of veins; if, however, such angioma be pricked, the blood which oozes thence will be found to be bright red and plainly of arterial character. The color, though varying, is of valuable diagnostic import; yet this sign is not infallible, since the cyst of liquid content may also contain blood, which, permeating the wall of the cyst, gives the semblance of an angioma. The ordinary angioma is usually painless, and the subject would be unconscious of its presence if he did not see or touch it; this, however, is not always true, since the angioma may cause much discomfort, and even acute pain, when it is large and presses on nerves.

The history of an angioma is usually an indefinite one; as a rule it is coeval with birth, having originated in embryonic life; yet there are a few exceptions to congenital origin. When congenital, its origin has been associated with some error in the development of the primordial segments of the early embryo; others, discarding this theory, refer the origin of the angioma to some accident occurring in intra-uterine or post-uterine life. Angiomata having arisen often follow divergent lines in their subsequent course; one retains its primitive form and character without much change; another grows slowly or very rapidly, and, having reached certain dimensions, ceases to grow and, later, it may increase in size. The tumor, when it follows a course of unlimited growth, may press on and destroy bones, muscles, nerves, etc.; in fact, destroy or render the affected part wholly functionless. And finally, in another class of cases of congenital origin, during infantile growth, it sometimes fortunately occurs that the angiomatous structure atrophies, and, finally, nearly or entirely disappears; this desirable event is seen now and then in the superficial dermal form; the infant loses the deformity, greatly to the delight of the mother, who suspects that she is guilty of marking her child. The belief in such origin is deeply rooted in the popular mind, in which so many errors planted in the past have taken fast hold; to pluck thence the present one, which lives in the name *nævus maternus*, or mother's mark, will demand a long period in future time. And the prospect of its eradication is

narrowed, when the fact is recalled that this error is shared by some minds otherwise noble in our profession. The author heard a clinical lecture some years ago in which a famous European surgeon quite failed to show his disbelief in regard to maternal agency in the causation of dermal angioma; indeed, the cases which he enumerated, in which these stigmata might be referred to the fear, fright, or fancy of the mother, were so pointed that it was clear that the would-be skeptic was a partial believer. The speaker forgot to call the attention of his hearers to the host of uncounted exceptions in this field, where "millions miss for one that hits." Beliefs of the kind here cited are often so fondly nursed, especially by the great multitude that finds it awkward and irksome to think outside of wonted lines, that he who would eliminate them is seldom complacently listened to.

The marked characteristics of angioma, especially that of purely dermal site, is its want of circumscription; no definite boundary isolates it from adjacent parts, and the lack of such limiting bounds favors its extension into contiguous parts; there are, however, exceptions to this diffusion, viz., the growth may be capsulated so as to resemble a cyst. In these exceptional cases the containing wall is closely adherent to the vascular structure; in fact, it cannot, without violent dissection, be separated from the vascular structure; on the contrary, this quasi cyst is loosely connected to the parts which contain it, since there only intervenes between the two a loose, filamentous tissue.

As has been stated, the angioma can spontaneously vanish and leave no trace of its previous existence; besides this most desirable ending, other changes may occur which deserve mention. For example, in one of these, from structural changes which occur in the angioma, the supply of blood may be interrupted and the remaining spaces or vacuoles in the tumor remain, and the separating partitions vanishing, there finally is left a common cavity, similar to a serous cyst. A deviation from this form is that in which the liquid content of the cavity is absorbed, and there only remains some solid material. These altered forms of angioma have resulted from some of the modes of treatment resorted to for the cure of the tumor.

The diagnosis of the dermal angioma is easily made where the growth is superficial; its congenital origin, red hue, temperature above that of the parts around, and capability of becoming turgid from an expiratory or straining effort of the child, are marks which clearly distinguish such growth from other abnormal

developments. When more deeply seated, the livid color, turgescence, and warmth are characteristic features; and should there be doubt as to its nature, the rapid bleeding that would follow a prick or slight incision, would clearly indicate an angioma.

From numerical observation it has been found that the dermal angioma is found on the head much oftener than elsewhere, viz., two-thirds of the cases observed were on the head. Some occur on the hairy scalp, yet the larger number have their site on the forehead and face.

The surgeon's aid is often invoked for the relief of the angioma; especially, when it is congenital, there is usually an urgent desire on the part of the infant's parent to have the marring part removed. And even the adult who has inertly and complacently borne, for years, a red, purple, or wine mark, some day may be seized with an irresistible impulse to be freed of his deformity, his chief reason perhaps being that he desires to "look like his friends." Such an impulse once awakened is similar to all ungratified whims, it never vanishes until its purpose has been realized.

In most cases the dermal angioma is painless; and its removal is only desired in order to be rid of a disfiguring mark; and, as this is the principal thing sought, the surgeon's task is surrounded with unusual difficulties; for in no way can such work be accomplished without leaving some cicatricial evidence of what has been done; some scar must inevitably remain; and this often becomes to the patient quite as offensive as was the angioma; but as the latter has vanished from view, it is quickly forgotten, while the cicatrix remains and becomes an ever-during, hated object. The footsteps of time are constantly changing the human face; and, though they may obliterate some of the unsightliness of a cicatrix, yet the latter can never be wholly effaced; and in it, as in an indelible inscrpition, the imperfections of the surgeon's art ever legibly appear.

Instead of commencing his work at once, the prudent surgeon will premise his treatment with certain preliminaries intended to prepare the patient's mind, or that of the friends, for the future condition of the part operated on; the scarring which must result from the operation must be heralded in emphatic terms; and should this be strongly deprecated by the patient, then it is far better that no operative procedure be attempted than that the surgeon should plant in the patient's heart a feeling of unending resentment against him. In cases involving life, such pre-

cautionary policy and prophylactic conservatism on the part of the surgeon should be allowed no place in his action; but in the case under consideration, in which the patient's life, comfort, and ease are not interested, and the removal of the deformity will not remove a pain, nor add one day of life, and where the proposed work is one of "complacency," then to such prudential consideration prominent place should be given. The clear-minded Celsus duly estimated such discretion where he refers to the hesitancy of the physician to adopt treatment of doubtful result in a "splendid personage."

The patient having consented to accept the results of scarring, which may never vanish from sight, the surgeon proceeds to select one of the many methods which may be chosen for the removal of an angioma; the principal ones of these methods are excision, ligation, cauterization (actual and potential), the induction of coagulation of the blood of the growth, destruction by vaccination, and induction of atrophy by compression.

Of the methods mentioned, the author has a decided preference for excision, based on an extended use of the same; yet the beginner may be wanting in some of the requisites needed to do the work in this way. The peril in this method is from the loss of blood; to lessen this loss, the excision must be done rapidly and the vessels secured quickly—work which is best done by one who has had ample discipline in operative work. The advantages which the method of excision has are that it reduces scarring to the minimum amount; and it reduces the period of healing to its shortest limits. To operate by excision one must have two assistants, and, as instruments, scalpel, curved needles armed with wire, scissors, hæmostatic forceps, and silk ligature. The silk ligature is rarely needed, yet it should be at hand. To one assistant should be committed the important task of making compression around the part to be removed, and also on the carotid artery which furnishes blood to the tumor; for the latter compression, a third assistant may be required. Inattention to these means of preventing the loss of blood has been the cause of death in several recorded cases. The temporary compression of the carotid artery is an important precaution, where the growth is unilateral in site, as thus the bleeding may be controlled in a great measure.

The cutting may be done quickly or slowly; in the first way the growth is removed as rapidly as possible, the vessels being secured after the removal; but in the second way, the vessels are

secured as they are divided. As Petit advised, the line of incision should be in the boundary between the sound and the affected structures; done thus, the hæmorrhage will be reduced to the smallest amount. Where the angioma is of small dimensions, it may be easily and safely removed by the rapid plan; when thus done, the assistant who is compressing the parts around, lessens the wound by sliding its borders towards each other; and when thus approximated, the edges, through the aid of the sutures, can be brought quite together, provided the angioma is of small extent. The sutures should be introduced so as to include the vessels, and thus the bleeding is controlled. In introducing the suture, the needle must avoid the vessels; and if these be tranfixed, which will be revealed by blood escaping from the wounds made by the needle, then the needle should be withdrawn and passed at another point. A suture transfixing a vessel not only causes bleeding externally, but it may do so internally, beneath the scalp. Hæmorrhage under the scalp may occur where an edge containing a vessel is infolded, and such bleeding, being concealed, may be so great as to be dangerous. This concealed bleeding may occur in operating in other parts of the body in which wounds are closed externally, while vessels are left open, and bleeding continues in the wound beneath. In such cases the blood continues escaping and fills every recess of the wound; and the clotting blood, wedge-like, thus insinuates itself between the opposite walls of the wound or cavity, and prevents healing. And in the wound caused by removing the angioma from the child's scalp, such concealed hæmorrhage is very perilous, since in the loose interspace between the pericranium and the hairy scalp the blood has room to collect in large amount; enough, in fact, to cause death, as occurred in a case reported some years ago. In this unfortunate case the angioma was excised from the frontal region, the wound closed by suture, yet the blood continued to flow unperceived, until the infant perished, when it was discovered that an immense quantity of blood was imprisoned in the space referred to. Hence in excising the angioma from the scalp, the operator should neglect no precaution to avoid both seen and unseen hæmorrhage.

If the angioma be of large extent, then the slow method of dividing section by section is the safer plan; then the vessels can be ligated as soon as they are severed. Another method is by percutaneous transfixion, in which one so circumscribes the vessels beyond the line of cutting that the incision can be made

in nearly bloodless tissue. This hæmostatic precaution being taken, the excision is next to be done, and the vessels ligated as they are opened. Or should the provisional circumscription be so complete as to quite control any bleeding from the wounded vessels, then the ligation of the latter may be dispensed with, and the circumscribing ligatures be left in site for three days, when they can be removed. Meantime, an attempt should be made to close the wound as nearly as possible. This is best done by metallic sutures which are introduced a little distance from the margin, so that some traction can be made with them. Where the breach made is very extensive, and the closure by direct apposition is impossible, then the work may be done plastically by dissecting up flaps from the contiguous scalp, and turning these into the opening; thus complete closure can sometimes be accomplished; or if it be not complete, then the small spaces left uncovered will soon heal by cicatrization.

The infantile angioma has been removed by ligation; and the work can be done in sections; or the growth may be tied in one mass. If ligation be attempted, the plan of doing this in mass is the better one; for when done in sections, some of the structure may not be included, and through this the vitality of the growth may be maintained, and thus a failure result. Ligation in mass is best done subcutaneously. To do this, let a well-curved needle armed with a strong silken thread enter at some point on the border of the angioma, and, passing some distance under the skin, emerge at another point in the border of the growth; let the needle reënter and emerge again; and thus let the work proceed until the needle has passed quite around the growth, and emerge at the first point of entrance. When it is thus done, the silken thread will have encircled the tumor, and the two ends of the ligature having been tied firmly together, the growth will be cut off from its supply of blood, and die from strangulation. The cord should be so tied that it can be retied as soon as it loosens. This method has been successfully used by the author, yet there is an objection to it in this, that it is attended by suppuration, and, there being no free outlet for the pus, it may have a septic action. Yet in a large erectile tumor in an infant's face, the author obtained a satisfactory result; the scarring was not unsightly, since the skin remained intact except where the needle wounded the parts. Where the tying is done in sections, the skin being included, the skin must necessarily die, and thus the scarring is greater than when the work is done by subcutaneous

circumscription. The plan of ligating by means of a ligature thrown around transfixing needles has been tried; this method is less effectual than the other modes of ligation which have been described. Also, temporary ligation, in which the ligature is removed after a couple of days, has not given satisfactory results; for the part that has thus been deprived of blood is rapidly resuscitated after the removal of the ligature.

Cauterization, actual and potential, has been employed for the removal of angioma. When the growth is superficial, it may be removed by touching it with a cauterizing iron that has been heated only to brown heat; at such a temperature the work can be done without breaking the surface acted on. Such a heat will coagulate the albuminoid content of the blood, and thus an important step is taken towards lessening the nutrition of the angioma. This cauterization should be repeated once in forty-eight hours; and if persevered in, a superficial angioma may thus be removed. A degree of heat sufficient to do the work can be obtained by immersing the cauterizing iron in boiling water. But in case the growth be thicker and approach to the cavernous type, then superficial cauterization will be insufficient; in such case the work can be done by means of a needle at red heat, that is inserted into the tumor. This can be done in the manner described for the destruction of warts, in which a long needle having been made to penetrate, the latter is afterwards heated to a red heat. The needle must be made to enter different parts of the growth at intervals of a quarter of an inch; thus done, the clotted blood interrupts the circulation, and, checking the nutrition of the growth, the latter is caused to atrophy. In the author's essays with this plan he found that there was less danger of wholly destroying the growth by excessive heat than he apprehended; even though the angiomatous structure was pierced and burned at many points, yet it soon regained its vitality, so that it became necessary to repeat the cauterization two or three times, at intervals of a week or two. Done in this manner, the skin is not destroyed, but the subjacent vascular structure atrophies, and the affected part gradually approaches the type of the contiguous sound parts; some months, however, will be needed to finally complete this reduction. Besides the plans described, the cauterization may be done by means of the thermal cautery; for this a special apparatus is required, while for the method above described, some simple means may easily be contrived.

The dermal angioma may be removed by the potential cautery.

For this purpose, when the growth is superficial, nitric acid may be used; to do this, let a glass rod be dipped into the fuming acid and applied to the surface of the angioma. This repeated daily for a number of times, by coagulating the blood in the superficial vessels, ends in causing atrophy of the vascular growth. It is only in cases in which the growth is very superficial that this plan is successful. This treatment was much employed by Langenbeck, yet in trials of it by the author, the results have not been satisfactory. It might, however, be tried in cases in which the angioma is merely superficial; but when the growth comprises the entire thickness of the skin, then cauterization done potentially requires a more active agent than nitric acid; as such are chloride of zinc and caustic potash; arsenic, also, has been used, yet its poisonous property renders its use unsafe. To use chloride of zinc, let the following mixture of it be made:—

℞. Zinci Chloridi.
Farinæ. ....āā ʒi
Misce.

This moistened into a paste may be spread over the growth, when it hardens into a crust-like coat. In this way a stratum of the angioma is destroyed, and, after a few days, it will fall off as a dry eschar. After this detachment, the escharotic paste may be applied again, and this work may be repeated until the growth is wholly removed. This is one of the safest plans of potential cauterization; yet the work is painful and tedious. The work, however, may be more rapidly done by means of potassa fusa; but the caustic potash is too violent in action if used in its pure state, and, hence, it should be employed in a dilute form; for this it may be mixed with an equal part of Pulvis Radicis Sanguinariæ, or with an equal part of calcined magnesia. The use of the latter compound is original with the author, and his experience justifies him in recommending its use. The latter compound is a white powder, and, for use, must be moistened and spread in small amount over the angioma. This acts more destructively than the chloride of zinc, and hence caution is required not to apply too large a quantity. A few hours after the application, the structures underneath are black and lifeless; and the dead eschar must be detached by poulticing, which must be continued for some days, to complete the detachment. The caustic potash may also be used mixed with an equal portion of Pulvis Sanguinariæ; and the action from this has

seemed to the writer to be more severe than that composed of caustic potash and magnesia. Instead of the external use of the potential caustics, they may be used interstitially; both the chloride of zinc and potassa fusa may thus be employed. The chloride of zinc, with wheaten flour made into a paste, can be cut into arrow-shaped portions, and these, hardened by heat, can be inserted into the openings made into the growth, and, being left there, they do their work of destruction. The caustic potash mixed with one of the ingredients mentioned, may be introduced into the angioma through the canula of a trocar after the stilet has been withdrawn; thus cylinders of the escharotic may be passed into the angioma, at different points, and in this way the growth may be destroyed. A serious objection to the method of destruction by the potential cautery is the destruction of the skin, and the deforming scar which afterwards remains.

The angioma may be removed by injecting into it some agent which will induce coagulation of blood, and as a consequence so impair the nutrition of the growth as to cause its atrophy and disappearance. Agents employed to accomplish this work are ergotine, the tincture of iodine and astringent solutions, as that of the chloride or sulphate of iron, alum, and the strong decoction of oak bark. Considerable trial has been made of this method, yet the results obtained have not been such as to awaken much enthusiasm on the part of those who have employed it. The best results have followed the injection of tincture of iodine and ergotine. The coagulating fluid is to be introduced by means of a hypodermic syringe, which is caused to penetrate at different points, and not more than two or three drops are to be injected at each point. The ergotine used and praised by Langenbeck is objectionable on account of the pain it produces. The solution of the salts of iron used by injection may arrest and prevent further growth in the angioma, yet the most serious objection to these agents is that the iron remains incorporated with the tissue of the angioma, giving the same a black color, so that the work ends by giving the patient a black mark in place of the previous red one. The tincture of iodine is free from the objections which can be urged against the other agents mentioned; and if the treatment by subcutaneous injection be decided on, this agent may be selected as the best one. In cases in which the angioma contains large vessels, pressure should be kept up for a time around the angioma, so as to retain the clotted material in the tumor, and thus prevent its escape into the general circulation;

and thus proceeding one avoids the embolic closure of vessels elsewhere. As final injunction to those who may adopt this treatment, let the tincture of iodine be used, and the injection only be done with minimum amounts of the tincture, and repeated a number of times, at intervals of two days; and should reaction indicating suppuration appear, then the treatment should be suspended until the reaction has disappeared, and resumed again at longer intervals.

The angioma may be cured by vaccination in a subject who has never been vaccinated. This is done by introducing the virus at different points of the growth; and this is not an easy thing to do, since the wounds made for the insertion of the virus bleed so freely that the latter is washed away. Hence the plan has been successfully tried of vesicating the surface with cantharides, and then placing over the denuded part lint saturated with vaccine virus. Or threads saturated with the material may be passed seton-like through the growth. It may also be done by slightly scarifying, and then placing the liquified virus on the slight wounds. The work of inoculation might be done with a hypodermic syringe. Vaccination done in this way takes a peculiar course. After the common period of incubation the vaccine vesicles open and ulcerate; the ulcerating process dipping inwards, as well as extending laterally, so that each vaccinated point becomes a large open wound. In an angioma seated on the chest the author saw, from vaccinating, an ulcer several inches in diameter, and which was accompanied by so much destruction of tissue that for a time the infant's life seemed imperiled. The action deviated wholly from the normal cycle of vaccinia; the ulceration continued for a number of weeks; and, what was remarkable, it appeared to follow, attack and break down the abnormal vascular structure, and to leave the normal tissues unacted on. After a tedious period of ulceration, cicatrization ensues and continues until the wounded surface is closed by a white scar. In this way an angioma of superficial character may be safely destroyed, but where it is of great extent and penetrates deeply, its removal had better be tried by some other means. An objection to this method is that, after the surface is healed, it retains the characteristic marks of the vaccine scar. A plan cognate to this is that by pustulation, which may be done by the application of croton oil or tartarized antimony. The pustules produced by tartarized antimony have a striking resemblance to those produced by the vaccine virus.

And, lastly, the angioma may be retarded in its growth by compression continuously applied for a long time; and in this work the surgeon should bear in mind that the angioma often continues to grow until the subject's body has attained its final term of development. It is stated that infantile angioma has been cured by compression maintained by the mother's hand; it is probable that the successful continuance of such a task could only be maintained by maternal affection. Compression, indirectly used, has been obtained by astringents used locally; cures thus obtained have been announced. As a substitute for the mild action of an astringent, the contractile action of collodion might be used. For this, the best quality of collodion should be employed; and of this a thick coating should be applied on and around the affected structure. The long continuance of this might induce atrophic regression of the vascular structure. Fingers, even the mother's, may tire; the action of astringents may prove impotent; and collodion through its ethereal ingredient must irritate and cause pain; hence, if compression be selected for the cure of the angioma, some mechanical way of accomplishing it should be used. Such compression may be made by means of a pad similar to that of a truss; to the truss straps may be attached made of leather or of India rubber, and such straps are to be carried around the head and fastened by buckles, so as to remain in place and exert a continued pressure. As already said, this compression must be continued an indefinitely long period to accomplish its purpose.

Vascular Growths.—Besides the growths which arise from abnormal development of the capillaries, which have been described as very frequently occurring in the scalp, there are seen there tumors in which the leading constituents are vessels of larger caliber; and such tumor may consist of veins alone, or veins and arteries may unite in the formation, or the growth may be wholly arterial.

From the position of the veins of the scalp, in which the force of gravitation is slight or absent, venous dilatation, occurring so often in the lower part of the body, is rarely seen in the head. And where such widening, named phlebectasis, is found in the scalp, it is a result of congenital enlargement, in which the veins are primordially dilated; and, in some cases, this irregular development continues after birth, until an extensive portion of the scalp becomes affected. The overlying skin becomes attenuated and livid in hue, and the affected structure when opened

to view seems intrenched with irregular channels, on the walls of which the pigmentary matter of the blood is usually found deposited. Ordinarily such venous growth is painless, and, having reached a certain volume, it ceases to grow. The hair, in part or in whole, falls from the affected structure.

Not unfrequently, along with the venous dilatation, the arteries undergo a similar change, the condition then being named arterio-venous aneurism. This form resembles simple phlebectasis, yet in such growth there may be felt the vibratile thrill of the widened arteries; and rising and falling movement of the superjacent surface is also visible; and if touched it will be found warmer than parts adjoining. In a case of this vascular growth seen by the author, the greater portion of the scalp was affected. The man who was the subject of this growth was over fifty years of age; it had existed many years. The vascular development seemed to be greater in the deeper portion of the scalp, and as accurately as could be estimated by palpation, it was an inch in depth. This increased thickness was not wholly due to the vessels, but depended on growth of the tissues which lay around the vessels. This development had arisen from the irritation caused by the pressure of the encroaching vessels. This growth, commencing near the summit of the head, reached downwards on one side of the forehead; the structures of one pinna were affected. This growth was not painful, yet it was the sight of a vibratile movement and a buzzing sound which was very annoying to the patient; and, for relief from this constant sound, the man sought surgical aid. The growth was too extensive to admit of removal; in fact, any of the known methods for the care of such a morbid development are too perilous to life, and should not be advised unless the growth has become such a burden to the patient that he is willing to risk his life in the effort to find relief; and in that event a recourse might be had to arterial ligation. The supply of blood might be cut off by tying the external carotid arteries. The ligation of these vessels, though mechanically difficult, is not a severe assault on the patient; and it should be tried in preference to excision, or parenchymatous injection of some agent to cause coagulation. The ligation of one carotid would be insufficient, since through the remaining untied artery the blood would soon reach and fill the growth. Instead of ligation, an attempt to relieve might be made by direct compression of the affected structure; in this way the growth might be prevented from further development; and, besides this action, if the

growth had reached such dimensions as to seriously annoy the possessor by its buzzing fremitus, then the latter might be lessened by a properly adjusted compress. Pressure should not be too great, lest it might cause abrasion of surface, and thus cause hæmorrhage.

Aneurism occurs in the vessels of the scalp; but before considering it, a brief consideration of the subject of aneurism should precede. The medical etymologist finds difficulty in discovering the origin of the term; the author thinks he finds traces of it in the Greek preposition *ana*, meaning up or upwards, and *eurys*, an adjective meaning wide; and the name thus constructed signifies an upward widening. An aneurism is a hollow tumor of irregularly rounded outline, which arises from an artery into which the cavity of the tumor opens, and which is filled with blood in irregular motion. The walls of the tumor are continuous with those of the artery whence it springs; and when these walls are complete, one finds in them the three tunics which constitute the walls of the artery; or some of the tunics may be wanting. Hence arises the classification of *true* and *false* aneurism; in the wall of the true class no tunic is wanting, but in the false, called also the mixed form, the wall may be composed only of the external arterial coat; or the external and middle tunic may have been ruptured, and then, in this rare form, only the innermost tunic will be found, forming the wall of the aneurism. The wall of the aneurism has been the matter of discussion; some claim that with careful dissection all three tunics may always be discovered, and that their continuation with the normal tunics of the artery can be traced out.

In another form akin to the false species, the wall has no direct anatomical connection with the wall of the vessel; and since it arises from an injury in which the vessel is opened, such aneurism is named traumatic. An essential condition here is that the artery be surrounded by soft parts, into which the blood, escaping from the torn vessel, forces itself and forms a hollow cavity. In time, around such cavity there is formed an irregularly organized wall, which prevents the further diffusion of the blood into the neighboring structures. In case the rupture is in a vessel which lies in a cavity, where it is not walled in by other structures, then a fatal hæmorrhage can ensue; such has been seen in the thorax and abdomen.

True and false aneurism may be conjoined; namely, one arising from an artery and contained in the distended tunics of the

vessel may burst, and form a hollow in the parts adjacent, and the latter form a containing wall.

The connection of, and communication of the aneurism with, the supporting artery, may be termed its pedicle or base, and the form and extent of this base have an important bearing on the course of the aneurism. When an aneurism has ceased to enlarge, there is a tendency to spontaneous occlusion of its cavity. This occlusion occurs through the agency of the cellular, fibrinous, and albuminous constituents of the blood, which in solid form are deposited on the wall of the cavity, so that this wall slowly thickens at the expense of the inner cavity. This deposition is from the blood, which is stagnant or in torpid motion, and the stagnation or tardy movement is favored by the narrowness of the opening in the aneurism. The materials thus precipitated become organized and are stratified, so that the superadded structure is separable into layers. This is tinged with the pigment of the blood. The formation of this material depends on a due amount of blood which enters the aneurismal cavity, and, tardily moving there, again escapes into the onwardly moving current of blood. Spontaneous rupture seldom or never occurs, where the tumor is inclosed by other structures; and bursting there occurring would be from some violence. Nevertheless the pulsatile movement, or action of an aneurism, on neighboring parts, tends to attenuate the latter. Bone thus becomes eroded or softened, and disappears similar to a rock over which the watery tide constantly ebbs and flows.

As stated, there is a tendency in every aneurism to become occluded through concentric growth or thickening of its walls; this work is tardy and uncertain of its aim, so that in case the tumor lies external, or is accessible, the surgeon's aid is invoked.

To favor and accelerate the deposition of the occluding material two methods are prominently in use,—ligation and compression. Ligation, introduced by John Hunter for the cure of popliteal aneurism, has been resorted to for the cure of aneurism elsewhere. There are different plans of ligating. It may be done between the heart and the tumor, or on the distal side of the tumor. Hunter's method was to tie at some distance from the aneurism on the cardiac side. Anel and others advised to ligate on the cardiac side close to the tumor. Aneurism may be cured by each of these plans, though that of Hunter is more commonly practiced. An exceptional method is the ligation of the artery beyond the tumor, known as Brasdor's operation; and a modifi-

cation of this method is the tying of the two branches into which the vessel bifurcates beyond the aneurism; and this method is named from its introducers, the operation of Brasdor and Wardrop. Ligation beyond the aneurism has been chiefly done on the carotid and subclavian arteries.

Aneurism has been cured by compression made on the afferent vessel, on the cardiac side of the tumor; and this compression may be done close to the tumor or at a distance from it. Again, the work has been successfully done by pressure made directly on the aneurismal tumor. Such compression may be done with the human hand, or it may be done by means of an instrument.

And finally, a method of cure known as that of Anthyllus, is that in which the aneurismal tumor is opened, cleaned of its clots, and the entering and emerging portions of the artery are ligated. This method is only applicable to aneurism seated on small vessels, and usually such as have arisen from the rupture of the vessel, that is, in traumatic aneurism. It would be wholly inapplicable for the cure of an aneurism arising from a large artery. A plan cognate to this has recently been practiced, viz., to tie the artery on each side of the aneurysmal tumor, and then dissect out the latter.

The arteries of the scalp are of diminutive caliber, and are rarely the site of aneurism; and when this occurs it is commonly of traumatic origin; such aneurism is met with in the frontal and temporal regions of the head. The usual cause is a penetrating wound or violence on the part through a fall, blow or moving missile. The dense structures in which the vessel lies imbedded prevents the aneurism from attaining a large volume.

Aneurism seated in the scalp tends to spontaneous occlusion; yet this mode of ending is slow of accomplishment. Hence it is better to hasten this desired event by the selection of some of the means previously described. Direct compression should first be tried, since it causes no scar and is bloodless—conditions always agreeable to the patient. For this purpose let a compressing pad be constructed of yielding material, such as soft leather or India rubber, and let this be placed on the tumor and be fastened there by retaining straps. By such an appliance continued compression may be made on the tumor; enough of force must be used to flatten the tumor and arrest the pulsatile movement in the latter. The author has seen a traumatic aneurism of the frontal artery thus compressed, and a cure effected after a few weeks' continuance of the treatment. Should this fail, the tumor might

be opened and the vessel tied on each side; this method would surely cure, but also scar the patient.

Infantile Sanguineous Tumor.—The newborn child usually presents a swelling of greater or less extent on the parietal region of the head. This tumor or tumefaction is caused by the violence to which the head is subjected during its passage from the uterus through the pelvic outlet. It is commonly located on the upper and posterior part of the head, which corresponds to the posterior portion of the right parietal bone. There are two forms; in one, the blood is diffused through the soft tissues by simple extravasation; the capillaries are dilated or burst; the greater part of the swelling is due to effused blood, since mere swelling of the capillaries cannot account for the greatly increased volume of the part. In another form there is a collection of blood which rests on the cranium, and is separated from the parts around by an imperfectly formed wall. The infiltrated form, first mentioned, is due to the protracted delivery; the head having partly protruded through the os uteri remains there for some time, while the surrounding uterine neck grasps the retained head like a strangulating band. The form of this tumor is that of a non-pedunculated growth, which is soft and slightly elastic. During the progress of labor this protrusion can be felt, and also observed to elongate during the time of the uterine expulsive acts, and its volume is increased proportionately to the length of the labor, the causal mechanism being in the firm and resistant collum uteri, which, during the pains of labor, catches and holds the dependent portion of the scalp, and ties off, as it were, a portion of blood from the general circulation.

This vascular tumefaction seldom requires attention; if anything be done, it may be limited to protecting the part with cotton wadding, and the application of camphorated liniment. Sometimes, however, the quantity of effused blood is too great to be absorbed, and the result is suppuration, in which there is formed an ichorous fluid, which is required to be liberated by an incision of the overlying skin. There should not be haste to do this, since unaided nature, usually, can effect a cure.

In the second form, in which there is a collection of dark, grumous, uncoagulated blood, absorption of this fluid sometimes occurs; yet in many cases the fluid remains, and the containing parts show by their heat that there is inflammation tending to breaking down and opening of the cavity. In such condition the cavity should be opened, and after the blood has been evacu-

ated, the containing space should be washed out with an alcoholic or sublimated solution. In lieu of this an emulsion of iodoform might be injected. In the emptying of such cavity, care must be taken not to press violently on it, as there is danger of reopening the afferent vessels; if this should be done, the cavity would quickly refill. This has occurred in the author's practice. After the evacuation and washing out of the cavity, slight pressure with a compress of cotton wadding should be fixed over the cavity; thus closure is promoted. Nevertheless, it is rare that one evacuation suffices; the cavity partly refilling will probably demand reopening once or twice again, before a cure is effected. And, despite these precautionary measures, suppuration may occur and entail a tedious recovery.

Pigment Marks.—The chapter on benign tumors of the scalp would be incomplete without considering pigmentary marks of congenital origin, which are of occasional occurrence. Such marks are dark or black in color, and are commonly accompanied by increased thickness of the affected part; and, if covered with hair, the latter is luxuriant in growth and sometimes of intense blackness. Such growth may occupy a large surface, even to the extent of three or four inches. The author has met with two examples which were seated on the anterior portion of the cranial vault, and extended from the coronal suture forwards to the eyebrow, on one side. This coloring of Ethiopian blackness was congenital in each case. The limit between the normal and abnormal parts was clearly defined; and in one case the hair was several times the length of that on the unaffected portion of the head. Such pigmentation does not appear inclined to spread beyond the limits it has at birth. The affected structure is not erectile; nor on section does it seem very vascular. It is probable that such growth originates from a capillary angioma which has undergone retrograde transformtion.

This pigmented growth is a serious inheritance to a newborn child, since it fatally disfigures the head, especially when it reaches down on the forehead. The author, though familiar with infantile deformity, carries in memory pictures of the two cases mentioned, traced with unusual vividness; and especially does he recall the parental appeal for surgical aid, even though such aid in removing the mark should remove the infant. In the cases mentioned life was saved, though extensive excision was done. To do this properly, the cutting must reach quite through the scalp; and the operator must be sure that his inci-

sion reaches beyond the affected structure; for a small marginal portion left will remain as a black seam on the border of the cicatrix. In this work divided vessels must be seized and ligated. Partial closure of the wound should be attempted, even though the breach made be a large one; by lateral displacement the wound may be materially lessened in extent, and opposite borders may thus be made to coalesce. Wire and catgut sutures must be used for the closure. The wire sutures must be so placed as to fix the parts and relieve them from tension, while those of catgut must effect accurate union. Hæmorrhage being controlled, and the part being sprinkled with iodoform, it is to be covered deeply with lint which has been saturated with the compound tincture of benzoin, and held by adhesive strips, which surround the head. Such a dressing may remain in place for a week, or longer, should there be no discharge; and afterwards changed as occasion may demand. In this work of excision, should hair, either of the scalp or the brow, be removed, the cicatrix will afterwards remain bald. In case of an eyebrow, this should be announced to the parents beforehand, since no art will supplement the loss.

Malignant Growths.—The author will next consider malignant growths which occur in the scalp.

Whence the malignant growth arises, to what extent spontaneous evolution, traumatism and indeterminate contingency figure as elements of causation, how far the tendencies of ancestry, distant or proximate, as transmitted heredity, may influence such growth, whether cell or microphyte may be the primary causal agent, are questions which have been asked, and will continue to be asked, until this department of Pathology has reached a stage of unquestionable fact, far, very far, from where the writer now finds it. Though much is known here, probably much more remains unknown. The best work in this field will be done by those who combine in themselves the theoretical pathologist and the practical clinician; those in whom the exuberances of theory will be lopped off or corrected by observation and study of the thing as it exists in nature. And, though such students of nature labor earnestly and diligently, yet the line of progress only slowly approaches, and rarely reaches the line of truth; and it finds an analogue in mathematical lines, as the inclining sides of the oblique parallelogram, which, though indefinitely prolonged, ever draw nearer, yet never touch each other. Illustrations of how

much labor, reaching through many generations, is needed to pluck up error which has taken deep root in the human mind, may be seen in the example of how long the notion lived that inorganic nature was constituted of four elements,—earth, air, fire, and water,—and an analogue is also seen in the long shadow of error which was projected over the field of medicine by the doctrine of the four elements which were thought to constitute organic beings, viz., blood, phlegm, bile, and atrabile; and from these elements the old pathologist derived phlegmon, dropsy (œdema), erysipelas, scirrhus, and the family of tumors. Atrabile was the element whence sprang all preternatural growths. Medical science bowed its head to this idol, moulded into such enduring form by the hands of Hippocrates and Galen. These old notions, formulated so neatly and become sacred through traditional preservation, were parted with reluctantly. Yet the eighteenth century gave medicine many heretics, who renounced many of the old doctrines, who read facts as they are recorded in the tissues, sound and unsound, rather than their misinterpretations as treasured up in the parchment-bound tomes of antiquity; and none plucked up more weeds of error, and planted more truths in their stead, than John Hunter. And into this field, hitherto so little trodden by the foot of patient research, the nineteenth century has sent a host of diligent workers, among the most famous of which may be mentioned Paget, Virchow, Waldeyer, Cornil, and Ranvier. From the numerous facts which have been brought to light by these students of abnormal growth, a few will be presented to the reader concerning sarcoma and epithelioma, forms of malignant growth met with in the scalp.

Sarcoma, literally flesh tumor, has had a changeable history, as soon becomes apparent when one attempts to study the literature upon this subject, and tries to form a clear notion of what is meant by this term. After much errant search for exact knowledge, in which the student is often lost or puzzled by vague descriptions of tissues seemingly very different, the fact is finally grasped that the various elements of the animal body are held in union by a web, which, from its office, is named connective tissue; through this the peculiar elements, which distinguish the derm, muscles, bones, glands and other organs of the body, are held together, and the special structures individualized; and, finally, it has been observed that this connecting structure is the starting point of a large group of malignant growths. To the growth which originates from connective tissue the name sarcoma is

applied; and as connective tissue abound everywhere, hence arises the regional universality of sarcoma. And if the writer has not erred in his observation, besides the connective tissue, the parenchymatous elements which the latter unites, may exceptionally be the starting-point of sarcomatous development. Nay, more, the epithelial elements may stray from normal line and contribute to sarcomatous formation. And such deviation finds a parallel in the license sometimes taken by epithelioma, since, in the latter, cells of connective-tissue origin sometimes occur.

In the healing of wounds, both concealed and open, repair is accomplished through the medium of cells which originate partly from the adjacent connective tissue, and partly from colorless blood-cells, which have escaped from the contiguous vessels. This reparative material, having reached the limits which correspond to normal form, ceases to grow, and, as it does so, the component elements are transformed into fibrous tissue. When the sarcoma is studied in reference to its cellular constituents, it is found to be singularly similar in composition to the structure that repairs the wound. Both structures present us with the same nucleated round cells, regularly arranged around vessels which traverse the developing structure. The similarity, so marked in the early stages of the two structures, vanishes at a later period; the one becomes on the surface of the body a scar, hard, fibrous and non-vascular. The sarcoma may undergo a similar change, yet, as a rule, it is stamped by the permanency of its round cell-form; hence the name of the round-celled sarcoma. But these cells, similar to those of granulated tissue, do sometimes undergo a species of development or transformation; the cells become organized into a tissue of fusiform or doubly conoidal fibers; and this species is named the fusiform or spindle-celled sarcoma. The round cells and spindle-shaped cells are, usually, found combined with some growth. The student of the microscope will soon learn here, as he has already learned in his study of other structures, that there are many deviations from the leading or typical forms; that though there are many approaches towards roundness of cell form, yet there are few cells which are perfectly round; and, likewise, that the schematic spindle-cell, so familiar to the eye in plates, is a rarity in nature, which, delighting, here as elsewhere, in freedom, spurns uniformity and revels in variety. Exact type, definite rule, and measured division of parts, are valuable aids in the acquisition of knowledge, and they further mental discipline; yet these artifices are

unknown to nature, a fact which the experienced student soon learns to his regret, and for which he must make due allowance everywhere, and nowhere more than in the field of Pathology. The minute components of pathological structures must be viewed again and again with untiring patience before order appears and confusion vanishes; thus working, the typical at length asserts its presence and predominance, and the non-typical and amorphous are lost sight of. Having reached such a stage of proficiency, one readily descries and distinguishes the round cells of the sarcoma, many of which through pressure or manipulation have become irregularly polygonal or elliptically elongated. Also, along with these rounded forms may be often seen figures of shuttle-form, or similar in shape to the oat-grain; these are the spindle or fusiform cells. One or the other of these cell-forms predominating assigns the sarcoma to the round-celled or fusiform species. In the latter there has been an effort at organization in the transformation of the round embryonic cells into the long forms simulating fibers; such a tumor is indurated and is fasciculated in texture.

A third form of this tumor, which has been particularly described by Sir James Paget, is that known as the giant-celled sarcoma, this name being given on account of the enormous size of the constituent cells. The giant-cells, when carefully examined, are seen to be compound forms, that is, cells in which a number of nucleated round cells are packed in, and held together by, a common containing envelope. A similar giant-cell has been found in the syphilitic gummy tumor and in exuberant granulation. As a cell of this character is a normal constituent of fetal marrow, it has been designated the myeloid cell.

In the three forms of sarcoma described, the component cells lie in contact, or are exceptionally separated by an amorphous intercellular substance.

In the development of the sarcoma, along with the production of cells, there is also a vascular growth; vessels of minute capillary form are developed in the tumor. And these vessels are more numerous in proportion as the sarcoma is more closely allied to the embryonic type, that is, to the round-cell species. There is a similarity between the vessels of granulative and sarcomatous tissue; yet the vessels in the granulation are more highly organized than in the sarcoma; in the latter they are of a very rudimentary form, and are easily ruptured. Hence, from slight violence the vessels of the sarcoma may be torn and blood effused

into the tissue. The constituent cells lie in immediate contact with the vessels, in this respect differing from the vascular arrangement of carcinoma, in which the vessels are separated from the characteristic carcinomatous cells by a layer of tissue.

The sarcoma viewed macroscopically presents itself in different species or varieties; thus we have forms of it which are named encephaloid, fasciculated, ossified, and myeloid.

Encephaloid sarcoma is constituted of round cells and vessels; in structure it is very analogous to that of the early embryo, viz., a compound of very rudimentary cells grouped around minute vessels. The cells and vessels grow rapidly, and sooner or later the cell growth outstrips the vascular growth; and then the cells which are most distant from the vessels perish from defective nutritive supply; and if this be within the growth, a collection of semi-liquid material appears, which in composition may be compared to ill-formed pus; and if such disintegration occurs near the surface of the tumor, then the integument of the latter may open and an unhealing ulcer result. With such characteristics, the encephaloid sarcoma is entitled to a place among malignant growths of a highly destructive tendency.

The fasciculated form of sarcoma is one in which there are efforts at organization; the most of the round cells are converted into imperfect fibers; and these are disposed in an irregularly lamellated order, so that when an opening is made in the surface, and the tumor torn open, the torn surface presents a stratified appearance. This species is less vascular than the encephaloid sarcoma; it grows less rapidly, and as it does not reach such dimensions as the encephaloid species, its presence may be tolerated a much longer time. The fasciculated variety is often found in connection with muscular tissue; and the stratified form of the muscle may be regarded as the prototypal model, according to which is developed its abnormal correlate, the fasciculated sarcoma.

The ossifying or osteal form is seen in the sarcoma which originates from periosteum or bone. And, exceptionally, the bony tissue is developed within the sarcomatous tumor which is not contiguous to bone, especially in sarcoma that is of the typically fasciculated species. When it occurs in the growth not adjacent to bone, the origin of the osteal tissue cannot be so readily accounted for as when found in a growth having connection with some bone of the skeleton; in the latter case there can be traced propagation by continuity. The bony tissue in the

isolated sarcoma is produced similarly to that of the upper half of the fœtal cranium, in which the bones grow directly from fibrous structure, without the intermediate cartilaginous stage which occurs in the growth of the bones at the base of the skull; and this latter, as the histologist knows, is the normal mode of development of the other bones of the body; consequently the bone in sarcoma is not without a physiological analogue. The partially ossified sarcoma has a long course; the slow growth of such tumor gives long security to the integument covering it; its firm and resistant texture enables it to withstand violence which would disintegrate the encephaloid tumor; nevertheless, its malignant character is incontestable, being shown in the frequency of recurrence after the removal of such tumor.

The fourth species of sarcoma is the myeloid, which is constituted mainly of the giant-cells already mentioned; besides, there are intermingled with these the embryonic cells, a composition similar to that which is revealed by the microscope in fœtal marrow. This species is situated always adjacent to or in bone tissue, and originates from the medullary tissue of the bone; starting from the marrow, it grows at the expense of the bone. In this tumor either the small or the giant cell may predominate in development; and when the small cells are the leading productive factors, then the tumor has a rapid course, and soon attains large dimensions; but when the giant cell is the predominating element, then the growth is tardy, and the life of the tumor is a long one. The myeloid sarcoma occurs oftenest in the head, especially in the maxillary bones; but it appears also in the long bones, especially in the tibia and femur, oftenest in the head of the tibia. It has a tendency to undergo a vascular transformation; and in that event, the development of vessels may proceed to such extent that the pulsatile movement of the tumor is perceptible to the touch. When the tumor has undergone this structural change, it is liable to be mistaken for an aneurism. This mistake may be made when the tumor is seated on the leg or thigh, and is in proximity to the vessels of the limb. But if remote from vessels, the case can at once be decided to be one of vascular myeloid sarcoma.

Writers disagree concerning the degree of malignancy of this form of sarcoma. Gross estimates that it passes from its primary seat and becomes constitutional in one-eighth of the cases; other surgeons have seen generalization less frequently; and after removal of the myeloid sarcoma, they have seldom seen recurrence.

There have been described other forms of sarcoma; these, however, are histologically so cognate to some of the former above described, that a description of them here may be omitted, except the species known as melanotic, of which the malignant nature commends its study to the surgeon.

The melanotic sarcoma, as its name implies, is dark or black in color, and owes its hue to the deposition of granulated pigment in the component cells. The minute components of this dark material are fusiform or rounded in form; and the remaining constituent cells of the tumor are either round or fusiform in shape, that is, similar to those of the normal sarcoma; as a rule, the spindle-cells exceed the round ones in number, so much so that the tumor is usually fasciculated in structure. The pigment is not due to an accidental effusion of blood into the growth, but it is formed in the sarcomatous cells, first around the nuclei, and then it enters the nuclei, and finally appears in every part of the cell.

The melanotic sarcoma is soft in consistence; and it appears especially in the eye, and in the dermal and muscular tissues; and in its work of generalization and destruction, it stands in the front rank of malignant growths.

The above description contains in an epitomized form the prominent points in the history of sarcoma; in more elaborate detail the subject may be found in the voluminous chapters which surgical writers have devoted to the matter. It must be acknowledged, however, that the grouping of the different species together is arbitrary, and that the relationship between them is a constrained one. The incongruity of placing together things so diverse has led some writers to drop the name sarcoma, and to apply to these tumors the name of fibro-plastic growths. Though there is something rational in this proposal, yet the term sarcoma, stripped as it now is of the irrelevancies which surrounded it in the older writers' minds, has so firm a place in surgical Pathology that it seems proper to leave it undisturbed as a prominent section of malignant new growths.

When compared with epithelial cancer, sarcoma was formerly deemed peculiar to youth and early adult life, while the advent of the former was referred to more advanced years; the bloom of youth was associated with sarcoma, while carcinoma and epithelioma were deemed the evils of wasted age; though this, in a measure, be true, yet a wider observation of sarcoma has shown that its advent may be in both youth and age, though it occurs oftener in the young.

When sarcoma and carcinoma are compared in reference to curability, the former has advantages over the latter; for after proper surgical treatment the patient of sarcoma is less apt to have a recurrence of the disease; and should there be a recurrence, the sarcoma reappears with less violent character than is the case when carcinoma recurs after removal. If carcinoma reappears after excision, abstention from interference, as a rule, is wisdom; but if removed sarcoma reappears, there is a fair prospect that benefit will be reaped from another operation.

In the treatment of sarcoma, constitutional treatment has proved of little avail; however, in this field internal medication has not had a fair trial. The author has hope that the future contains some happy surprises, and that some day will witness the discovery of remedies which will check the growth of, and finally extinguish, the malignant tumor. Man with his innumerable ailments is, doubtless, surrounded by countless remedies, the most of which as yet are unknown; a condition of things destined to change when greater progress has been made in the knowledge of materia medica. And there is ground for encouragement when one recalls what has been done elsewhere in the therapeutic field.

To turn attention for a moment to what has been done in recent years, nothing can strike the medical mind with more gratifying effect than the story of coal tar, whence chemistry has extracted so many remedial agents. Who knows but that in some material now deemed useless, a remedy against the malignant growth may be found? Perhaps the agent which is destined to replace the present destructive treatment of the malignant neoplasm is to be found in the field of botany, and that some simple plant not even adorned with flowers, is elaborating the organic compound which can accomplish the great work, and is only waiting the advent of the fortunate one who shall discover it. In the innumerable family of plants the author has no doubt but that such a boon exists, and which, when found, as a gift to suffering humanity must take rank alongside of the discovery of anæsthetics. Though as yet such remedy exists only in enthusiastic hope, yet the unfortunate victim of malignant tumor is not without some aid from internal medication; for it has been learned by observation that, though certain therapeutic agents do not directly possess a resolvent action, yet they are able to retard growth; as such may be mentioned mercury, iodine, and arsenic. Mercury is more active when combined with iodine, in

the form of the protiodide or deutiodide of mercury. Of the protiodide, a half grain may be given three times a day. And in such amount it can be given for a number of weeks; meantime, its action should be carefully watched, and should symptoms of phyalism supervene, as may be found in the weak and cachectic, then the remedy should be temporarily suspended. Arsenic may also be tried, and in the form of Fowler's solution of the arsenite of potash, five drops may be given three times a day; and this dose should be increased in amount, one drop daily, until as large a dose is reached as the patient can tolerate. From the well-known property of arsenic of acting on the skin, it is probable that it will act more efficiently on the dermal sarcomatous tumor. And, again, as its effect is only obtained after prolonged administration, it is presumable that its beneficial action is better suited to tumors of slow growth.

Besides the use of these remedies taken into the alimentary canal, they may be employed parenchymatously, that is by direct injection into the tumor; thus one may employ Fowler's solution, or a solution of mercury and iodine known as the iodohydrargyrate of potassium; of either of the solutions mentioned there may be injected with a hypodermic syringe from four to eight drops daily; the best action is gotten by injecting not more than two drops at one point, for if more be thrown in, the resulting irritation is apt to be so severe as to cause suppuration. In this work a syringe with very fine point should be employed, and care should be taken that the point should be sharp and clean. Besides the solutions mentioned, one may use ergotine or the tincture of iodine; the latter is the preferable agent. The surgeon should be careful to insert the syringe point into a new place for each injection. Also, the point should pierce to different depths in order to bring the solution into all portions of the tumor. And should suppuration be excited, the work of injection should be suspended for some time, and when resumed again, it should be at a point as distant as possible from the site of recent selection. The author urges a persevering trial in this method of hypodermic treatment of the sarcoma; if only a retardation of growth is accomplished, this is a valuable gain.

Should the means detailed fail to effect a cure, then a resort must be had to the radical methods of cauterization or excision. To accomplish anything with caustics, the most potent ones must be chosen, as the chloride of zinc or potassa fusa, preferably the latter. To use this, the surface of the tumor, if not opened,

should be abraided, since the epiderm offers some barriers to the action of the escharotic. When the surface is opened, then a wall of adhesive plaster should be built around the part, so as to prevent the destruction of the adjacent sound parts. The caustic potash should be mixed with an equal part of Pulvis Radicis Sanguinariæ, and of this a layer equal to a line in depth should be placed on the tumor, and retained there by a covering of lint and adhesive plaster. This amount used will destroy much more than a line's depth of the growth. The destroyed part must be detached by means of moist warmth. Proceeding in this manner, successive strata may be destroyed until the tumor is destroyed. A serious obstacle in the way of this work is the peril of opening vessels, which may bleed; and hence where large vessels underlie the tumor, the escharotic must be used with caution or wholly omitted. This plan always causes a large wound, which will be tedious in closing. In the patient, however, whose shyness of cutting quite excludes the scalpel, this method may be tried; and if the tumor be small and readily accessible, with no adjacent vessels which may be imperiled, there is a reasonable hope of thus eradicating the tumor.

The use of the knife, as a rule, is a much surer and speedier method, and by it the patient will be spared much pain of which he is the victim when escharotics are used. The great misfortune of most patients is, however, that blatant charlatanism has implanted in their minds the belief that the cancer quack (or quackess) possesses for his relief some means of cure unknown to the rest of the world. This false notion has such a hold in the popular mind that intelligent medicine thus far has availed little towards its removal. The efforts of our profession to protect the public from the cancer-harpy are misconstrued; and hence medical legislation has accomplished but little; the vermin, against whom its acts are directed, continue to thrive and pursue their work of villainous imposture.

If the victim of the sarcomatous growth escapes the pitfalls of charlatanism, and confides his life to conscientious medicine, then the latter may choose for treatment between the escharotics detailed, or the use of the knife. In cases in which the growth is superficial, the escharotic plan should be preferred, especially when an extensive surface is the site of the disease; but when the tumor admits of circumscription and ready removal with the scalpel, then the latter should be used. And on the scalp, where we are supposing the growth to be situated, then the work should

be so done as to avoid conspicuous scarring. The work then done must conform to those already given for the extirpation of benign neoplasms on the head. The form of the wound should, as far as possible, be so made that the breach can be closed, or if not closed, reduced to the smallest size.

Epithelioma.—This growth until recent times was ill understood, and, like sarcoma, it received different names from those who wrote concerning it; thus, among the old writers, one finds the terms noli me tangere, cancerous ulcer, rodent ulcer, cutaneous cancer, etc., names which plainly meant the same thing. The use of the microscope, which introduced more precision in our knowledge of sound and morbid tissues, though it threw light on the structure indicated by these names, yet it did not lessen the nomenclature of the subject; for example, such names as the following have been introduced: false cancer, bastard cancer, cancroid, epithelial cancer, and epithelioma; and there is appropriateness in the latter name, when the fact is recalled that the histological components of the growth are epithelial cells.

Epithelioma consists of an infiltration into the tissues of the affected part of epithelial elements which resemble the cells on the surface of the skin, or mucous membranes. The growth begins as an insignificant elevation of the surface, on which the normal covering is thickened; yet finally, as the growth increases, the surface opens, and continues open as an unhealing ulcer. The covering of the epithelioma before opening is composed of numerous strata of cells, which individually have a marked resemblance to cells investing the adjacent unaffected parts; on the face or scalp they are similar to the normal epidermal cells. In the progress of the growth, the cellular elements grow both outwards and inwards; and it is in the encroachment of these cells on the subjacent structures, sinking into and infiltrating these structures, that we have the distinguishing characteristics of the epithelioma.

The cells are small when compared with those of carcinoma; they are nucleated and lie in layers or spheroidal masses which can be squeezed from the affected structure. These rounded masses when placed in water, though they may swell, do not dissolve or readily break down, but swim as separate particles. In consequence of the form of the follicles or depressions in the structures in which these cellular masses lie, the cells are often arranged in a rounded or imbricated manner; and if these be divided in a certain direction, the appearance under the micro-

scope is that of a bird's nest, or a floral whorl. As this whorl-like form is common to the normal depressions of the skin and mucous membrane, care must be taken not to confound the normal with the abnormal forms. The youthful microscopist often finds bird's nests, which are normal structures of nature and contain no element of disease.

Epithelioma commences on the surface and may be designated a superficial disease; yet, as it spreads on the surface, it finally penetrates inwards, and then causes extensive destruction of the tissues. The ulcerated field which is produced is irregular or winding in its boundary, and uneven or nodulated in its surface. From such a wound there is discharged a thin viscid fluid which is neither pus nor pure serum, yet it is similar to the latter. This open surface is of a reddish gray color; it has no tendency to granulate; and if wounded it does not bleed freely, thus differing from granulative tissue. If this diseased structure be examined by the touch, it will be characterized by induration; both the floor and border are unnaturally hard. Before opening and afterwards, the affected part is coherent, so that it can readily be taken between the fingers, and moved on the parts on which it rests. This mobility is an important characteristic of epithelioma; and when duly estimated it will aid the surgeon in distinguishing this lesion from a chronic ulcer.

In its primary stage there are three forms in which epithelioma presents itself: papillary, nodulated, and squamous.

In the papillary mode of origin, the disease begins by the enlargement of one or more cutaneous papillæ; as the papilla enlarges, it becomes ensheathed in a coat of epithelial material. If the growth commence by one papilla, others soon appear around this one; these have a red or grayish color, and around the affected part, there may be observed dilated capillaries. This form is seen oftenest on the back of the hand and the lower lip.

The second primary mode of appearance, somewhat cognate to the preceding, is in the form of a tuber or nodule; and this enlargement may vary from the size of a small pea to that of a walnut, the greater form arising from the enlargement of a smaller one, or from the fusion of two or more smaller ones. This growth is usually irregular on its surface; and hence the designation of lobulated epithelioma, by which it is often distinguished. In such a nodule one finds sudoriparous and sebaceous glands; the latter are the most conspicuous; in fact, they furnish a characteristic of the nodulated epithelioma; for if the structure be

pressed, from the clefts on its surface there may be forced out particles of sebaceous material, mingled with epithelial detritus. This growth as a rule is sessile on the part whence it arises, and, exceptionally, it is pedunculated. The author has seen a case in which around the original nodule smaller ones were present, separated by small spaces of the unaffected structure.

In the third or squamous variety, the first sign of the epithelioma is a small gray or dark-colored scale, a line or less in diameter, and which seems as if set in a casing of sound epidermal structure. This scale can be detached; and the patient, as a rule, falls into the unfortunate habit of loosening and detaching it with his finger nail. This constant irritation of the part promotes the development of the disease, and is entitled to the name of a causal factor.

The papillary species occur oftenest around the mouth, especially in the lower lip. The nodulated form is less common, and has, as special site, mucous and semi-mucous surfaces of the genitalia. The squamous form is so closely allied to lupus that they may be regarded as akin or, possibly, identical structures. This form appears on the cheeks, nose, forehead and temporal region. It may occur on the scalp which has become denuded of hair. Depressed dermal vitality disposes to its origin and subsequent development. The initial scale consists of altered epidermal material; and by its adherence, it becomes a local irritant of the part, and interferes with nutrition at that point. This form develops and grows slowly, and, as a rule, it penetrates but little beneath the surface; its growth is principally through peripheral extension, the morbid work being limited to the skin; exceptionally, the superficial epithelioma may change its type, and, having become carcinomatous in character, it then penetrates inwards and attacks indifferently any tissue which may be in its way. Thus the author has seen skin, adeps, muscle and bone destroyed by an epithelioma, which, having begun as a simple squamous affection of the skin of the cheek, penetrated to and attacked the superior maxilla. The patient attributed his affection to the mischievous habit which he had acquired of constantly detaching a scab from the malar region of the face.

A distinguishing characteristic of epithelial cancer is that it continues a purely local disease for a long time. In many cases the affection does not attack the glands; glandular affection occurs oftenest when the epithelioma is seated on the lower lip, parotidean and genital regions. Secondary or glandular infection

from epithelioma seated on the lip or cheek occurs in glands situated near the submaxillary gland. Such infected gland gradually enlarges, and, for a time, it is freely movable; later, the gland contracts adhesions to the parts around it, and while thus movable, the removal of the gland may not be followed by a reappearance of the disease. But if the gland is fastened to the parts around so that it cannot be easily enucleated, then the removal affords no guaranty against an early recurrence.

For a period during the enlargement of the gland, its structure presents a uniform consistence; and this consistence is less firm than that of those parts which have undergone induration through the advancing disease. The gland will continue to enlarge until it has reached a volume of an inch or more in diameter; then it softens in the center, and opens at some point of its surface; and this opening continues through the overlying parts until it pierces through the skin. Through the opening thus formed, there is discharged a semi-liquid material composed of the disintegrated gland and serum; this is not pus, but an emulsion of softened glandular material and serum. This stage of secondary metastatic development having been reached, the disease progresses rapidly; the parts contiguous to the disintegrating gland become hardened, and afterwards break down. The affected part is then swollen, and presents a number of ragged openings, from which there is a constant discharge of the emulsified material mentioned, often tinged with blood. Where the glands of the neck have become secondarily affected, and the structures break down, not unfrequently the blood-vessels are opened and hæmorrhage ensues: death has often thus occurred at a period much earlier in the disease than otherwise would have happened.

The course of the disease on the skin is always slow; on the semi-mucous surfaces it is more rapid; and on the mucous surfaces the disease, in its progress and evolution, is still more speedy in its course.

Besides the implication of glands contiguous or near, in rare instances, the disease appears in some remote organ or part of the body; thus cancer of the liver or stomach may follow an epithelioma on the head.

This growth is oftenest seen in those who have passed the vital meridian: namely, in those who are over forty years of age. Sex is an important factor; the growth occurs much oftener in men than in women; the male is three times more liable to

epithelioma than the female. This probably depends on the fact that the disease originates usually in the skin, which, in the male, is more exposed to injury than that of the female. Likewise, the greater abundance of epithelial elements at certain points in the skin of the male, may render his skin a more fertile field for the origin of epithelioma. The lack of cleanliness among the poor is assigned as a reason for the more frequent appearance of the disease among that class, and the greater want of cleanliness in the male, explains the more frequent occurrence of the disease among men.

The opinion has been expressed by a few writers who have studied the causation of epithelioma, that it originates from a microphyte. A reason urged for this is that the growth oftenest commences where there is a lesion or breach favorable to the implantation and preservation of such parasite. As yet, however, such an agent has not been discovered, and the suggestion that this disease is of a parasitic nature is as yet a speculative deduction based on the tendency of modern Pathology to find, or think to find, in the microphyte the universal cause of disease.

Treatment.—This is best done by external or surgical means, though within the last few years an attempt has been made to cure it by the employment of internal remedies. For this purpose the chlorate of potassium has been praised; cures are claimed to have been obtained by this remedy. For this purpose commence with small doses, as for example, five grain three times daily, and increase the amount until as much as as half drachm is taken within twenty-four hours. In case the growth has opened, and an ulcerated surface is present, then a solution may be made of the salt, and applied externally by means of lint. To accomplish anything with this treatment, it must be continued for a long time. The author has made trial of this plan of treatment, but with only doubtful results. But since a doubtful treatment is more satisfactory to the patient than forlorn expectance, hence, in cases in which the disease is so situated as to be inaccessible to external treatment, this remedy might be used. Another remedy which deserves trial is arsenic. As this remedy has been demonstrated to have a curative action in squamous disease of the skin, from analogy, a beneficial action from it might be expected in epithelioma of the squamous species. Fowler's solution is the best form for use: commence with three drops of this, three times daily, and increase the dose one drop each day, until the stom-

ach will not tolerate a larger amount; then gradually lessen the amount until a small dose is reached. Thus by ascent and descent in the quantity given, a large amount of arsenic can be safely administered. This agent may be used where the disease is inaccessible to local means; also, it may be given in cases in which an operation has been performed, as a prophylactic against recurrence. Chrysophanic acid, which has recently gained much celebrity as a remedy against skin disease, might be tried in epithelioma; for this purpose it may be used externally. As it has recently been given internally in psoriasis, so it might be given in a similar manner in epithelioma; for this purpose, very small doses should be used, since the strength of the medicine has not been definitely determined.

A more direct way of using these agents of internal medication would be through hypodermic injection; in this way the author has tried Fowler's solution; also the solution of the muriate of lime, which is a useful agent, when given internally, against neoplasms. To use these remedies, the syringe point is to be introduced into the growth at several points, and not more than two drops injected at each point; a larger amount might cause local death and breaking down of the tissues, and thus defeat the purpose of inducing atrophic change of the morbid tissue. The author has made trial of several agents in the manner mentioned, and, from the results gotten, he gives the preference to the arsenical solution. The hypodermic treatment of epithelioma is a field which invites further trial, and it gives promise of furnishing weapons against this disease, especially in cases which have been operated on, and in which there has been recurrence in such form that an operation is not practicable.

Though considerable has been said in favor of medication, internal and hypodermic, yet the practice and observation of the author have taught him that of all the means of treatment, the knife or, its equivalent, the scissors, is the most effective one. The fear of, or popular prejudice against, the use of the surgeon's instrument, has caused the loss of many a life. This fear, planted by the charlatan's hand, has been carefully cultivated by him, for it is in this section of disease that the conscienceless montebank plies his villainous craft, and reaps his richest harvest. The result is that often when the patient applies to the surgeon, the disease has made such advances under the torturing methods of the charlatan, that the latter is forced to cease his caustic mutila-

tion; and, at the same time, there is left to the surgeon no opportunity of using the scalpel, for the disease, in such a case, has so intrenched itself in the patient's body that it holds equal possession with life itself. In such unfortunate position, the surgeon usually errs in operative interference, and he does better if he limits his work to internal and hypodermic medication.

Should, however, the patient shun the snares in which he is so often entrapped by charlatanism, and consult the surgeon at an early period, then the growth should be removed with knife or scissors. As an important preliminary to the work of excision, the implicated surface must be carefully looked at, and the extent of the affected structures be determined, as nearly as possible, with the unaided eye. In the act of looking, it is seldom that the eye is permitted or made to see all that it is possible to see. In the work of vision, the eye falls into the habit of overlooking much that lies within the field of vision; in fact, this is requisite to the conservation of sight; for, if the eye were forced to continually give close attention to all that lies before it, the task would be painful, indeed, it would soon become intolerable, and the overtaxed organ would soon be overpowered and no longer able to act. This conservative act of inattentive vision, so needful for healthful function, soon becomes our wonted habit, and must be studiously avoided when it is necessary to study all the features, lines and external appearances of an object. Sight must be so employed as not only to take in the superficial extension of what is observed, but with equal thoroughness, the eye should penetrate and seize, in the logical meaning of the word, the intension of what is seen.

In the study of a surface, the site of an epithelioma, aided as well as unaided vision should coöperate in the work. To aid the eye a hand microscope of slightly magnifying power should be used; thus enlarged papillæ are discovered, which otherwise would have escaped detection. Vision in these ways having made its best search, the finger must next do its duty in the way of examining tactilely the surface, and also be made to explore the structure beneath the surface. The surface must be lightly taken between the fingers, and any abnormal hardness must be noted. Such hardness is discovered by comparing the density of the adjacent sound parts with those affected; thus the gradual transition from normal to abnormal structure may be found. At the time that the local conditions are thus being studied, the adjacent glands should be examined, and any inclination to enlargement

in them carefully noted; for such enlargement means that the affection has outlived its local period of development, and has already made one great stride towards generalization.

The extent of surface and structure involved in the growth having been accurately determined, the operator should mark the boundaries with a tinting pencil; or, what is better, this tracing can be done with a pencil of nitrate of silver, a few hours before the cutting is to be done. The work of preliminary tracing is one of great importance, and though it may obstruct the manual freedom of the operator, and render his work somewhat tedious, yet the patient is a great gainer thereby. The laurels won by celerity are too often dimmed by an early recurrence; it is here, as often occurs elsewhere, that the painstaking plodder is the final victor. As before said, a tinted line, previously traced, must serve as a path to the knife, and the work to be effective must be done early. Then the sacrifice of the tissues is so small that the wound can usually be closed, especially where the tissues can be slidden, or laterally displaced. The cut edges then should be perpendicular; or if they be made slopingly, then the two should be so cut that they will rest on each other in accurate coaptation, so that when the sutures are introduced the closure will be complete, and no gaps or interlying vacuoles will be left to delay healing. Thus done, early healing without scarring will be obtained; yet scarring must be reckoned as a subordinate incident in the removal of an epithelioma, for the removal must be complete and unsparing of tissue.

After the excision of the affected structures, the cut surfaces of the latter must be carefully examined, in order to ascertain whether the cutting has been done through sound tissue; the examination can be more readily made on this than on the bleeding surface of the parts whence the growth has been removed. The excised part being washed, it can easily be seen whether the entirety of the growth has been removed; if it has been completely done, then close the wound, or dress it open, as the conditions permit. But if there be found suspicious tissue in the removed part, then the cutting must extend further, until thoroughly sound tissue has been reached. As before directed, the nearest lymphatic glands should be carefully palpated, and if evidences of disease are found in them, the operation must be directed to these structures; each enlarged gland must be removed. At an early period the glands can be easily enucleated; but later, they contract adhesion to the contiguous parts, and the

extirpation is a more tedious task. When such adhesion is found, along with the gland, some of the surrounding adherent tissue should also be excised. Such fixation with adherence of the glands is always of ominous portent; and in such case, to guard against recurrence, the parts suspected of infection should be unsparingly sacrificed. And even these precautions are usually unavailing, for adjacent glandular implication means general infection. In such cases internal medication with arsenic should be rigorously pursued; thus the patient, if not cured, is, at least, solaced with hope of relief.

Where the growth lies externally and is so situated that complete excision is impossible, then among the means of attacking it is the use of destructive escharotics, viz., the potential or actual cautery; of the former, one of the most effective is a compound of potassa fusa already spoken of. In this way deep sections of the growth can successfully be removed. The ascertained virtue of arsenic in cutaneous disease would point to its probable utility, used as a caustic, in dermal epithelioma. For this purpose an excellent compound is that consisting of equal parts of arsenious acid and cinnabar. This trustworthy escharotic, however, must be applied cautiously, lest it act as a poison; hence, but limited sections of surface should be successively attacked. When the disease lies in a mucous surface, then heat in the form of the galvanic cautery or ferrum candens may be used.

Carcinoma.—Carcinoma and cancer, equivalent names, derived respectively from the Greek and Latin tongues, have reference to the form of the diseased part, or to the appearance of the vessels which lie like radii diverging from the part; more probably, however, the name has reference to the firm hold with which this growth clings to its unfortunate subject. With Celsus the name cancer was applied to mortification or death of the soft parts, a meaning far remote from the modern signification of the word. A term cognate to cancer is scirrhus, which has reference to the induration commonly found in cancerous structures. For a century or more the term cancer has been used to denote malignant growths of a destructive tendency. This term was vaguely and indefinitely used until the beginning of this century, when Bichat carried the study of disease from the crude mass to the constituent tissues of diseased parts. Bichat classified morbid changes of structure under two heads: general alteration or change, and particular alteration or change. According to him, the affections in which general alteration is seen are inflammation and scirrhus.

That the name cancer was obscurely used is shown in John Hunter's remark that the diseases which are classified as cancerous are different in appearance and probably differ in their nature. Yet Hunter left these differences unexplained.

Early in the nineteenth century the notion was held, that, in the malignant growth, elements exist which cannot be found elsewhere in the normal or unaffected parts, and thus a broad distinction was established between the benign and malignant growths. And thence arose the classification of heterologous and homologous tumors, as synonymous with malignant and benign. The peculiar element of cancer was particularly isolated by Cruveilhier, who, in cutting a cancerous tumor and squeezing it, obtained the heterologous elements in the expressed fluid. This fluid examined microscopically presents small bodies, some of which are definitely formed, and others shapeless or irregular. This fluid, or emulsion, as it might be named, can not be derived from a benign growth. Thus an advance was made in the knowledge of cancer; and further, cancerous tissue was found to consist of an areolar, mesh-like, or connective framework; and this framework contained the fluid in which were discovered cells of a peculiar form, which were named cancer-cells. These cells, according to Lebert, Broca and others, have peculiar characteristics, differing from any other cells found among the component elements of the body, and which, when seen, justify the observer in declaring that they are of malignant nature; and, from not occurring in normal tissue, such cells are named heterologous. After further study of the subject, Lebert has been forced to admit that, from the observation of the cell alone, one is not justified in declaring that it is of cancerous origin. But if the tissue containing the cells be given, then a microscopic inspection of its structure will enable the observer to declare that the case is, or is not, one of cancer.

Virchow, who has studied the cellular components of tumors, asserts that there is no cell peculiar to, or characteristic of, cancer; in fact, that the cancer cell should not be named heterologous or heteromorphous, since it is identical with other normal cells. Virchow pronounces the cell of cancer identical with cells constituting epithelium; and where a difference from epithelial cells occurs in cancerous structure, it is due to some accidental circumstance in the growth of the cell. Virchow finds that cancerous structure consists of a stroma of new-formed tissue, originating from preëxisting connective tissue, which is arranged in an

areolar or sponge-like form; and the minute spaces or vacuoles in this stroma are filled with a cream-like emulsion, the succus cancri; and an examination of this fluid reveals cells which are similar to normal epithelial cells. This cancerous tissue resembles that of epithelioma, the difference being that in the latter there is no new-formed connective tissue stroma.

According to the foregoing opinion of Virchow, and which is concurred in by others, there is no specific cell which can be declared cancerous, since the cell which is found in cancer occurs also in normal tissue; it is sometimes absent in the structure of tumors which are certainly cancerous, and it can occur in tumors which are neither scirrhoid nor encephaloid in type.

As there is no cell peculiar to cancer, so there is no single or isolated pathological form which can be pronounced to be typical of cancer; in fact, under the head of malignant growths, there exists a great variety of tumors which have some analogies with each other, yet, also, offer many points of unlikeness, and these points of unlikeness are so numerous that Robin has proposed to drop the name of cancer, and to study each individual growth separately. Though this might be justifiable, yet it would greatly embarrass both student and practitioner in their respective tasks

It being, then, impossible to formulate a definition of cancer founded on its microscopical appearances and anatomical form, a resort has next been had to the clinical history or course which the tumor follows from its commencement to its final ending. Such a history, briefly traced, runs somewhat as follows: Cancer begins as hardened tissue, at first of small or insignificant volume, for a long time painless, and, hence, for a time unobserved; it grows continuously, and when it attains some size, it may cause some inconvenience or pains of a shooting character; its boundaries are rarely uniform or regular; it may arise in every structure of the body, yet it oftener originates in glandular structures, and oftener in those which lie near the external surface of the body, the disease seeming to prefer as site, parts which are the scene of much functional activity, or those which are in incessant vibration between inaction and action; the tumor, by increase of volume, encroaches on, and finally destroys, parts around and over it, and its development is only impeded, and at length arrested, through an insufficient supply of nutrient material on one side, and through the escape and loss of the same through the opening or ulcerated breach which finally appears in the tumor. The patient nearly always refers to some local injury of the part

which was the starting point of the cancer, and the connection between such lesion and the growth is so clearly traceable that it is safe to conclude that some traumatic agency is, if not always, at least usually, the exciting cause of cancer. The last act in this eventful history, when the growth is unrestrained in its development, is always death, which is preceded by infection of the contiguous glands, and, afterwards, the disease appears in the more remote parts of the body. This generalization seems to take place through the medium of the lymphatics and blood vessels.

As has been stated, in the microscopic study of cancer, two leading constituents have been found, viz., the areolar framework and the so-called cancer cells contained in this framework. In any given cancerous growth these two constituents may exist in very different proportions; the framework can be greatly in excess, and so can the cellular elements. In the former case, the growth is remarkable for its hard and firm structure, and this form is named scirrhus. Where the cellular elements are the chief constituent, then the tumor is named encephaloid. This name is derived from the resemblance of the structure to the substance of the brain; and, as will be recalled, this name, for similar reasons, is used to designate a species of sarcoma.

The scirrhous and the encephaloid types were the ones which first attracted the attention of the early observers. The error existed for a long time of considering scirrhus as the primary form, and encephaloid cancer as the direct derivative from the former, through some powers of softening, for which no satisfactory explanation could be offered. It soon became apparent that they were separate species, being distinctly different structures from their earliest commencement; their histories having nothing in common, except that each one ended in the death of the patient. Scirrhus, however, develops slowly, and presents, later in its course, signs of regressive action, or an effort at healing in the oldest portions of the tumor; that is, both stroma and contained cells seem to have reached their maturity, and are found in a stage of degeneration and decay. And to this is due the scar-like depression often found over this form of cancer; and when the disease is limited to the skin in the lenticular form, such retraction explains the irregularity of surface. The encephaloid type is soft and commonly of a uniform rounded outline. It is soft, so much so that it has often been mistaken for a lipoma, or a collection of pus. It is of very rapid development, especially

where it has recurred after an operation. This type examined microscopically is found to consist of an areolar stroma and cells; the cells are the predominant constituent; and to the small amount of stroma is due the characteristic softness of this kind of cancer. Glandular infection also follows this, yet the tumor may attain considerable dimensions before the glands are implicated. As to the primary point of commencement, encephaloid cancer begins oftenest in the testicle; according to Paget's observation, it is found there in one-third of the cases of cancerous testicle. This organ, as the author has seen in three cases, may be attacked in early childhood. It attacks also, not unfrequently, the bones. It is remarkable for the rapidity of its fatal march.

Though carcinoma is constituted mainly of the constituents mentioned, yet other elements may be added, and give a special character to the tumor; and to this is due the great confusion among writers who have written on the subject of cancer; and it was on this account that Robin and others proposed to relegate the term cancer to the historic past, and to describe separately each form of malignant disease: to extricate himself from the difficulties of such a method, Robin was forced to adopt some generic name: he chose that of epithelioma; and thus his would-be improvement in nomenclature amounted to no more than a substitution of terms. Through the addition of pigmentary material to the two fundamental elements of carcinoma, melanotic cancer arises. And by the addition of colloid or gelatinous matter, there arises a peculiar form named colloid cancer, which has been a puzzle to the pathologist; and, as yet, the origin of this jelly-like material is a subject of investigation. To say that it arises from a liquefaction of the solid components of the growth, throws darkness rather than light over the problem. In another form of cancer there is found cartilaginous material, and which may be in such quantity as to conceal the true nature of the growth for a time. Beside the malignant cartilaginous tumor there is one which is benign, and which has neither tendency to ulceration nor generalization; this form is hard and has a tendency to ossify, while the malignant species is softer, and tends to change to a semi-liquid or pulp-like material. This soft chondroid form of cancer tends to generalization, and is very malignant. In another form of tumor, to the dual primary components, elements of bone may be added, and thus a tumor of extreme hardness is formed, to which the name of osteoid cancer is applied. Thus besides the two typical forms of

scirrhous and encephaloid cancer, through superadded elements four other forms have arisen, bearing the names melanotic, colloid, chondroid and osteoid cancer, the name being derived from the new element which has been added.

Besides the forms of carcinoma which have been mentioned, the disease may appear in the site whence a benign growth has been removed. Again, a growth has forsaken its simpler type of an epithelioma or sarcoma and appeared as a species of cancer. To attempt an explanation of such transmutation in the present state of our knowledge would be fruitless.

Cancer is of infrequent occurrence on the scalp; still it does occur here; one of the worst cases of the disease ever seen by the author was in the scalp. This was concealed by the patient for a long time. Commencing as a small nodule, the disease of encephaloid type developed into a tumor of large volume; this attacked the cranium, finally destroying almost the entirety of one parietal bone, and extensively exposed one hemisphere of the brain. The brain was never attacked, and for a long time the mind remained unimpaired; later, mental perversion appeared in which there was a slight excitation of the faculties, similar to the excitement from wine. This extensive destruction of the soft parts and cranial wall was attended by only a small degree of pain. During the last few weeks, the chief complaint of the patient was from fatigue. Meantime, the hopes of recovery were cherished by her, and plans for the future made by the patient, though an extensive surface of one hemisphere lay exposed to view. In this case, there is probability that a cure could have been effected had an early operation been done; for the history showed that, for a long period, the disease existed as a small wart-like nodule, which, for a time, was concealed by so dressing the hair as to cover the growth.

Treatment.—Cancer may be treated by internal means, by topical applications, and by means which slowly destroy or at once directly remove, the part.

Internal medication has been industriously pursued; and, at different periods, the much-sought-for agent has been announced as actually discovered. A reference to the old books on Materia Medica will present the reader, under the head of Anodynes and Narcotics, a number of agents for which there was claimed a curative agency against cancer; conspicuous among these are aconite, conium, stramonium and hyoscyamus. These agents have failed to do that which was claimed for them. In the use of these med-

icants, as well as of others, it is probable that a satisfactory trial has not been made of them: they have been administered too late, in insufficient amount, or for too brief a time. As the disease is sometimes met when it has reached a stage that forbids operative interference, when the case of the physician is limited to work in which but little result can be expected, and what he attempts is with the view that *aliquid fecisse videatur:* then these remedies may be retried, and besides those mentioned, a trial should be made of arsenic and iodine. And if the tumor is opened through ulceration, then some of these remedies may be used topically.

Treatment by cauterization, actual and potential, has frequently been tried; and if it be decided to make use of some of these methods, then the work may be done in accordance with plans which have been described in the treatment of sarcoma and epithelioma. Though these methods deserve mention and occasional trial, yet of all plans of treatment, a resort to excision, in which the knife is used early and radically, promises the best results; and the manner of doing such excision has been generally indicated in a preceding section in which the writer described the treatment of sarcoma.

Instead of assuming the exuberant growth presented in the case just mentioned, cancerous disease when seated in the scalp commonly approaches to epithelioma in type. For besides the six varieties of carcinoma which have been cited, there are others; and among the latter are those which so closely resemble epithelioma that it is difficult to establish a clear distinction. Nature, in the domain of both normal and abnormal products, is often a fugitive from both law and rule; she has infinite resources whereby she can indulge in continuous variation. The surgeon, as well as the practitioner of medicine, daily meets proof of what is here stated, and must take due account of them if he attain success in his practical work. The one who uses well his eyes and remembers what he sees, even though he has not fathomed the utmost depths of Pathology, often becomes successful in the practice of his art.

Pneumatocephalus.—Beneath the anterior and posterior portions of the scalp there sometimes occurs a singular tumor, of which the content is air. Thomas, of Tours, a pioneer in the observation of this development, was struck by its sonorous character. This tumor when seated behind, over the mastoid region, receives its air from the mastoid cells or antrum, of which the

outer wall from congenital defect, or eroding disease, is open, and permits the air, received from the middle ear, to escape beneath the scalp; and this air finds isolated lodgment there. It does not insinuate itself irregularly in the structure of the scalp, as is seen in emphysema, in which air has escaped from the air-passages and diffused itself in the adjacent or overlying soft parts. The air, in the case under consideration, is contained in a common cavity. Besides in the mastoid region, such air tumor has been observed on the forehead, where air is derived from, and communicates with, the frontal sinus, which, congenitally or accidentally, has been opened and permitted the air from the nasal passage to enter and remain. Such emphysematous tumor has received the name of pneumatocephalus. An explanation offered of the commencement of such tumor is that in violent expulsive efforts from the lungs, when the mouth and nostrils are closed, or partly closed, the compressed air escapes from the nasal passages through the middle ear and unclosed mastoid antrum beneath the covering scalp; or should there be an imperfection in the outer wall of the frontal sinus, the air may find escape there, and the result be a pneumatocephalous development, lying on the corresponding side of the forehead. A diagnostic sign in each case would be that the tumor could be reduced in volume by pressure, viz., its air content could be forced from it, and the tumor thus made to vanish. And to further verify the true nature of the tumor, a testing puncture might be made with a hypodermic syringe.

This air tumor, if let alone, would never endanger the patient's life. It is simply an annoyance to him through its conspicuous volume, or, perhaps, it may interfere with the dress of the head. Should treatment be decided on, two ways are open, viz., a simply conservative one, and a radical one. As conservative treatment, there may be made simple compression over the tumor by means of a pad, which is retained in site by means of straps and buckles. Or a more radical plan would be to lay open the cavity and dissect off its parietal surfaces, so that the walls, so denuded, might be brought together in such a way that by their coalescence the cavity would be occluded, and no space be left in which air might collect. For some time afterward, pressure should be made over the part, so as to guard against a recurrence of the tumor. This case, however, like many others, is one in which the prudent surgeon would rarely interfere, since such interference is not free from peril. It can readily be seen that inflammatory action might there be awakened in the mastoid

cells in case of a pneumatocele over that region; and once appearing there, the inflammation might readily enter the cranial cavity and attack the encephalon. Hence surgical effort should be limited to simple compression, as above mentioned. Should the *prurigo secandi* torment the young, or the conscienceless old surgeon, he may be assured that this is an ill field for such adventure; too near intrusion is forbidden to the household of life situated close by; the mariner does not carelessly trifle with the wooden wall which distinguishes (separates) him from death.

Pericranium and Its Affections.—The lowermost layer of the scalp is the pericranium, or periosteum of the cranium, which is rather a dependence of the subjacent bone than of the overlying scalp. This structure, closely allied to periosteal tissue elsewhere, has already been briefly referred to. Though loosely adherent to the skull except where it is inserted into the sutures, yet the attachment is sufficiently intimate between this membrane and the skull to permit of disease or lesion being often shared in common by them. And the same applies to the soft parts which lie exterior to the pericranium. Yet it is the site of isolated injury and disease, which we now proceed to consider.

Wounds.—Deep wounds of the scalp necessarily implicate the pericranium; the treatment of such does not differ from that already detailed. But especial care should be taken to cover the bone, for exposure of bone to the air, or prolonged contact of the same with the detritus or excreta of a wound, ends in death of the bone so exposed; and such necrosis greatly prolongs the time of healing, since weeks and even months are required to complete the exfoliation of the dead surface, so that the part can close. The attempt to shorten this time may be made through erasion or exsection of the necrosing bone; yet such attempt is usually fruitless, since the surgeon's instrument will never follow the line which nature selects for the line of detachment. Indeed, the exsecting chisel in the author's hand has seemingly prolonged the time of healing, since the new surface made, sometimes, exfoliated. To remedy necrosis, then, in case of a wound exposing the skull, after scrupulous antisepsis, close the wound so as to cover the bone.

There may be an unopened wound consisting of simple detachment of the pericranium from the skull; and such separation may be so slight as to be insignificant, or it may be very extensive; in the latter case there might occur some effusion of blood beneath the pericranium. Yet such effusion would not equal

that which can occur in the space of lax tissue just outside of the pericranium; hæmorrhage here can be excessive, while that beneath the pericranium is of limited amount. It could only be in large quantity in a case in which the pericranium was torn so that an intercommunication was established between the space beneath with that outside of the pericranium. In such cases a mild, conservative treatment is indicated; only where the blood is effused in excessive quantity would it be proper to evacuate it. Simple compression, if properly and patiently employed, will dissipate the blood.

The most frequent affection of cranial periosteum is inflammation, which may be local or general; and this may be of an acute or chronic type. Local as well as general periostitis may be the sequent of some affection of the overlying scalp. For example, it may arise from an abscess, ulcer, or wound; it is frequently of syphilitic origin. Scrofula and rheumatism are occasional causes of it

From whatever cause the periostitis arises, the usual conditions of inflammation are present; of these the most important is proliferation, or cell-growth, in the affected structure. Thence there is thickening. This cell growth may be absorbed, and then the membrane returns to its normal condition. Or the new cellular elements may undergo organization and become added to the periosteum, and cause permanent thickening. Such an event is rarely a source of trouble to the patient. Another event is osteal growth, in which the new material is converted into bone. Such bony growth appears in laminated, spinous, or irregular form; and it is attached to the external plate of the cranium, and remains as a permanent addition to the same. Such development is named an osteophyte or bone growth; the term exostosis is also applicable to it. It is seldom so large as to become a source of trouble; and it could only become so when it arises as a sharp spine, or thorn-like process pricking the parts which rest on it. In flat or laminated form it would be wholly without action on the superjacent parts. Where the growth is of sharp spine form, then it should be excised, as it became necessary in a case seen by the author in which the offending growth was situated on the upper and lateral part of the occipital bone. After exposing the growth it was exsected, and the wound treated as a simple one. The complete healing was tedious.

Periostitis may assume on the cranium, as elsewhere, a different form. The inflammatory action in some cases is confined

chiefly to the outer structures of the pericranium; but in others it chiefly attacks the deeper layer; and the course will differ in the two cases; for if the inflammation is chiefly in the deeper texture of the periosteum, then its march will be trammeled by the sutural adhesions. On the outer face there is no such limitation; the disease spreads rapidly over a larger part of the pericranium. This diffuse periostitis quickly ends in suppuration; the pus formed rapidly diffuses itself beneath or upon the pericranium. When outside, the diffusion may be so extensive that a large part of the overlying scalp may be uplifted by purulent fluid.

In the early stage of periostitis, the most efficient agent to check the inflammation is iodine. The action of this agent is obtained when it is applied externally, in the form of the tincture or ointment of iodine. The iodide of potassium may likewise be given, in dose of ten grains, three times daily. By this treatment, both in local and general pericranitis, suppuration may be averted, or greatly limited. But when pus has formed, it should be evacuated by one or more incisions; several openings will be required when the pus is widely diffused. And through the openings there made, an antiseptic fluid should be freely injected. This may be a sublimated solution, or iodized solution, or one of chloride of sodium. Along with the pus, filamentous shreds of dead tissue will also be detached and discharged. If such shreds are not fully detached, violent traction should not be made on them, since such pulling may open vessels which may bleed and retard the healing. The work of opening should be done early, since then the destruction of tissue is lessened. In the worst cases of diffuse suppuration, sections of the scalp die; and then, after recovery, some deformity will remain. When the pus lies for a time in contact with the outer face of the skull, some necrosis ensues, and the healing will be retarded. In such cases the outer surface of the bone, dying, is slowly detached from the adjacent sound bone; and the detachment of such bone is best confided to nature.

A frequent form of disease of the pericranium is gummy periostitis. Syphilis announces and records its possession of the subject by various eruptions on the skin, clearly visible and legible by the eye; these eruptions, called *syphilides*, differ much from each other in nature and appearance. But subcutaneously, the disease has but one leading characteristic, viz., a neoplastic production, the so-called gummy growth. Or, put figuratively, the syphilitic pathological tree is rich in fruit of various hue and

form; if we should select a characteristic specimen of these products, it would be the gummy growth. The other rashes have their non-syphilitic analogues; but the gomme, or gumma, is an isolated original, without correlate, kinsman, or analogues in the pathological household. The pericranial gomme appears in two forms, the circumscribed and the diffused.

The circumscribed gummy growth commences in the deeper surface of the periosteum, and thence developing and growing in conical form, it presses on the subjacent bone and causes absorption of its tissues; one has here, on a small scale, progressive osseous rarefaction. The gummy structure, when of limited volume, undergoes the fatty change, and, later, it is absorbed. If of larger volume, the growth might suppurate and open externally. This disappearance by absorption is the usual event; and the process is then named by Virchow syphilitic dry caries. The site of such vanished gomme is indicated by an irregular, bony growth, in the form of minute plates or spine-like points, which circumvallate the depression in the bone.

The gummy growth can develop in diffuse form; it primarily commences then, in and beneath the periosteum, as a soft gelatinous structure, which soon appears as a pulpy layer of a whitish hue. Beneath this the bone undergoes rarefaction; and in the spaces opened in the bone the gummy material likewise develops in nodular or conical shape. These masses of gummy material are traversed by minute blood-vessels which remain permeable. The gummy matter is thus distinguished from tubercular material, in which no vessels are found. This diffused form of gummy periostitis may recede, and absorption of the new material occur; and then osteophytic growths remain to mark the surface. Or the mass can suppurate, open and be eliminated. The pus thence evacuated is viscid, and resembles acacia gum in solution.

The treatment in such cases should be topical and general. The local application of iodine acts most satisfactorily in periostitis arising from any cause, but in no case does it act so beneficially as when the case is syphilitic. Applied either in the form of ointment or tincture, it acts as a resolvent of the new growth. That such action does occur has been proved by direct observation with the microscope of living tissue, to which iodine had been applied. If the tincture of iodine be used, then, from time to time, the dried epidermal crust must be removed, else such material soon becomes an impenetrable obstacle to the action of

the remedy; and, on this account, the ointment acts better. This local treatment must be long persevered in, in order to obtain the full action. Meantime antisyphilitic remedies should be taken internally; these should consist of a combination of mercury and iodine. Syphilitic pericranitis whether limited or diffused, treated early, in the manner mentioned, will be made to recede and vanish in most cases. If the disease is not thus checked, but proceeds to suppuration, the condition becomes graver; for the suppurative action is rarely limited to the soft structures, but also attacks the adjacent external plate of the skull and causes death of the same; in fact, a limited portion of the entire thickness of the cranial wall may then die and be detached. And though such breach, both in the scalp and skull, is repaired by fibrous tissues, yet the site of the disease is permanently impaired, especially the bone, which will never be restored to its normal integrity. When the entire wall is thus perforated, it is probable that there is likewise similar disease of the dura mater lying underneath, that is, both intracranial and extracranial gummy development.

CHAPTER IV

CRANIUM.

HAVING concluded the surgical studies of the scalp, we will take up the cranium, premising with some general remarks in regard to the form, structure, and general characteristics of the skull. The form of the cranium is that of an ovoid, of which the larger end is directed backwards; in a few cases, the anterior and posterior ends are similar in extent and form. The transverse and antero-posterior diameters may be nearly equal in the brachycephalic skull; or the antero-posterior diameter may be much the greater, and the form is named the dolicho-cephalic skull. The anterior and posterior faces may be rounded or approach to a quadrangular form. The vault of the skull may be flatly rounded; or it may have a ridge-like elevation in the median line from before backwards.

The rounded contour of the vault of the cranium is exchanged below for a more irregular and flattened form; the surface below is more broken and abruptly interrupted than is the upper one. The inner surface of the skull is more uneven and interrupted than the external one; this applies especially to the base, where anteriorly, the orbital wings of the sphenoid, and behind, the petrous portions of the temporal bones, abruptly break the surface and form topographical boundaries of the parts contained there.

Structurally, crania differ greatly; some are much thicker than others; this is a national characteristic, as well as an individual peculiarity. From a limited range of observation, the author ventures to decide that those who labor with their heads have thinner skulls than those who labor with their hands. In two instances, of unusual intellect, the tenuity of the cranium, as revealed by necropsy, was remarkable.

The cranial vault and base differ greatly in regard to interruption of structure through canals and direct openings. Such interruption is wholly exceptional in the upper half of the cranium.

These varieties of conformation, surface, and of thickness at points, or in totality, have a direct bearing on, or relation to, the capacity of the skull to resist violence; one skull may successfully resist violence which another could not withstand.

The power to resist is influenced by the sutures, or possibly is due to the inter-sutural material. As is known, the bones of the fœtal head are but imperfectly developed, and are united by sutures which are also incomplete. This disposition permits of the safe transit of the fœtal head through the pelvic passage; without such arrangement, in most cases the child's life would be lost. And the continuance of the sutures for many years, also acts protectively. The natural fusion of the cranial bones commences at from forty to fifty years of age; and this process, called synostosis, continues through many years, being, in the majority of cases, only ended when the subject has reached seventy or eighty years of age. After this synostosal fusion, the skull has the appearance as if cast in one piece, and it is much more fragile than it is prior to such fusion. This is demonstrated by taking two dried skulls, one of a young subject and another of an old one, and allowing them to fall the distance of four feet upon a stone pavement; the skull of the young subject will rebound almost to the starting point, and not be broken; but the other skull will break, and as it does so it yields the sound of a broken kettle. Besides the vanishing of the sutures, the lessened amount of the organic constituents of the bone may probably account for the increased fragility of the bones of the aged skull.

In early fœtal life the skull is a simple fibrous capsule; in the subsequent course of development, cartilage replaces this fibrous structure in the lower part and base; and, later, this ossifies. On the contrary, the parts constituting the vault directly undergo ossification without an intermediate stage of cartilage. And this may account for the tardiness of repair which occurs after fracture of the vault and sides of the skull; months are required for recovery after such injury, and even then the work is imperfectly done. Fibrous tissue, and not bone, is the medium of union between fragments of the fractured cranium. And also the portion of bone removed by the trephine usually remains absent; and unless the excised portion be replaced with certain precautionary preparations, the breach, in future, will only be replaced by fibrous tissue.

Traumatic Lesions of the Cranium.—The cranium may be the subject of contusion, penetrating wound, incised wound and fracture.

Contusion here originates from direct violence; and it may be limited to a small surface, or a considerable extent of bone may thus be implicated. The diagnosis of such injury is difficult, in fact, impossible, when the overlying scalp has not been opened; and in such a case the contusion must be inferred from the subsequent action of the injured bone. The contusion consists in a derangement, or limited displacement, of the constituents composing the bone. The lesional work does violence to the minute vessels contained in the bone, and the circulation of blood being disturbed in the bone, the nutritive processes of the latter are altered and interfered with. And according to the nature and extent of the local nutritive disturbances, so the subsequent character of the lesion will take shape. For example, if the injury is a slight one, restoration to perfect integrity will ensue after a few weeks. But if the violence has been greater, then acute inflammation of the bone will occur, and, as a result, there may remain subsequently, at the place, an increase of osseous structure; and this increased thickness may be permanent. And, finally, the molecular injury may be so great that restitution to the former state is impossible; there occurs then necrosis of the injured part, with final exfoliation and detachment of a layer of bone. In the several instances cited, the contiguous periosteum participated in the alterations; and in case of necrosis, the periosteum will inflame and suppurate, so that it will be necessary to incise the membrane and set free the contained pus.

The penetrating wound of the cranium may be caused by a round instrument similar to an awl; or it may be caused by a sharp blade; or the injuring instrument may be angular, as a spike or a nail. If the instrument be small, then the resulting lesion may consist of a simple displacement of the substance of the bone; and when the injuring agent is removed, the wound closes partially or incompletely, so that a fine probe could not pass through it. This closure is due to the inherent elasticity of the bone. Such penetrating wound may pass partially or completely through the thickness of the skull; the partially piercing wound is not a dangerous one, while that which passes through the cranial wall may in two ways be dangerous; it may fracture and detach a fragment from the inner plate of the skull; and, secondly, it may pass still deeper and wound the encephalon. The detached fragment of the internal surface of the skull becomes an element of intense peril. The pulsatile motions of the adjacent brain would cause such piece of bone to become a

constant source of irritation; there are no conditions present which favor or allow of the fragment becoming encysted. The final end would be the formation of a pus cavity, which might attain great dimensions and cause extensive destruction of the brain. The true condition in such a case might not be suspected in the commencement, since, for a time, no symptoms would manifest it, but when suppuration occurs, this would be indicated by impairment of some function of the brain. Another occasional complication of such penetrating wound is that the injuring instrument may break, and a fragment of it remain in the wound. Such fragment may protrude beyond the inner wall, and, remaining there, become a violent irritant of the brain; to do so, the broken point must pierce through and beyond the dura mater.

Among such penetrating wounds of the skull may be included those which enter the orbit, and, having pierced the soft parts, they perforate the bony wall of the orbit at some point, and enter the cranial cavity. Such a wound has been caused by a piece of wire, a sharp fragment of hard wood, an umbrella staff, the point of a saber, etc. An infant of the royal family of France was killed by a needle which was thrust through the orbit into the brain. And Henry the Second, of the house of Valois, was killed in a tournament by a fragment of a lance entering his brain through the orbit. He was treated by Ambrose Paré, with the great anatomist Vesalius as consultant, both princes in medicine. The execution of four criminals sentenced to death was hastened, so that their heads might serve for experimental work to aid in discovering the broken lance point; yet in vain, for the wounded man died on the eleventh day.

From what has been said of the penetrating wound of the skull, it is manifest that, though the lesion may be minute in its proportions, yet in its fatal consequences it may equal in fatality wounds of much greater magnitude. The author has knowledge of what seemed to be an insignificant injury of this class, in which the small blade of a knife was forced through the occipital bone, and, breaking off, the point remained. For some days the man suffered no inconvenience, then cerebral inflammation developed, which soon ended the victim's life. The necropsy revealed the broken point of the knife fixed in the skull and slightly penetrating the surface of the brain. Similar cases, of which examples abound in surgery, illustrate the importance of the early recognition of and careful treatment of these wounds, and furnish verification of the Hippocratic aphorism that no wound of the head should be carelessly treated.

In the treatment of the penetrating wound of the skull a cardinal rule should be that the surgeon see and examine the instrument which caused the injury. Thus one may decide whether a fragment has been left in the wound; also, whether the entering object was clean or unclean. Another rule is that, where the wound in the scalp is a slight one which does not permit a view of the injured skull, and there be a suspicion that the penetrating agent has been broken, then the track of the wound should be laid open, and the cranial wound inspected: and should it be probable that a fragment remains concealed in the wounded bone an opening should at once be made, and the case treated as will presently be explained. Though there remain a broken fragment of the instrument, or a piece of the inner plate be detached, yet for a few days probably, no symptom will indicate this; for intra-cranial reaction from any cause is only slowly aroused; and when once awakened, surgical intervention is often too late. Hence the urgent need of an early determination of the conditions. If it be evident, or even probable, that a fragment of the penetrating object has been left in the wound, then if it cannot be seized and extracted, the crown of a small trephine must inclose the wound, and a small section of bone, including the object, be removed. If the penetrating object be not wholly buried in the bone, then with a proper instrument it should be seized and extracted. Or if it be visible and yet so buried that it cannot be grasped, then the bone adjacent may be removed with a chisel, so that the body can be grasped; for the removal in these ways would be less hazardous to the patient than if the work be done with the trephine. If, however, some days have elapsed, and symptoms of encephalic irritation are appearing, then the trephine should be used, and, if pus be found, the part should be carefully cleansed, sprinkled with iodoform and so dressed as to permit of free drainage. The patient's head should rest in such a position that any material, excreted by the wound, shall spontaneously escape. The details for this work will be more fully given under the head of Trephination.

In case the penetrating agent has entered the orbit and there be signs that it has passed through the orbital foramen or sphenoidal fissure, or has pierced the thin, bony septum which at certain points separates the eye from the brain, then such wound becomes a matter of the gravest consideration to the surgeon. Should there be a visual or motor disturbance of the eye, such fact would be of diagnostic assistance. Should the causal agent

have left a fragment behind, then its extraction must be attempted; and even if the eye must be injured in the work, still it must be done. It is probable, however, that where the object has penetrated the supra-orbital plate, by an incision made either below the lid or through its base, the roof of the orbit can be reached, explored, and a foreign body found and removed.

Incised Wounds of the Cranium.—The incised wound of the skull necessarily includes the scalp. Such wounds occur in many grades, from slight to very extensive. The wound may merely attack the surface of the bone, or the latter may be divided through its entire thickness. The bone may be wounded perpendicularly or obliquely. Where the bone has been wholly divided, the adjacent brain may be wounded also. Wounds which are superficial, both the perpendicular and the oblique, are seldom dangerous to the patient. Far more grave are those which penetrate through the cranial wall. When the wound passes through the wall, the inner plate being pierced, a fragment may be wholly detached, or remain adherent; in each case the complication is a dangerous one.

The most important class of incised cranial wounds is that in which the cutting has been done obliquely, so that the wound assumes a flap-like form; and the bone which has been wounded may be completely sliced off, or it may be only incompletely separated from the remaining skull. When not entirely separated, the flap has a hinge-like pedicle, so that the wound may be opened and closed. When the flap has been wholly severed, its thickness will be a measure of the injury to the brain; such injury may vary from a simple exposure of the dura mater to one in which a section of the brain has been sliced off. An incompletely severed osseous flap may become entirely separated through fracture. The sharpness or bluntness of the incising blade will have an influence on the surface of the wound; fracture of the border of the divided bone arises from a blunt instrument.

The treatment of the incised cranial wound, in case the latter be superficial, is simple; it may be limited to antiseptic cleansing of the wound in the scalp, and closure by suture, or tying the hair so as to accurately unite the edges of the wound. In case of a perpendicular wound that has pierced through the wall, one must carefully examine with a fine probe for fragments of the fragile inner plate. Such fragment is so often present that, though it cannot be found in this exploratory search, yet it is

better to omit nothing in this search; and though it would add to the existing wound, still it would be better to convert this into a less perilous one by using a small trephine over the suspected point, and extracting the detached or partly detached fragment. If this exploration seem premature, or pushed beyond the line of caution, it may be answered that if it be delayed until encephalic symptoms plead for interference, such interference will almost certainly prove to be too late. But if the exploration be done just after the receipt of the wound, it adds but little to the primary wound; but if done later, it seldom does more than to arouse to action and intensify the latent inflammation. In this work conservative judgment and vigilant promptness should have full participation; promptness in action should, however, lead.

In case of cleft or flap-wounds of the cranium, in regard to the manner of treatment, surgeons have not been in accord: where the bone flap is still adherent to the cranium, the usual rule is to remove splinters or fragments of bone, hair and other foreign matter that may be in the wound, and then replace the bone, and close the wound in the scalp. Such wound should afterwards be attentively observed; and should signs of encephalic trouble arise, the wound must be reopened and a free outlet made for subsequent drainage. But in those cases in which the section of bone has been wholly separated from the rest of the cranium, and yet the scalp wound is incomplete, viz., the severed bone is covered by integument which is adherent to the rest of the scalp, then the course of treatment has been a matter of sharp controversy among military surgeons. The plan of Paré was to replace such a flap, and endeavor to obtain reunion of the bone. Fallopius and cotemporaries of Paré opposed this plan; they advised to remove the bone and close the wound by the remaining flap. The latter has been the plan pursued by most surgeons, and the results have been more satisfactory than where an attempt has been made to save the bone; since, not unfrequently, such bone has died, so that it afterwards became necessary to reopen the wound and remove the necrosing bone. Guthrie, a famous English authority, counsels to examine such flap, and if the bone is extensively separated from the rest of the flap, then it should be removed; but if it has unfractured edges and is well adherent to the tegumentary flap, then the bone should be retained and an attempt be made to reunite it; by this plan, which is commonly successful, the integrity of the cranium will be restored. The position of

the foot-stalk of such flap must have considerable bearing on the life or death of the bone adherent to it; when the pedicle lies peripherally, the bone will be less apt to survive the violence than when the pedicle is directed towards the heart, since in the latter the supply of blood will be better. The smoothness or roughness of the incised surfaces will favor or oppose reunion. Unless the position of the pedicle and the nature of the cut surfaces be very favorable for reunion, it would be safer to sacrifice the detached section of bone; the bone then should be cautiously dissected from the tegumentary flap, care being taken to preserve the periosteum. If the work be thus done, one might hope that some bone would be formed beneath the retained periosteum, similarly to what occurs in the rhinoplastic operation, in which the periosteum is preserved with the flap taken from the forehead, as was practiced by Langenbeck.

Fracture of the Cranium.—This is one of the oldest chapters in the history of surgery, and in many respects was as well described four hundred years before our era as it can be done to-day; for in Hippocrates one finds that which the modern writer, in the main, repeats. The cranium, in which nature has stored the most precious portion of the human organism, is frequently broken by accidental violence, or by that which is intentionally inflicted by man on himself or on his fellow.

The skull may be broken by direct or indirect violence; the former is by far the more frequent. Examples of fractures through direct violence are those in which a club, missile, or some falling body strikes the head and breaks the cranial wall. Again, the cranium may be fractured by a fall from a height, through railway accident, or the overturning of a carriage. Fracture from indirect cause is where the violence is transmitted from some more remote point to which the force was primarily communicated; such force may be first communicated to the crown of the head, the face, especially the chin, or to the feet.

There are varying grades of fracture, viz., fissure, stellate, or fracture in star form, fracture with depression, and communicated fracture with or without depression. The cranium may be broken in more than one place at the same time. The wall may be incompletely fractured, in which the outer plate only is broken, or the inner plate may be cracked while the outer one remains intact. Also, there may be inequality between the fragments of the inner and the outer plate; as a rule, the outer fragment is the larger one; yet the outer one may be small and the inner one

much greater in magnitude. The fracture of the skull may be the only injury, since it may exist while the scalp, dura mater and brain are injured. Or the scalp may be openly wounded over the cranial fracture; or the skull may be broken along with lesion of the dura mater and brain, while the overlying scalp is unopened. Each of the fractures enumerated are dangerous, and not unfrequently end the life of the patient, though the danger is far from being directly proportionate to the extent of the fracture; for a slight fissure has destroyed life, while a great fracture in which a large breach has been made in the wall through loss of bone, has not killed the subject, as might have been apprehended. Hence, accurate certainty in prognosis cannot be attained in these injuries; though extent and range of experience may aid the surgeon, he can never infallibly foretell the ultimate events of a fractured skull, and even though life be retained, yet often the injury leaves an indelible defect in the mentality of the victim.

As has been said before, there is a small class of cranial fractures in which the causal violence strikes the body at some point other than that which is the site of fracture; thus a blow on the summit of the head, on the chin, or a fall on the feet, knees, or ischia, may cause fracture at the base of the skull. This fracture has been the subject of much controversy. It was once taught that when the point of first impact was the head, the violence traveled from the point of primary contact to the bone which was broken, without lesion of the intermediate structures. More accurate observation has rendered this uncertain, and, especially, experiments made on the cadaver have rendered it doubtful. Aran, in 1844, published the results he obtained from a series of experiments; he concludes that "a fracture never occurs at the base of the skull without there being likewise a fracture at the point which was first struck. A fracture of the vault of the cranium may travel by radiation to the base; even the sutures do not oppose the passage of the radiating fracture; the line of fracture takes the shortest course; that is, it follows the curve of the shortest radius." This, though nearly correct, is not wholly so, since both by experiments made on the dead body, as well as through necropsy of those who had died from cranial fracture, such isolated injury has been found at the base of the skull. Hence the old surgeons were right in their doctrine of independent fracture at the cranial base from transmitted or indirect force, though it is much more rare than they thought; we are, therefore,

not justified in erasing from the page of surgery, as some would do, the word *contre-coup*, the French term by which the injury is commonly designated by the English writer; or counter-fracture, as the name becomes when anglicized.

The symptoms of fracture are of two kinds, physical and rational. The physical signs are those which reveal themselves to the sight and touch of the surgeon. When the scalp is entirely opened, and the skull can be felt and seen, then the character and extent of the injury can readily be learned, especially where the breach is an extensive one; by palpation and inspection, it can then be learned whether there be depression of bone, and whether there are fragments in large or comminuted form. The most valuable knowledge obtained by this inspection is whether there is anything escaping through the opened cranial wall. For example, if cerebral matter be seen exuding, this indicates that the inclosing membranes and the brain have been penetrated; or if a serous fluid only is escaping, this denotes, probably, an isolated injury of the dura mater, and that the fluid escaping is the cerebro-spinal liquid. Thus, when the bone is exposed, the extent and gravity of the injury done can be accurately estimated. The case, however, in which sight and touch may err, is where the fracture is a simple fissure. A suture has been mistaken for such fissure, and this is more apt to occur in regions which are the occasional site of abnormal suture. For example, in a small percentage of cases, the sagittal suture is continued through the frontal bone; and, as a rare anomaly, there may be a transverse suture dividing the occipital bone into two portions. Saucerotte mentions one instance of the latter in a clergyman, who, after a fall on his occiput, was on the eve of being trephined, yet one of the consultants claimed that the supposed fracture was a suture: the patient was rescued from the trephine, and in his gratitude willed his skull to the surgeon who prevented the operation. As errors have been made on this side, so it can be conceived that they might be made in mistaking a fissure for a suture. For instance, in the old subject's skull, a suture that has been closed might be reopened in fissured form. In former times, when the trephine was the inseparable follower of the fissured fracture, the diagnostic determination of the latter was pushed to the verge of pedantic refinement. Some staining material, as ink, was poured on the suspected point; a rasp-like instrument was next used, and the surface removed; if there was a fissure this was discovered by traces of the ink which had penetrated. Since the use

of the trephine has ceased to be a fashion, and this instrument has been restricted to exceptional employment, such adventurous method of diagnostic exploration, as that referred to, has ceased.

Formerly, where a cranial fracture was suspected, and the scalp was unopened, the practice obtained of opening the soft parts, so that the bone suspected of injury, could be seen. This practice is now wisely limited to those cases in which the patient's symptoms indicate internal injury of the head, which demands surgical interference; in the absence of such indication, the conversion of a subcutaneous fracture into an open one would be a wanton meddlesomeness deserving of strong reprehension.

A partial breach of the scalp, caused by some direct violence, has been mistaken for a fracture with depression; and only through some tactile experience can such error be avoided. In such injury of the scalp, the finger sinks into what seems manifestly to be a sunken condition of the bone. There will, however, be found a quick transition from the apparent depression in the bone, to the normal structure of the scalp. The finger rests in a hollow arising from a partial breach of the scalp, and the broken tissues, somewhat abruptly bounding and walling the sunken point, are indurated. In such pseudo-depression the bounding wall is more rounded and less resistant than is the case in cranial fracture with depression of the bone.

The old surgeons had a number of odd signs which they valued as indications of fracture; for example, the pain that was awakened at the site of fracture when the patient crushed some hard object between the molar teeth; or when a handkerchief was seized between the teeth and this was jerked, pain was felt at the place of fracture. Or if the patient was unconscious, and moved his hand to some part of the head, this was thought to signify fracture at the point touched by the patient. These signs have lost their former value; in fact, but little importance is now attached to them.

When some time has elapsed since the injury was received, continued swelling or œdema over the site of it has been thought significant of subjacent fracture. Or if the bone is open to view, its condition, even if unfractured, is suggestive; for if dry, gray or yellow, encephalic lesion may be inferred; subjacent pus may be suspected.

When the fracture is seated in the lower part or base of the skull, though some of the conditions above described are present yet it has peculiarities and characteristics which require some

further description. Such fracture may be from direct or indirect violence. In that from direct force the fracture may be with, or without, an opening through the external soft parts. The causal agency is oftenest some missile or projectile. As the base of the skull is nearly inaccessible to sight and touch, exploration of injury there is much more difficult than when it is in the cranial vault. And even when in the borders of the base, the thickness of the overlying soft parts interferes with accurate palpation. The sterno-cleido mastoid, splenius and complexus muscles both protect and pretty effectually hide the bones beneath them.

From indirect violence or transmitted force, as before mentioned, the irregular structure composing the base of the skull may be broken. Such fracture would be indicated especially by functional disturbance of adjacent parts. Thus nerves and blood vessels may be compressed or torn, and, in case of the nerves, the result would be the abolition or perversion of their normal office; thus might arise disturbance of motion and common and special sensation. There is some interruption of the media or routes of intercommunication between the head and the trunk and limbs.

Fracture occurring at some point of the base of the cranium may be indicated by ecchymosis, hæmorrhage, effusion of serous fluid, or crushed cerebral matter.

If the fracture be located behind, there may be ecchymosis of blood, visible through the skin, in the inferior occipital region, and especially behind the ear. Or if the fracture be in the anterior structures of the base, then the ecchymosis may appear in the eye, or in the pharynx. In all these cases, the ecchymosis does not instantly appear; it only does so after the lapse of a brief time; the blood, having penetrated the tissue from within, gradually travels thence and finally appears at the surface. Such ecchymosis should not unreservedly be depended on as furnishing certain evidence of fracture. The author has seen cases in which ecchymosis was present, where he was convinced that no fracture existed, but that the effused blood was from superficial vascular lesion due to violent concussion. This is frequently the case where the effusion is sub-conjunctival.

Hæmorrhage from the ear, nose and pharynx, denotes lesion of blood vessels caused by fracture of bone adjacent to the site of the escape of blood. From the ear, it would imply that some portion of the temporal bone had been broken, but if this symptom be too implicitly followed, it may mislead; for bleeding from the

ear has been seen, several times, by the author where the injury was not deeper than the external auditory canal. Bleeding from the ear may be caused by rupture of the typanum, by lesion of the auditory canal, by fracture of the adjacent mastoid process, and it can arise from other injuries of the head in which the skull is not broken. Where there is fracture of the base, there may be only the appearance of specks of blood in the external outlet and lobule of the ear. In other cases, the blood slowly trickles from the auditory meatus, or it may flow in a constant stream; and in the latter cases an artery, or sinus, has been opened coincidently with a fracture of the skull.

The blood may escape from the nose and mouth through fracture of the base; and there may likewise be simultaneous issuing of blood from the nose, mouth and ear, due to fracture of the base; still it must be remembered that such hæmorrhage may arise from other causes than cranial fracture.

The escape of serous liquid from the ear and nose indicates fracture; that from the ear denotes fracture of the petrous portion of the temporal bone. It may have been preceded or accompanied by hæmorrhage; it is of more diagnostic certainty when unaccompanied by bleeding. The fluid, for a time, was thought to be from the internal ear that had been opened; it is now known to be the cerebro-spinal fluid, since it has been shown to be chemically identical with the latter. Large quantities of this fluid have sometimes been lost. The same fluid may escape from the nose; then the sphenoid bone is the site of fracture. The flow of this serous fluid may continue for hours, or even days. When it appears some hours after the injury, and there has been antecedent hæmorrhage, and the escape of the liquid is variable in amount, then it is more equivocal, and must be reckoned as a certain sign of fracture.

Observations made in regard to the temperature of the subjects of cranial fracture have revealed the following facts: During the period of shock and depression which immediately follows severe cranial injury, the heat of the body sinks below the normal rate, viz., to 97° Fahr. or even lower; then there is a moderate rise, which, not unfrequently, is followed by a depression of temperature, which continues for some days. The increase of temperature depends on the lesion of the encephalic structures, rather than on that of the cranial wall, and rise of temperature, gradual or abrupt, denotes morbid action of the parts outside of or within the skull; abscess or erysipelas in the scalp would thus be indicated;

and so meningitis, encephalitis and intracranial abscess might reveal themselves by increased heat. Such augmented temperature might arise from both intra-cranial and extra-cranial morbid action, and, hence, in erysipelas or abscess of the scalp, one would not be justified in referring the rise of temperature wholly to these extra-cranial conditions. In his study of the fractures of the base of the skull, Battle has met with a few cases in which a few hours after the receipt of the injury, the temperature rose to the enormous extent of ten degrees above the normal rate; he says that such great increase of heat portends a fatal termination, and is due to severe contusion of the brain.

The functional disturbance in cases of cranial fracture depends on the amount of injury done to the brain. The violence seems often to expend itself in the fracture, and, in such favorable condition, the encephalon being intact, the fracture becomes a lesion of no great importance. In such a case, the fracture may be looked upon as a conservative event, in which the injury ends. If the violence had not thus been expended or used, it would have passed inward into the cranial cavity, and done its work in the graver work of cerebral concussion. And thus, not rarely, is seen the paradox that a patient, who has fracture of the skull, is much less injured than one whose cranium was not broken; the former may rise and walk, and declare himself but slightly injured, while the latter, having concussion of the brain, lies unconscious, and is most seriously injured.

The region of the skull fractured has an important bearing on the gravity and danger of the injury. Fracture in the anterior half of the cranial vault is less dangerous than in the posterior half. From the author's experience, a fracture in the region of the forehead is better tolerated than elsewhere; cases have been seen in which the frontal bone had been broken most extensively, and, though fragments were lost and cerebral matter escaped, still the patients recovered. A fracture in the occipital region is more dangerous than when seated anteriorly; yet, in both cases, the character and conditions of the fracture determine the amount of danger which it brings to the patient. An open fracture in which the integument has been torn, the bone broken into two or more pieces, and these pieces have been removed, is occasionally followed by recovery, in any portion of the cranial vault; while a fracture on a much smaller scale, in which no bone has been lost, more often ends unfavorably. For in the former case, in which the fracture is open, the surgeon is able to dress the wound

more conformably to the conditions which favor healing; osseous fragments can be removed, bleeding arrested, and the margins of the broken bone can be restored to normal site; work that cannot easily be done in a smaller fracture.

A fracture in any part of the base of the skull is more hazardous to life than one in the cranial vault; for the reason that more important parts of the encephalon are thereby imperiled; danger increases as the medulla oblongata is approached. In an exhaustive study of fractures of the base of the skull, published in 1890 by W. H. Battle, of London, this writer has collected fifty-four cases which ended fatally; in nearly two-thirds of the cases the cause of death, as revealed by necropsy, was from cerebral contusion with laceration and hæmorrhage. Death occurred in from one hour to fourteen days; the most died within three days after the injury.

Though the danger from these injuries may be estimated with a fair degree of probability, yet the keenest prognostic acumen often errs, since the seemingly trivial fracture may destroy life, while a breach a hundred-fold greater has often defeated fatal predictions by ending in recovery; the latter error escapes criticism; since all is well that ends well.

A fracture of the cranial bones is less perfectly repaired than elsewhere; though the broken bone be but thin in extent, and is invested externally and internally by a periosteum, still there is a very limited amount of callus produced; so that union is accomplished chiefly through the medium of fibrous tissue. The opposite fractured borders are connected, similar to a cranial suture, by a thin layer of non-vascular fibrous tissue.

Treatment.—Since fracture of the skull presents itself in varying degrees of severity, so the treatment must vary in character; and as the encephalic complication is far more important than the injury of the cranial wall, so the former must ever be kept prominently in view; in fact, it must claim the principal share of attention. At present, only the fracture will be considered, as a special section will be devoted to injuries of the brain.

The treatment of cranial fracture has been the subject of sharp controversy; methods long held in reverence have been replaced by those quite opposite to former ones. For centuries trephination, as a shadow, was the inseparable sequent of a fracture of the skull; even in case of the minutest fissure, this instrument was used, and, in the exploratory work done with it, the cranial injury was increased many times. Such instrumental

interference is now seldom resorted to; and by its present conservatism, surgery has removed a trammel with which nature formerly had to contend in the work of restoration.

In a simply fissured fracture, or one in which there is slight depression without symptoms of cerebral disturbance, the treatment is exceedingly simple; the patient, or rather his head, should be placed at rest; the ear and eye should cease their work; in fact, the door of all the senses should be closed against external impressions. These precautions, even though the brain has been spared any injury, will not harm; and if the organ has received a latent lesion, such precautions may prevent further development. If the alimentary canal was laden with materials at the time of the accident, these should be removed by a proper cathartic. Fortunately much of this material is often gotten rid of by spontaneous vomiting. This vomiting, probably called into action through the pneumogastric nerve and the sympathetic nervous chain which connect the head and stomach, usually ceases as soon as the stomach is emptied.

Along with these matters of general management, the injury of the head demands some local treatment. If there be a breach in the scalp, this must be dressed by one of the methods before described, best adapted to it. And if there be no open breach, the management of the wound will be limited to a topical application; and for this, cold in some form has general sanction. This may be applied in the form of a compress saturated with cold water, or broken ice or snow, in an India rubber bag, may be placed over the injured part. As ice and snow may freeze, and have done so when indiscreetly used, there should be interposed between the containing sack and head a piece of cloth, woolen or cotton. If a compress merely wet with water be used, such compress is best made from some porous or wide-meshed material; mosquito netting, of which several thicknesses are folded together, serves the purpose well. Such a compress wrung out of cold water will retain the cold and moisture for some time; and there will be little inconvenience from the water escaping, as occurs when the compress is made of closer texture. Cold with moisture is more agreeable than dry cold.

In regard to the topical use of cold in the treatment of wounded parts of the head, when the matter is studied, there is some difficulty in understanding how the cold can act beneficially. For the immediate effect will be to contract the vessels which are cooled, and thus lessen the quantity of blood which

enters the arteries, and cold will also empty the veins; the result of this must necessarily be to increase the amount of blood contained in the structures around and beneath. Only where the scalp is thin can the action of cold reach into the underlying bone; but when the covering structures are thick, then the blood would merely be collected in greater quantity in the underlying cranial wall. Hence it is probable that in most cases, the local use of cold to the head is hyperæmic, rather than anæmic, in its action on the injured bone. And, further, in those regions which are the site of the emissaries of Santorini, or canals of intercommunication between the extra-cranial and intra-cranial structures, the effect of cold is to cause the blood to flow from the cooled scalp into the skull, and there cause a local hyperæmia; in fact, the cold in such case does quite the opposite of what it is intended to do. Emissaries of Santorini exist in the lower margin of the forehead and in the parietal bones; hence cold applied over these regions causes an afflux of blood into the skull. And though the author has, in accordance with common usage and authority, advised the local use of cold in these injuries of the head, yet it is equivocal whether local cold here, as well as elsewhere, is actually beneficial. The subjective experience of the patient often influences or directs the treatment; the wounded part being benumbed by cold loses its sensibility, and this fact probably first led to the use of cold. A possible benefit from cold is conceivable where the blood in the scalp, being cooled, traverses the wall and lowers the temperature within the skull; but here, as not unfrequently occurs elsewhere, the medical writer who is seeking to give truths, pauses in embarrassment and must ask his reader to await until Theory and Experience, becoming more intimately acquainted, shall unite in a common task of reconciling and adjusting contradictory and incoherent facts.

In case both scalp and cranium have been opened and there be no depression, then, after removing fragments, the margins of the broken bone should be carefully attended to, viz., if there be depression, the edges should be lifted into proper position. Besides being restored to position, broken edges should be trimmed with extreme care and rendered perfectly smooth. If this precaution be neglected, the adjacent encephalon, moving under the influx and efflux of blood, will be brought in contact with, and irritated by, any sharp point impinging against it. And, though this irritation be slight and produce but little present trouble, yet, after the part has healed, the overhanging osseous promonto-

ries may increase in thickness and become an enduring source of irritation; thus epilepsy has been caused, and continued until the causal agent was removed. In one instance seen by the author, from the osteophytic irregularities of a fracture of the vault, suppuration arose, with opening of the old wound, and prolapsus of the brain, from which death ensued in a few weeks.

Healing, as before said, even in fissural fracture, is through the medium of fibrous tissue; and where, from the loss of bone, the broken edges are not in contact, then the interlying breach is closed by fibrous material. This tissue is analogous to that composing cicatricial structure closing a breach on the surface of the body. And this is true in all varieties of open wounds of the cranium, whether merely bone has been removed, or, in addition to this, whether the meninges have been opened and partially destroyed; and, likewise, where there has been loss of bone, membrane and cerebral substance; in each of these conditions of wound, the healing is through the medium of granulations, which finally become converted into normal cicatricial structure. And this reparative material does not completely fill the breach; there is afterwards left a depression, arising from the contraction and sinking of the new-formed material; and a consequence of this is that the adjacent brain is disturbed in situation and form. As a result, there sometimes remains functional impairment; and this is more especially so in the young subject, in whom the parts have not attained the dimensions of adult life. Such maimed heads are often the victims of epileptic or other encephalic disease.

The treatment of cranial fracture in which the bone is depressed has been the subject of shifting change. Formerly the trephine always found work to do in such injury, and a surgeon, who would have neglected to perforate the sunken wall in such case, would have been deemed guilty of great carelessness towards his patient. The opposition to trephination, which is one of the conspicuous events in the history of modern surgery, has quite reversed the management of such injury, so much so that he, who would invariably trephine in cases of depressed cranial fracture, would be pronounced guilty of wanton temerity. In the annals of medicine similar examples are met in which the pendulum of opinion, swinging to and fro between adverse doctrines, through the zeal of the contestants has been made to move too far in each direction; but as the pendulum committed to the constant force of gravitation soon resumes its normal arc, so the controlling power of truth is ever adjusting medical opinion to its own stand-

ard. The author is of the opinion that the sweeping renunciation of the trephine is an error in practice; still he would not adopt the medium way, as the compromiser is wont, between the old practices, since the middle line, instead of being the safest, is too narrow for occupancy and action. Experience permits and indicates the use of the trephine in cases of fracture in which there is extensive depression of the cranial wall. For such depression, if unrelieved, must hamper the brain in its functions. Of these multifarious functions, that of motor innervation is one of which the site has been definitely located in the surface of the brain; the others have doubtless their special sites, and await for the exploring hand of vivisection to discover and indicate them. The encroachment of a depressed cranial wall must interfere with any such subjacent center, impairing its nutrition and, partly or completely, annulling its function. In the plastic period of youth, the changes in the wall occurring through growth, may finally compensate or efface the ill form; but where the cranium has attained its complete form, such depression must be more detrimental in its action, since, if unrelieved, the deformity will be permanent.

Guided by these principles, the author would use the trephine and uplift the bone in every case in which there is an extensive depression of the cranial wall. For this purpose, with precautionary asepsis, a small opening shall be made in the center of the depressed bone, and the latter carefully uplifted with an elevator. This, in the young subject, can easily be done, but in the old, the work of elevating is more difficult; and, in the latter, there may have occurred an isolated fracture of the inner plate, so that a fragment must be removed; and in such case the patient will afterwards be indebted to the trephine for saving his life. In the work of elevating, care must be used not to injure the inner surface of the bone, as well as the adjacent dura mater. This method of practice the author would pursue in every case of extensive depression of the cranial wall, which, if unrelieved, must entail a future deformity of the inner and outer surfaces of the skull.

The treatment which has been detailed is only applicable to fractures in the superior and lateral parts of the cranium; but if the injury be in the base, its inaccessibility will place it out of the reach of any direct surgical treatment. The character of such fracture, owing to the injured part being invisible, can only be inferred; and here the surgical management is restricted in its

sphere of action and has only occasional opportunities for indirect intervention. For example, where there is a profuse escape of the cerebro-spinal fluid from the ear or nose, resulting from injury of the petrous part of the temporal bone or the body of the sphenoid, then an attempt should be made to arrest the discharge. This should be tried by plugging or tamponing the outlet of the fluid; if this be from the ear, the meatus should be plugged with lint saturated with some astringent, such as a solution of gallic acid, alumen, or some salt of zinc or iron. Or if the fluid should escape from the anterior or posterior openings of the nostrils, indicating the escape of fluid through the sphenoid bone, or possibly through the Eustachian tube from the tympanic cavity, then an effort should be made to arrest this by tamponing the nostrils before and behind by means of astringent lint. If the fluid be thus arrested for a day or two, then it is possible that the breach in the base of the skull might become closed, and further escape of fluid be prevented. When the escape is from the ear, as a co-adjuvant to plugging, one might first inject an astringent solution into the auditory canal, and, perhaps, thus directly plug the fissure in the petrous bone. Where the serous discharge is small in quantity, and has its probable origin in serum expressed from clotted blood, or is derived only from the internal ear, then no treatment is required, as it will cease spontaneously.

If, instead of serum, the escaping fluid be blood, then its arrest is more urgently demanded, since the amount lost may be so great as to destroy life. An astringent solution should be injected into the ear, if the blood issue thence, and afterwards, the meatus should be carefully plugged. In this way a clot will be formed which will extend into the open vessel and, possibly, occlude the rent in it, until healing occurs. Or if the bleeding be from the nose, then the nostrils in front, and the choanæ behind should be tamponed with lint saturated with some astringent. The astringent solution, if not antiseptic, should be rendered so by the addition of corrosive sublimate, viz., one in three thousand. By these means severe hæmorrhage from the ear or nose due to cranial fracture, might be controlled. The tampon should be renewed and a new one substituted from time to time. Instead of the astringents mentioned, the tincture of iodine may be used, and the tamponing material saturated with it; the same may be used in the auditory canal before the latter is plugged up. The tincture of iodine coagulates the albumen in the blood, in a manner simi-

lar to an astringent, and it has a less corrosive action on the parts with which it is in contact. Such clot, probably, after partial absorption, undergoes organization and may aid in closing the fissure or cleft in the broken bone.

After recovery from a fracture at the base of the skull, it is probable that the patient will be maimed in some way; there may remain complete or partial deafness; and with this there may be unilateral facial palsy. And so there may be lesion of one or more of the first six pairs of nerves, which have exit through the base. Thus, besides deafness mentioned, the sense of smell, sight, common sensation of the face, and the muscular movements of the eye may be interfered with. And such peripheral lesion would point with certainty to the site of fracture. Recovery from such sensory or motor lesion could not be facilitated by any procedure now known to surgery. The patient might be consoled with the slight and delusive hope that in time the parts might accommodate themselves to the pressure; or that if the pressure were due to a coagulum, this might be absorbed; and to favor such absorption, some aid might be derived from large doses of the iodide of potassium.

GUNSHOT WOUNDS OF THE CRANIUM.

The history of fracture of the skull which precedes will conclude with an additional chapter devoted to gunshot wounds; the individuality of these injuries entitles them to a special consideration.

Missiles propelled by some explosive compound, of which gunpowder is the most common one, are in infinite variety; as they vary in form, volume, and velocity of movement, so the violence done by them differs. The difference in lesion varies from the slight marring caused by grains of powder, to that arising from an exploding bomb, or shot of large surface and great weight; from a superficial deformity to an instant destruction of the victim; and of these varying forms, wounds caused by missiles of small size chiefly engage the attention of the civil surgeon. On the battle-field, wounds from large projectiles are seen; in civil life the missile from the pistol or rifle is the usual agent of such wound; and wounds inflicted by these weapons upon the skull are the ordinary ones requiring the surgeon's care; those from larger guns and explosive projectiles are more rare, and, as a rule, are speedily fatal.

Gunshot wounds made on the cadaver are equal in severity to

those made on the living body. Accuracy in shooting is rarely attained with the revolver; and even though the instrument be rested, yet the mark is often missed. A shot fired from this weapon at a distance of forty inches, leaves no marks of powder; but at the distance of sixteen inches, stains are made by the powder. At the distance of seventy-five feet, small shot penetrates but slightly; but at the distance of five feet and a half, the shot penetrates, yet no marks are made by the powder. The exit opening is greater than the entrance point. At the distance of five feet, small shot does more violence than a bullet fired through the same distance.

Stains of different character are produced by different kinds of powder. Fine powder leaves but little marking or burning; powder which contains much sulphur is more violent in its action.

The gunshot wound of the cranium presents itself in two leading forms; in the one class the scalp is not opened, the injury to the cranial wall being wholly subcutaneous; but in the second class, along with the osseous wound, there is also a lesion of the scalp. Experimental work illustrating the action of the gunshot projectile on the human body has been done and reported upon by several surgical writers. On the cranial gunshot wound, one of the ablest and most trustworthy reports has been made by Teevan; later, reference will be made to the same. In 1875 Crespi and Tazon published some general observations in this field, of which the subjoined is a summary. The ball or projectile from oblique or glancing contact with the head may cause no external wound, yet produce a fracture of the cranial wall; and this fracture may be very extensive and even destroy life, though the scalp is unopened. Such wound can only arise from a large ball; a smaller one will wound the scalp, and if it pass deeper than the latter, it will also wound the skull. As wounds of the wall, which then arise, diverse forms present themselves, of which we will mention the following leading ones:—

1. The ball may penetrate the scalp, and at the same time carry the clothing with it which it does not penetrate, and, having reached the skull, it may rebound and be withdrawn with the clothing; in such a case the bone is only superficially injured. Or without any intermediate clothing, the missile, having been spent or lost its speed, enters the uncovered scalp, impinges on the bone and then rebounds through the same wound.

2. The missile may enter the scalp, and, having channeled a

slight furrow in the surface of the skull, it stops and remains buried in the scalp; or it may escape from the scalp at some point near by. The open canal, then formed, will lie partially in the cranial wall, and the gravity of the injury will then depend on the depth of the furrow in the wall. The furrow may be deep enough to fracture and detach a fragment from the inner plate; and such shot-wound, though it does not directly pierce the wall, yet it is more perilous, perhaps, than one which pierces quite through the wall; for the loose fragment of irregular form may act more deleteriously than would the ball itself.

3. The ball may enter the cranium, and, having pursued a straight route, it may lodge within the brain, or at the opposite wall of the skull which remains uninjured; or instead of passing straight into the brain, it may be deflected by the dura mater and pursue a curved line along the inner surface of the skull, and lodge in contact with the skull, without having opened the meningeal envelope of the brain.

4. The ball may fracture and pass through the cranial wall, and, having traversed the brain in a straight direction, it may break and pass through the opposite wall of the skull; in this form there is a straight shot-canal through the head. It is possible in this last case, that the missile having passed through the second wall may lodge beneath the scalp; and there would then remain a blind canal, with a ball at the bottom of it.

To sum up, the cranial shot wound may present itself in one of the following forms: wound by simple contact, in the form of a furrow, a blind canal, or in the form of a complete canal passing through the head.

The diagnosis is commonly easily made, since the history of the case, in which a firearm was used by the patient or some one else, clearly reveals the causal agency of the wound. In determining the fact, one may be assisted by the presence of marks about the wound in the integument; also, the form of the wound can aid. The extent, direction, depth and character of the wound must be learned by the use of the probing sound. The sound judiciously used, carries, as it were, both an eye and a finger into the wounded structures, so that the searcher learns the condition of the injured parts.

Nearly connected with the diagnosis are the openings which the ball makes in entering and escaping from the wounded parts. The form of the ball and speed with which it is moving determine the character of these openings; also, the distance which the ball has

traveled before striking, influences the form of the wound. Simon of Darmstadt, in 1850, made a series of experiments on this subject; his work consisted in shooting at animals and masses of flesh at short and long range. He found that, at short distance, a ball, moving with great velocity, formed openings at its entrance and exit which were exactly alike. In case the ball is moving less rapidly, then, at its entrance, it cuts out a section of the wounded structure equal to the size of the missile. This was demonstrated by catching the material that was cut by the ball on paper properly placed. And in this case, the margins of the entrance point are contused, ecchymosed, and the edges are inverted; meantime, the exit opening is less round than that of entrance; besides it is torn and everted. But if the ball traversed the part obliquely, these diagnostic differences are less marked; and if clothing surround the part which is pierced obliquely, then the entrance through the clothing will be round, with loss of structure, while the exit point will be triangular, or slit-like. After healing the entrance point is round and depressed, while that of the outlet will present a scar uplifted and slit-like in form.

Simon found that, in the soft parts, the exit opening may be larger than that of entrance, when fragments of bone have been detached and are carried along with the ball; the same is the case when the ball has been flattened and enlarged in surface by contact with a bone.

The diagnosis of the entrance and exit openings, left by a ball in traversing the cranial wall, has been greatly aided by the experiments of Teevan of London, which will long remain as a model of excellence amidst the vast array of experimental work, which has been done to illustrate the character of violence done by the gun-powder missile on the human body.

In these experiments, made in 1864, Teevan found that, by firing from a short distance straight at a skull, the entrance through the outer plate of the cranial wall will correspond to the size of the ball, and the fracture will be smooth and without fissure or splinter; but the opening through the inner plate will be larger than the one through the outer one, and the orifice will be smooth and not fissured. If the ball be fired through the foramen magnum, then those conditions will be reversed; the outer plate will have a larger orifice than the inner one. The plate first impinged on and broken, shows the exact form of the traversing ball.

The form of the ball has its influence; a larger exit orifice is made by a round ball than by a conical one; the round ball produces a round opening, while the conical one makes a conical or elliptical one.

A ball, fired from a barrel of smooth bore, loses much more of its speed, in traversing a body, than does one which has been fired from a rifled barrel.

In traversing the skin, the inversion and eversion of the openings correspond to the direction pursued by the ball.

If a round ball be fired obliquely against the skull, it glances off; but if the ball be conical, it will nearly always enter the skull; and having been flattened by the impact, it will cause more violence than if fired perpendicularly.

If the skull be pierced by something other than a ball, violence, similar in character, is done. For example, if it be caused by a nail or the edge of an axe, then the opening in the outer plate will represent the entering object, while the inner plate will be opened more extensively.

In firing through two boards, which are near each other, the exit opening was larger than that of entrance, due to the ball having carried along with itself particles of wood, which increased its volume.

The experiments of firing at the skull were varied in several ways. For example, the firing was done from the inside, and through the wall where one lamella had been removed by trephining, and the conclusion arrived at was that the missile, in traversing one lamella, carries particles with it, which enlarge its volume, so that, when it passes through the next lamella or wall it opens a larger orifice.

The foregoing points, concerning the entrance and exit openings of the missile and the changes in form which it undergoes, are important subjects, which closely concern the student of Forensic Medicine; for the determination of the agent or person, who inflicts the wound, may depend on the peculiarities and forms of the wound which have here been detailed; and thus might be unraveled the facts whether the wound was self-caused, or made by the hand of an assailant.

A careful search should be made to discern whether the ball has passed through some article of the dress of the patient, and carried and lodged fragments of the same in the wound; hence clothing, which may have been traversed, should be inspected, and, if it be presumable that such fragments remain in the shot-canal, an

endeavor should be made to extract the same; for such foreign matter acts much more deleteriously than the ball itself.

In regard to the danger and fatality of wounds of the cranium, there is ample material to draw correct conclusions from, furnished by the surgical reports of the Northern army, during the War of the Rebellion, in the United States. These statistics cost an immense amount of labor, as well as the life of the compiler, Dr. Otis, who fell a victim to overwork. From these voluminous records, the following facts are extracted. Of gunshot wounds of the cranium without depression, there were 2,911 cases; of these, there died 1,826, that is, 64.6 per cent. There were 364 cases in which there was depression, and, of these, there died 129, that is, 35.8 per cent. From this, it singularly appears that depression acted conservatively in gunshot wounds of the skull. The only explanation which can be offered of these facts, so contradictory to what inexperience would have predicted, is that the violence done in the latter series of figures was less than that done in the former series.

Since the era of antiseptics, the mortality of all injuries of the cranium, including also gunshot wounds, has undergone a material revision. According to Estlander, the Finnish surgeon, who has studied the subject, before 1870, the mortality of wounds, in which the skull is laid bare, was twenty-four per cent; but since 1870, under antiseptic management, the number of deaths has been reduced to one and one-half per cent. Prior to 1870, the mortality, in cases in which the scalp has been opened and the cranium fractured, was near sixty-seven per cent; but since that time, five-sixths of such cases recover. But where the fracture is in the base of the skull, that is, cases in which the antiseptic treatment is not applicable, the mortality now is the same as formerly.

In 1879, a series of figures was collected by Gurlt, bearing on the fatality of wounds in which a foreign body enters the cranium, and which shows that, of three hundred and sixteen cases, one hundred and sixty recovered, and one hundred and fifty-six died. In one hundred and six of the cases, the body was extracted, and of these, thirty-four, or about one-third, died; while in two hundred and ten cases, in which no effort was made to extract the body, one hundred and twenty-two died, that is, somewhat more than one-half.

In the history of gunshot wounds of the cranium, Fritz finds that more recoveries have occurred in cases in which there has

been but little or no surgical interference. The young subject, with such injury, is more apt to recover than the old person. He finds that cranial injury becomes more perilous as it invades the sides and base of the skull.

Cranial gunshot wounds are least dangerous when produced by small balls. Küster, in 1882, reported cases in which small balls entered the cranium; the wound in the scalp was enlarged and osseous fragments removed, but the ball was not extracted. The cases recovered. Bergmann advises not to open the wound, nor remove osseous fragments, but to treat such as simple wounds. Langenbeck treated five cases of cranial gunshot wounds, in which a small ball had entered the skull. These cases recovered without any active treatment. Bardeleben also reports cases, in which there was recovery, without removal of the ball which had entered the skull.

Balls of large volume have frequently entered the cranial cavity and penetrated the brain without causing death; as a rule, however, in such cases there has occurred some impairment of the subject's intellect, or lesion of sensation or motion. Where a ball remains, the most favorable event that can ensue is that it become encysted, that is, that it become inclosed and held in its new position by firm material which is similar to cicatricial tissue. Such a ball may remain innocuous for an indefinite period. A much more unfavorable event is that in which the ball forsakes the site in which it is lodged; and when this occurs in the soft substance of the brain, the ball may sink directly downwards, or in that direction in which it meets with the least resistance. Thus gravitating, the ball may travel wholly away from its primary place of lodgment; and in its migration it injures the parts with which it comes into contact, and, thus, the gravity of the primary wound is much increased. Such migration may occur immediately, or it may ensue at a much later period; and in the latter case, the ball quits the encysting structures by which it had previously been held in place. From these facts, it is apparent that when a ball has lodged in the cranial cavity, it becomes an enduring element of danger, which will ever afterwards menace the life of the patient; and though such body has remained for a long time without giving trouble, yet there is no certainty that it will continue to do so; and, hence, the rule to be observed in all cases, in which the ball is large, is to attempt to extract it when this can be done without greatly adding to the wound already existing.

Treatment.—As the extent and gravity of cranial wounds vary, so their treatment must differ.

In the first class of wounds in which the projectile or ball has not opened the scalp, and still, from glancing impact, the cranium has been fractured, the extent of the fracture can only be inferentially determined through palpation and the condition of the patient. Since, frequently, the fracture is on a large scale, and consists of a number of fragments which are loose, in such cases these fragments can be pressed inwards or moved by palpation, and the gravity of the injury fairly estimated. Besides, the state of the patient, as respects mentality, sensation and motion, approximately indicates the amount of injury which he has received; and this is often so great that any active surgical interference, instead of benefiting the patient, would rather disturb the quiet which should be the privilege of the dying man. Where there is great depression and other symptoms denoting serious if not fatal lesion of the brain, then the primary care of the wounded person should be limited to giving him a stimulant, and the use of means designed to restore and maintain the temperature of the body. Should the patient, however, rally and present signs that his case is not hopeless, then attention should be turned to his injury. If there be marked depression of bone, or a fragment, perhaps, has been displaced beneath another, or forced under the undepressed margin of the adjacent wall, then the broken bones should be exposed by incision, and the depressed part uplifted. Likewise, through such incision any fragments which are found to be quite detached from the periosteum and dura mater, should be removed; for such loose pieces of bone would act as foreign bodies and prevent recovery. But if a fragment has sufficient attachment to adjacent parts to insure its vitality, then it should not be removed. After the removal of loose fragments, and the elevation of the depressed cranial wall, the wound made should be closed by suture except at a dependent point, where a drainage tube is inserted and allowed to remain for some days, for the escape of fluid detritus from the wound. Such wound should be covered by a protective compress of lint which has been saturated with a dilute alcoholic solution; and this should be retained cold by a light overlying ice-bag. And should signs of cerebral trouble appear, these should be combated by means described under the head of meningitis and encephalitis.

In the second group of wounds, in which the missile opens the

scalp, we will first notice the simplest form, in which the ball merely comes in contact with the cranium and communicates but slight violence to the bone. The injury then will differ according as the ball merely grazes the surface in passing or, having exhausted its motion, it lodges as a spent ball against the wall. In the first case, the injury done will be confined wholly or nearly so, to the soft parts; and then the treatment would be a simple matter, being similar to that of an incision or simple breach of the scalp. And so in the second case, in which the ball is an inert missile lodged against the wall, the treatment would be limited to that of a slight wound of the scalp; but as the full extent of the violence done is a matter of uncertain conjecture, the case should be thoughtfully watched; and should other symptoms arise, the latter should receive appropriate attention. Where severe internal complications appear, and show that the gravity of the injury was not fully estimated, then it will probably become necessary to use the trephine.

In the wound of the next grade, in which the passing ball has touched and broken the surface of the cranium, then the wound should be examined, and the detached or partly detached fragments should be removed; and the further treatment of the wound should be similar to that before detailed for injury of the scalp. As in the case of simple contact, the amount of internal injury done is not always known, so, in the case of the superficial furrowed wound of the wall, there may be injury to the subjacent dura mater; and the evidence of this will only appear at a later time. Hence the need of heedful attention to any indication that may point towards intra-cranial complication; such complication would probably arise from a fracture of the vitreous plate; the loosened piece of bone, deprived of nutrition, would die and act as a foreign body of uneven surfaces. In such a case, trephining would furnish the only means of relief, and, the earlier this were done, the greater would be the relief to the patient.

In the next form of gunshot wound, in which there is but one opening, the missile may carry along with itself fragments of clothing, hair, minute portions of the scalp and one or more fragments of bone. As a rule, the ball will be found within the skull; yet, as Guthrie, an eminent English authority in military surgery, remarks, this is not always so. The ball may strike the cranium and fracture and force inwards a fragment of the wall, and yet the projectile may rebound and not enter the skull. In such case the finger or sound can pass into the track of the wound,

and, finding a piece of bone nearly the size of the ball, this fragment can easily be mistaken for the ball; such a condition would greatly embarrass diagnosis, since, though the fragment of bone is removed, the surgeon could not be sure that the ball was not lodged somewhere in the head.

As the instances are very rare in which the ball rebounds from the breach that it makes, hence no pains should be spared in a diligent search for, and the extraction of, the missile when found. The hope that the ball may, when not removed, become encysted, and in such state remain inert and harmless, is doubted by Billroth, who, in 1870, announced a contrary opinion. He claims that from the irregular and battered shape which the ball often acquires, it is apt to induce suppuration. From its impact with the bone, the ball becomes roughened in form, and sometimes split into two parts. The striking of the ball against a bone can also cause inflammation of the latter. Billroth saw cases in which round balls caused suppuration, due, he thinks, to laceration of the tissue by the heavy body; and had the ball been smaller and lighter, probably no suppuration would have arisen.

As the ball usually carries along with itself and leaves behind, either in or at the side of its track, pieces of clothing and fragments of bone, the first work of extraction should be directed to the removal of these bodies; for their presence would be quite as detrimental to the encephalic structures as the ball itself. For the removal of these foreign matters, Betz invented a sound which terminated in a hook-like end, which must be short, not more than a line long; such a sound may be made of silver, attenuated at one end, and bent there at right angles. The advantages claimed for such a sound are that, without making any incision, the fragments can be caught, even if they lie transversely, and thus much more easily removed than can be done with forceps. In the absence of this instrument, one similar to it might be extemporized, viz., a long silver probe, bent at one end. The extraction might also be accomplished with a pair of long, narrow-bladed forceps, similar to those used in operations on the eye.

The ball, when lodged inside of the skull, penetrates deeper than the foreign materials just mentioned; and as it has insufficient momentum to bear it through the head, its lessened speed permits of deflection; and then, wandering from a straight direction, its detection becomes difficult. For this work various sounds have been devised; such an instrument may be wholly of metal

or gutta percha, modeled somewhat after the form of a urethral sound; and this is improved, if the sound be armed with a point of metal, ivory or porcelain. The sound with ivory or porcelain point was invented by Nélaton, and enabled him to discern, by the trace of lead left on the sound, the bullet in Garibaldi's ankle. Instead of this, the author, in a case of cranial gunshot wound, used a probe extemporized on the spot from a piece of white pine wood. This wood, as readily as porcelain, can receive and bring back a trace of the leaden ball. The work of finding the missile is often no easy feat, even for the most experienced hand. Also, without previous training and thoughtful management of the searching sound, not only will the ball not be discovered, but injury will be added to that already existing. Injudicious or careless manipulation may carry the probe beyond the ball, and thus the wound is made deeper; or the ball may be pushed onward into the brain, and thus the shot canal can be extended. The fruitless efforts, made by distinguished military surgeons, to discover the bullet in the ankle of Garibaldi, fully illustrate the difficulties attendant on probing for a bullet. The art attained by experience, and the secret possessed by him who successfully probes, consists of slowness and gentleness combined with thoughtful tact in the use of the sound.

Considering the difficulty that is experienced in discovering the ball, it is evident that there would be a special advantage in having an instrument in which were combined both probe and extractor; such an instrument is presented in some of the models of bullet forceps which have been produced by the untiring hand of invention; the desire to present something new, and the emulation to outstrip predecessors, have furnished here, as in other sections of surgery in which instruments are needed, a multitude of specimens. One of the best forceps for finding and at once removing the bullet, is one having sharp-toothed blades, of which each, when detached, resembles a tenaculum. The handles are long, and the joint, by which they are riveted and locked together, is placed at a considerable distance from the points which seize; this distance from the joints permits of the points being widely separated, so that a much larger body can be grasped than could be done if the joint were near the end. When the ball has been touched with the instrument, the hooklets of the latter can be made to fix themselves in the missile; and, as withdrawal is done, the ball is movable in the mouth of the forceps, and so adapts itself to the canal that the removal is more readily done than if

the ball were firmly grasped. This instrument, armed as it is with firm-holding tentacles, may be used also for the extraction of fragments of clothing and other materials lodged in or beside the canal. In this work of removing foreign bodies, the author will repeat the warning hitherto given, *to spare the encephalic structures.*

After this work has been done, the edges of the breach in the cranium should be carefully inspected, and if there be depression, this can readily be rectified. Also, the edges of the opening should be observed, and if fragments be found there, they should be removed. As the ball in passing through the wall fractures the inner plate more than the outer one, hanging, or loose fragments which have originated from the inner plate should be removed. This work can only be done where the opening is large, and admits of inspection with the eye. The bone fragments, bullet and other foreign material having been extracted, attention must also be given to the wounded soft parts. Cerebral matter oozing from the wound should be cleansed away by a small stream of aseptic water allowed to flow over the part; shreds of the wounded dura mater must be trimmed off, so that a sound edge will remain; and if there be grains of powder lodged in the wound traversing the scalp, the powder-stained edges of the wound must be trimmed off. The time spent in these tedious minutæ will be regained manifold in the accelerated healing which such care assures. If, however, the wound is a clean, smooth one, and there be no pendent fragments, then its margins must be left intact; and the surgeon will proceed to the external dressing. As preliminary to this, the part should be cleansed with a carbolated or a sublimated solution. Arrived at this point, the surgeon must select his course of treatment from the different ones which have been advised. The nihilistic tendency, which is seeking to overthrow the idols long venerated in the domain of internal medicine, has its advocates also in the surgical management of the gunshot wound. For example, Passavant, in 1871, teaches that the best method of treating such wounds is that heralded by Bartscher and Burow, in which the wounds are left open with little or no dressing. The author does not counsel such a Fabian course, believing, as he does, that total inaction is as baneful as excessive interference, since nature, like man himself, is ill tolerant of studied neglect. Roser, in the management of these wounds, while deprecating complicated dressing, would still do something; he would not sound, irrigate or inject; he only

dresses the external wound with carbolized gauze; in this simple way he finds that the shot canal will often heal. Should, however, the wound suppurate, he would open, dilate with laminaria and then introduce a tube for drainage. It is probable, however, that were more attention primarily given to the wound, suppuration would be averted, or much reduced.

Rejecting then a nihilistic course, as well as one which is nearly akin to it, the author would carefully note the condition of each case, and unless the ball had been so small that it had fractured but slightly the cranial wall, he would prepare the wound for the external dressing in the way that has been detailed; he would sound, extract the missile and bony fragments; and this completed, he would introduce a drainage tube of average calibre, so as to permit fluid excreta to escape: the external wound should then be powdered with iodoform, and lastly, over this should be placed a lint compress, maintained moist with a carbolated or sublimated solution. And to maintain the head cool, an ice-bag should be used; or instead of this bag, the work may be well done by means of a tubular helmet, through which there is constantly circulating a current of cold water; by this latter contrivance, the cold can be most equably distributed. In large canals in which the drainage is maintained through a tube, the latter should be allowed to remain in place for several days; too early removal has been the cause, here as elsewhere, of the accumulation of sero-purulent matter, which imperatively demands reopening of the wound. In brief, it is seen that the blind shot canal in the skull is to be treated, after it has been freed from foreign material, in the same way as such a wound should be elsewhere.

In the fourth class of gunshot wounds of the cranium, in which the canal has both entrance and outlet, the work of dressing will be more simple than that of the blind canal. First of all, the openings should be studied, and if that of exit be smaller than the other, then, according to Demme, it is probable that the ball has been broken, and a portion of it remains in the skull. Among the students of military surgery there has been a contest whether the leaden ball can melt through heat generated by impact with bone, and there seems to be credible evidence that such fusion does sometimes occur; thus the volume of the ball would be diminished, and the molten material might then lodge on the edge of the entrance. Meantime, the missile, lessened in volume, would produce a smaller opening at its outlet. In the open canal,

foreign material would probably lodge near the exit opening; hence the search for such material should be more diligent at that point. Demme likewise noted a difference in the healing of the two openings depending on the form of the ball; for example, where the bullet is solid at its base, the outlet heals sooner than the entrance, but if the base be hollow, then the exit opening does not heal earlier.

After osseous fragments and other foreign matter have been removed, if there be dependent shreds, these should be excised; and then, if the openings are large enough to admit them, drainage tubes should be placed in each one, and retained there as long as liquid excreta escape. This work being done, the dressing should be completed in the same manner as in the case of the wound with a single opening.

Though the lesion just described is greater than that of the blind canal, yet the fact that the missile has escaped from the head, and probably left but little foreign material in its track, are auspices more favorable for early and entire recovery than exist in the case of the blind canal; and especially, if the ball in the latter has not been discovered and removed; for such lodged ball may, at any time, obey the law of gravity, and, sinking, encroach on the vital nuclei in the lower part of the encephalon.

Trepanation.—In the treatment of injuries of the cranium, an important operation has been reserved for a special chapter; this is the use of an instrument by which the cranial wall is opened. This operation was denoted anciently by the term trepanation, and the instrument for doing it was named a trepan, which was worked after the fashion of a carpenter's bit or wimble. The more modern name for the operation is trephination, so called from the trephine, with which the work is done; the trephine resembles an auger or gimlet, and is worked similar to that implement. The work done by both the trepan and trephine is effected by a circular saw, in the form of a corona or crown, which on one end is armed with teeth. These instruments are only modifications of an instrument which was in common use in the earliest recorded period of antiquity. The wars of olden times, as well as of more recent ones, furnished ample material in injuries of the head. Cases of compression of the brain from depression of a portion of the containing wall must frequently have occurred, and it is probable that the observation was early made that the uplifting of such depressed bone was followed by relief of the injured one; and hence the recourse to some instrument by

which the elevation could be done; thence the early origin c such boring and elevating instruments.

In his admirable work concerning injuries of the head, afte Hippocrates has described five species of cranial lesion, h remarks that "among these modes of lesion, those to which th trepan must be applied are a contusion which is visible or invis ible, and a fracture that is visible or invisible." And then follow the mention of a form of wound, in Greek named "*hedra*," whic has so puzzled the Hellenists that Littré, the most famou translator of Hippocrates, instead of defining it, has retained th original word, in his French version. The word evidently mean a wound, or the site of a wound. Continuing then the language o Hippocrates, the following occurs: "Besides, if a wound (*hedra*) ha been made in the bone by a missile, and there is a fracture an contusion, or a contusion without fracture, the case demands th trepan. But when the bone has been displaced from its natura position and is depressed, then it is seldom that the trepan i needed; the more the bone is depressed and broken, the less nee there is of trepanning. The wound (*hedra*) without fracture an contusion, does not require this operation." These words, whic are the first existing lines in the long chapter since written o the subject of trephination, are remarkable as prophetically con curring with subsequent experience. It is clear from the referenc to trepan, without describing the instrument, that the latter wa well known and in common use. Hippocrates, afterwards, ofte refers to the operation, and carefully describes the cases in whic it should be employed. "It should not be done on a suture, bu to one side of it." The danger of injuring the meninges is spoke of, and the caution given not to expose these too much. Also, i the infant, the thinness of the wall is mentioned, and on tha account the work should be done with unusual care; and i some cases it suffices to merely open with a very small trepan In the work of using the instrument, Hippocrates advises t proceed with the section slowly when the bone is nearly saw through, so that the parts within the head may not be injured He counsels also to frequently withdraw the instrument an plunge it in cold water, to cool it; for without this precaution, th bone may be burned and caused to die. He tells how the wor should be done differently in different morbid conditions of th bone; for example, if the bone be suppurating, there is danger o sawing too rapidly. He likewise used as aid and precursor of th trepan the rugina or rasp, in all cases in which the injury of th

bone was not apparent; in such the surface of the bone was to be rasped away, and the deeper osseous strata were to be tested within and, if signs of deeper injury be revealed, then the trepan must be resorted to.

Enough has been cited to prove the popularity of the trephine the Hippocratic era of surgery. This popularity continued and is mentioned and mildly censured by Celsus, who says that in every injury of the cranial bones, the ancients proceeded at once to instruments, by which the bone was excised. Instead of this treatment, the more conservative Roman would first try local remedies: "but if these fail and fever appear early after the wound, and sleep be short and disturbed by tumultuous dreams, and the wound remain open and moist, and glands swell in the neck, and there be likewise a distaste for food, then one must resort to the scalpel and the trephine." In the work of trephining, Celsus directed that it be done by one, two or three borings, as the case may demand, and thus the bone lying between the bored orifices, may be removed. The opinion and practice of Hippocrates, however, maintained ascendency for many generations; and it is also probable that this practice prevailed for many centuries before Hippocrates, for his work on injuries of the head affords ample evidence that surgery in certain directions was well advanced, though there remain no records of it. The sanctity which attaches to the past, and that hesitates to abandon lines of action which are evidently erroneous, had its share in maintaining the use of the trepan in the middle ages, and transmitting it as an enlarged legacy to modern times. The fortune of trephining has been more lucky than that of the ligation of vessels; the latter, though one of the most frequent needs to the wounded man, stranded in the current of time for a thousand years, while that of the trephine survived and attained a larger sphere of action, with advancing time; the ligature was lost in the morass of scholastic inertia in which human science lay grounded for so many ages; the trepan, meantime, appears never to have fallen into disuse. During the eighteenth century and the first quarter of the present one, the trephine rose to a degree of favor unknown in antiquity. In fact, the operation became a fashion, and did its work, like the lancet, whether right or wrong, without rebuke or censure. The absolute recklessness with which this operation was done, and the instances in which a large portion of the cranial vault was removed, justifies the satirical remark of Sir A. Cooper, that "it is remarkable how much surgery

it takes to kill a man." Survival after such multiple trephination as one finds in the records of olden surgery, certainly demonstrates that the operation is rarely a fatal one.

Among surgeons of modern, or comparatively modern times, who have strongly advocated the trephine, are Petit, Pott, Sabatier and Louvrier. These urge that the operation should be done as a preventive measure; that by the timely use of the trephine, in case of injury of the cranial wall, inflammatory action and other accidents consequent on the fracture can be forestalled, and thus prevented, or diminished. On the other hand, as strong opponents of the operation, may be mentioned Sir A. Cooper, Brodie, Abernethy, Desault, Langenbeck and Malgaigne. Malgaigne was perhaps the most determined opponent of trephining among modern surgeons, and, by his writings, he tended to check the abuse, and perhaps the legitimate use of the trephine. Thus in words often quoted he says: "In my conviction most deeply grounded, all the doctrine concerning the compression of the brain from wounds of the head, in which it is claimed that trephining is demanded, seems to me to be a long and deplorable error, and which even in our time is still pursuing its victims." This denunciatory criticism was evoked by the illimitable use, or rather abuse, of the instrument. Thus it is recorded that Stalpart van der Weil trephined one patient twenty-seven times; the Prince of Orange had seven openings made in his skull by the trephine; and Fergusson tells the story of a surgeon, who, to remove extravasated blood from the cranial cavity, continued to use the instrument until he was told by the surrounding spectators that the patient had been dead for some time.

More exact knowledge of the relations of the brain and the cerebro-spinal fluid makes it evident that cerebral compression can, to a considerable extent, be compensated by the outflow of that fluid. And also, the observation has often been made that, after very extensive depression or driving inwards of the cranial wall, the abnormal condition did not cause cerebral trouble; or, if such was present, the sunken wall was soon tolerated, and no subsequent trouble was experienced from it. To this the writer would answer that it is true that the forces of life have great tolerance, and often endure what they cannot escape from, yet it is probable that, had their mute patience the power of language, submission would often be accompanied by remonstrance. It is certainly the duty of surgical art to remove the necessity of such tolerance, and to so clear the pathway that the forces of life can move without clog or fetter.

In a review of surgical literature from 1840 to 1850, one finds that the advocates and opponents of trephination waged an industrious controversy, and, as a partisan of the operation, Späth in 1844 decried the prevalent fashion of denouncing it. He claims that many cases of cranial injury demand it, and formulates, as a rule for guidance, that in all cases in which the functions of the brain are interfered with, through irritation or pressure due to a wound, one must trephine. Späth refers to the experience of E. Walther, who, in one hundred and thirty-three cases of trephining, lost but thirteen patients, while in a series of twenty-seven cases not trephined, which were similar in character to those which were trephined, thirteen died. The teachings of Textor, a German, discouraged trephining, while Cock, a surgeon of London, was favorable to trephining, especially in cases of suspected rupture of the middle meningeal artery; and, according to Cock, the evidences of such rupture are deep coma, stertor, puffing respiration, absence of muscular movement in the face, and death-like immobility of the limbs; trephining should be done when such symptoms are present.

In a discussion upon trephining in the Society of Surgery in Paris, 1867, it was shown that the violent opposition of Malgaigne to the procedure had nearly remanded it to disuse in France; Le Fort found that, from 1857 to 1866, but three reports of trephining were recorded in the journals. In England, however the operation remained in use, as hitherto; and there were reported in that time one hundred and thirty-five cases, of which fifty recovered, giving a mortality similar to that which occurred after one hundred and seven operations done by surgeons in the American war.

The eminent English authority, James Paget, 1870, laid down the following indications for trephining: "In simple fracture in which the scalp is unopened, and there is no depression of the skull, nor symptoms of compression of the brain, then trephining should not be done. But if signs of compression be present, and still there is no cranial depression, in such cases trephine, if the site of fracture can be located. When there is depression of bone, and there are signs of compression, if the subject be a young one, do not trephine; and if the subject be old, even then the propriety of trephining is doubtful." But an invariable rule laid down by Paget is that "though the scalp be unbroken, and yet the skull is depressed, and symptoms of compression are present, then trephining should be done. Again, where the scalp is opened, and

there is no cranial depression, nor symptom of compression, then do not trephine. But if the bone is not depressed, and yet there be present signs of compression, then one should trephine. In the young where the bone is depressed and no compression exists then do not trephine, but in such cases in the old it is proper to trephine. In cases in which the scalp is opened, and compression and depression both exist, then trephine."

The above rules seem correct guides, yet, as Hueter remarks, "Paget should have defined more accurately what he implies by compression."

Antiseptic surgery, here as elsewhere, has emboldened the surgeon to venture further in operative work. Leser, of Halle, in 1885 reported a series of thirty-six trephinations with four deaths; in the fatal cases, the injury was very severe. He used drainage tubes, which were brought in contact with the cerebral substance, and the patients soon were permitted to walk around.

For many years the doctrine held sway that the cerebrum was insensible to irritants, whether mechanical, thermal or electrical in nature. In 1860 the writer was a witness to experiments made by Flourens, in Paris, by which this doctrine seemed most certainly established. In terms of undisguised arrogance and vehement pomp, the famous Secretary of the Institute enunciated these doctrines with the strongest conviction that they were destined to remain as immutable truths. Less than twenty years elapsed when this doctrine was proved erroneous by the researches of Fritsch and Hitzig, in which they discovered that the cortex of the cerebrum is, at certain points, sensitive, and will respond to an electrical irritant. These discoveries probably had a germinal suggestion in the researches of Broca, who had found that articulate speech has its site of innervation in a frontal convolution of the brain. The discoveries of Fritsch and Hitzig, that centers of innervation for movement of the leg and arm are located in the cortex beneath the parietal bone, were soon afterwards verified in France and England. In France, the subject was studied by Vulpian; his experiments were witnessed by the writer, in 1876. In England, controlling verification was furnished by Ferrier, who experimented on monkeys; and from the similarity between the simian and human brain, the deduction was permissible that similar centers existed in the brain of man. In the pathological field, the diligent hand of Charcot soon collected a number of facts, which clearly demonstrated that there are localized functional centers on the surface of the cerebrum. And

soon the doctrine was corroborated and confirmed by many observers, that there are definite and determinable foci on the cerebral cortex of innervation of the organs of motion and of special sensation. This discovery is the offspring of vivisection so much decried by the half-educated sentimentalist, whose very existence has, probably, been permitted by the work which he decries. The discovery of cerebral functional localization is one of the most important of the nineteenth century; it has brought more light to the cerebral clinician; it has added a new jewel to the crown of the trephine; and this instrument, which has had so changeable a fortune in banishment and recall, will not be wrested again from the surgeon's hand.

Though a number of centres of innervation have been definitely located, yet those which specially concern the operative surgeon, are those for the upper and lower extremities, and that of Broca's lingual convolution; especially the former two.

The location of the centres for the limbs, according to Charcot and Lucas Championniére, is in a zone comprising the superior two-thirds of the ascending frontal and parietal convolutions, and is contiguous to the fissure of Rolando. And these motor centres are beneath the anterior half of the parietal bone, in a space which is a little over three inches in height and somewhat more than one inch in breadth.

Since these central points are adjacent to the fissure of Rolando, the following is the rule of Championiére to locate this line: First find the site of the anterior fontanel, by causing the subject to look straight forwards; then draw a line from one auditory meatus to the other, and the summit of the curved line will correspond to the fontanel. Next draw a line from the fontanel backwards, two and a quarter inches; then draw from the external angular process of the orbit, horizontally backwards, a line nearly three inches long; now, from the posterior end of this line, draw a line perpendicularly upwards one inch and a quarter; between the upper end of this vertical line and the posterior end of the first line, lies the fissure of Rolando. Though this admeasurement will prove correct for many crania, yet for some it will vary from accuracy; for in the brachycephalic, or broad head, and the dolichocephalic, or long head, the distance between the points above given cannot conform to any fixed standard. In such cases of abnormal cranial form, to open the wall over the motor centres, the trephine should be used in front of the parietal eminence, within a vertical zone two inches

broad, just anterior to that eminence. And this work should be done on the side opposite to that of the affected limbs. The dura mater must be opened, and the causal agency removed, whether this be a clot of blood, a collection of pus, or a neoplasm. If the trephining be done for the relief of aphasia, then the operator must seek the third frontal convolution by an opening lower and more anterior than that which is made to find the motor centre of the limbs. Should the point sought for not be discovered within the vertical zone mentioned, another opening may be made above or below the first one.

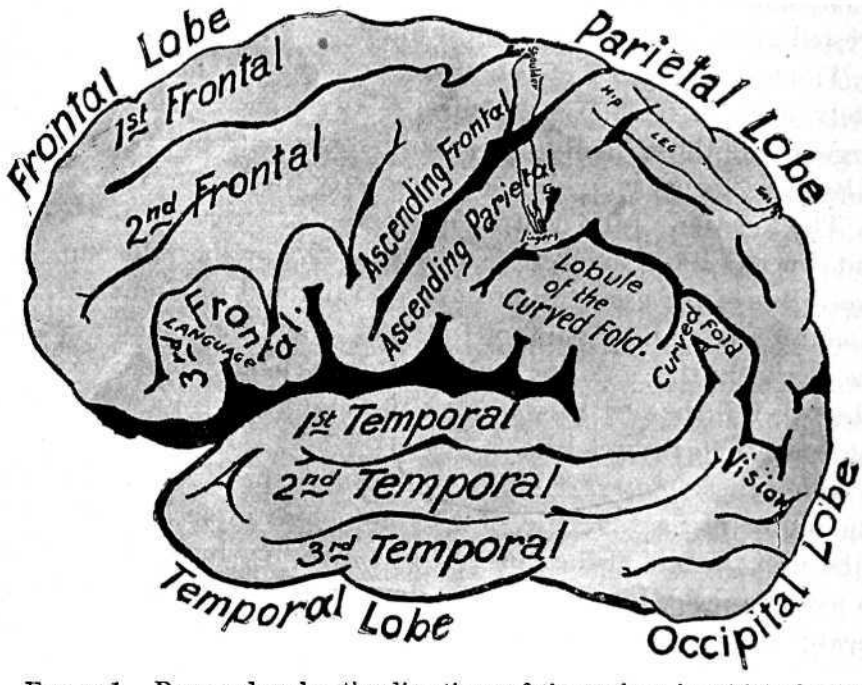

FIGURE 1. Prepared under the directions of the author, in which the cerebral convolutions are designated, and the lingual and visual centres, and those of the upper and lower extremities, are indicated.

The injury of the brain reveals itself in two classes of subjective symptoms the opposite of each other, viz., those of excitation and those of depression; or those in which excitation in one direction and depression in another are present in the same case. The indications for trephining may be present, arising from these opposite conditions.

As has been shown, the operation of trephining has been the subject of changing vicissitudes; an analysis of its history shows that it has been resorted to, at different periods, for three purposes: as an exploratory and diagnostic aid; as prophylactic or a

means of preventing the development of trouble in the head; and lastly, the trephine has been used as a curative agent.

As a means of determining the extent of a cranial injury, and especially, to determine the existence of fracture and possible detachment of the inner plate of the skull, trephining was recommended by Sédillot and a few others. And, with the object of discovering a suspected clot of blood, Sédillot would use the trephine; thus, as a mere aid in diagnosis, and to enable the eye to look through the cranial wall, the operation has been advocated; and if one opening did not reveal the concealed trouble, then the partisans of exploratory trephination would pursue their work, in fact, continue the boring until the object of search was discovered. The most remarkable instance in which this adventurous work was pursued to the utmost limits of possibility is that of Chabdon, which from the frequency of quotation has evidently won in surgical history the prize of frequent mention. Chabdon applied twenty-seven crowns of the trephine to the skull of his patient, and had the rare fortune to find the clot of extravasated blood, and, it is said, saved his patient. A pupil of Sédillot, who resorted to this multiple trephination, was less fortunate; his patient died. The innocuity of trephination has its limits; and, though trephining is now done with fair immunity from danger, yet the operation is not to be done for the purpose of merely permitting intracranial insight; for the knowledge thus obtained might be drawn more safely from the subjective and objective symptoms of the patient.

Trephining was used as a preventive measure by Hippocrates; in fact, it is probable that, inspired by his teaching, the use of the instrument was oftener invoked by the old surgeons as a means of prevention than as a means of cure. Among the modern English surgeons, Pott was an enthusiastic advocate of prophylactic trephination, and somewhat later, Sédillot among the French, besides using it as a means of diagnosis, employed it also as a preventive measure. The cases in which the author would use it preventively are the following: in all cases of stellate or lineal fracture in which there is depression, or thrusting inwards, of a portion of the wall; also where a foreign body has entered, and the entrance-opening is not large enough to permit the extraction of the body, or the removal of fragments of bone forced inwards. In the case of depression, through the uplifting permitted by the opening made, the existing symptoms of compression, sometimes present, will be relieved, and those of irrita-

tion destined to occur, will be anticipated, and probably prevented. Thus the wound will be at once placed in conditions so favorable for recovery that inflammation and suppuration will be avoided, or retained in safe limits. The objection urged in the case of fracture with depression, that the trephine will add another wound, is not valid, since the work done by means of the opening made allows the surgeon to substitute a much less perilous wound for the one that previously existed. The enlargement of an opening as aid in the extraction of a penetrated missile or foreign body, is a prophylactic measure sanctioned by all surgeons. But there is more hesitation concerning the propriety of the operation in cases of simple fracture without depression. To open the skull at once in this case, with the thoughts of encountering something which might be removed, would amount to mischievious meddling, and justify the sarcastic rebuke of Stromeyer, that "he who would trephine such a cranial crack must have a crack in his own head."

This early use of the trephine fails to receive support, in fact, is condemned by the results of statisticians who have studied the operation in long series of cases. For example, Bluhm, in 1876, collected 923 cases of trephination; when done primarily the mortality was 55.26 per cent; when done secondarily, the mortality was 39.24 per cent; and when done at a late period, the mortality was 40 per cent. These figures favor postponement of the operation.

If general objection has been urged against trephining as a diagnostic procedure, and opinion has varied in regard to operating as a preventive means, on the contrary, respecting trephining as a curative means in selected cases, opinion is not discordant. From adventurous exploration the hand had better be stayed, and in the field of expectant prevention hesitation should have a frequent place; but in a third class of cases, the demand for action is urgently imperative as a means of cure.

In the injuries of the head, there are those in which instrumental interference is demanded at once, or within a brief period after the accident; and in such cases, there may be an opening through the scalp, which exposes to view the entire extent of the injury; for example, there may be depression, fragments detached and driven inwards, and accompanied by a foreign body. Or, without an opening through the scalp, symptoms of irritation or depression may point to concealed injury. In the former case, the indications as to what is to be done, are apparent; the open-

ing, if too small, is to be so enlarged that it will permit of the removal of fragments, or a missile, or other disturbing agent. But if the scalp be intact, and symptoms of grave intra-cranial disturbance be present, then the integument should be opened and the wall explored. If the wall be found intact, then the surgeon's action must be shapen entirely by the subjective symptoms. If there should be present the phenomena of concussion, in which the patient is in a state of coma, with normal respiration and the muscles relaxed, then immediate trephining would be ill-timed; it would be better to wait until the patient rallies from the concussion. It should be remarked that coma here is not deemed by all surgeons a contra-indication to trephining; the more prudent, however, counsel delay.

But when in the commencement there exist symptoms of compression in which the subjective phenomena are of the type of depression in the form of monoplegia or more general motor palsy, with or without partial convulsions concurring with coma, and without or with a wound of the scalp, then it is proper to trephine. Le Fort, a strong friend of the trephine, has formulated the axiom: "When in doubt, one should act."

When the injury is such as to indicate the lesion of an intra-cranial artery, and the symptoms, whether of exaltation or depression, point to the effusion of blood from the ruptured vessel, then the immediate use of the trephine is explicitly indicated; if done at once, an opportunity will be afforded of removing the clot already formed, and to secure the vessel, so that further bleeding will be prevented.

Velpeau urgently advises the use of the trephine in cases in which blood has been effused between the dura mater and the cranium; for in such patients the blood continues to escape, and to push the dura mater more and more against the brain; and then the subject is menaced with inflammation of the brain, effusion into the arachnoid cavity, and softening of the cerebral structure; in such a patient symptoms of compression will soon appear, which will justify, in fact demand, early trephining. This intra-cranial effusion of blood is caused by rupture of the greater and lesser meningeal arteries, especially of the larger one. And in case the injury is at the base near the entrance of the arteries into the skull, then the blood will be poured out within the dura mater; but if the injury is higher up, then the effusion occurs exterior to the dura mater, and the latter membrane will then be detached on a small or large scale from the cranium.

Such detachment is less in the infant than in the adult, owing to the firmer connection of the membrane to the bone, in the infant. In the adult, Marchant has found that the separation can occur from the lesser wings of the sphenoid to within nearly one inch of the internal occipital protuberance; and it may reach to the falx major cerebri above, and downwards to a horizontal line which begins at the apophyses of Ingrassias and runs thence backwards—no small space to extract clotted blood from, as the author once verified. The higher up in the cranial wall the injury is situated, the smaller the vessel will be, and the less will be the amount of blood effused.

Krönlein, a German, in 1886, published his observations and studies of lesion of the middle meningeal artery; he finds the hæmorrhage may be limited to a small spot, or it may be diffused. When the clot is isolated, its site may be temporo-parietal, lying in the middle cranial fossa, or the clot may lie beneath the parietal tuberosity, which Krönlein designates the parieto-occipital site. A third location is the fronto-temporal, in which the blood lies under the frontal protuberance. The clot in most of these situations can be reached by trephining through the anterior inferior angle of the parietal bone; through this opening, the diffused clot, as well as that in the temporo-parietal and fronto-parietal sites, can be reached. And if no clot be found in either of these sites, then an opening must be made beneath the parietal eminence, and through this a clot in the parieto-occipital situation can be reached.

In the cases cited, trephining done curatively is performed immediately; in another small class of cases, the work may be done late, or after the lapse of some days or weeks. For example, if, after some time, symptoms of irritation or depression present themselves, the operation may be done as a means of relief. It is confessed by all the advocates of trephining here, that it is difficult to distinguish the phenomena of encephalitis from those which proceed from a local irritant which could be removed by opening the cranium. The most enthusiastic partisans would do the operation in encephalitis of traumatic origin, with the hope that the cause might be discovered and removed by trephining. As such cases almost always terminate fatally, the effort to avert such an end is commendable, even though it should not be crowned with success; for by such a course the patient suffers no loss; his friends are consoled with the view that something is being done for his rescue; and the surgeon has afterwards the

satisfying reflection that he did not stand supinely by, and let his patient die.

And, lastly, the trephine may be used at a still more remote period than the one mentioned. For example, there may arise, months after the receipt of the injury, trouble of an irritated or exalted character, such as convulsions and epileptic attacks. Or the supervening affection may be of the adynamic or depressed type, such as some form of palsy, aphasia, or some disturbance of the functions of motion and sensation. Such trouble may arise from a collection of pus, a clot of blood, a fragment of bone or a foreign body. The scar of a healed wound can cause similar morbid conditions. In such cases the trephine opens a way through which the central causal agency can be reached and removed. By this means it may be possible to cure or improve the patient's condition by extracting a missile, excising a splinter-like process of bone, excising scar-like tissues, or by opening a pus cavity.

This instrument has been invoked as a not infrequent assistant in the cure of epilepsy. It has been found that this disease can often be referred to some traumatic cause of the skull, to some injury in which the cranial wall is deformed, and presses on and alters the form of the brain. The wound of the skull may have been slight, so insignificant as to have left no evidence of itself on the outside; or it may have been an extensive wound in which the wall has been broken and fragments lost. The epilepsy may appear soon after the injury, yet, commonly, it supervenes at a later period. This is especially so in cases of the open breach, in which there is closure by cicatrization. From the author's observation, it is in the young subject that cranial injury most usually becomes the exciting cause of epilepsy; in the child, he has seen epilepsy originate from a seemingly insignificant injury of the head, in which there was merely a slight depression of the bone without fracture. The site of the injury was in the upper part of the frontal bone, to the outside of and above the right frontal tuberosity. The epileptic attacks occurred once or twice daily, and were increasing in both violence and frequency. The removal of a section of the wall from the part, which was reported to be the site of an injury from a fall, cured the lad of his epileptic disease. The bone which was removed showed signs of thickening. After the removal of the bone, the inner plate was removed to a small extent from the bony wall around the orifice. This work was so done with chisel and forceps as to remove the

sharp edge of the bone, against which the brain rested in its slight ascent into the opening made. Besides this inner beveling done with forceps, similar to those used by dentists in the work of dental exsection, there was excised an additional portion of the wall, which was found to be thickened similarly to that portion removed by the trephine. The remaining breach was elliptical in outline. The cure was a permanent one, as verified by subsequent observation. The epilepsy in this case may be ascribed to the continued irritation to which the brain was subjected by the slight encroachment of the thickened wall upon it. As the antithesis in injury to this case was another in which the skull was extensively broken over the motor tract of the cerebrum, and fragments of the bone were removed. The membranes were torn and cerebral matter was lost. The part healed with extensive cicatrization, contraction and inversion of the surrounding bone This boy recovered, and for some time was in perfect health; but after a few years, as he approached puberty, he became the subject of epilepsy. The osteophytic growths from the margin of the fractured bone evidently became the spines of irritation which caused the convulsions. As no permission was granted for trephining in this case, what the operation might have done for relief remains unknown. In a third case the man was at the middle of life, and his epilepsy was referable to an injury of the skull received seven years before. The operation was done by the writer, and furnished relief for a few months; the disease then reappeared in violence, and at intervals, similar to the former course of the disease. In a fourth case, a young man, who had often been injured by falling from a horse, became the subject of frequently recurring attacks of epilepsy; trephining over the left motor tract with ligation of the left carotid artery effected a cure. And a fifth man, the subject of epilepsy caused by a blow without fracture of the left parietal bone, was cured by removing a considerable section from the parietal bone.

In the three cases in which a cure was effected, the trephined portions of bone showed merely a slight thickening of the cranial wall; there were no signs of depression.

In 1884, Walsham, an English surgeon, collected statistics in reference to the results of trephination done for the cure of epilepsy; of eighty-two cases in which it was done, twenty died and forty-seven were relieved or cured; he concludes that these results justify trephining in such cases.

In a species of epilepsy, in which but one-half of the body is

attacked with spasmodic contractions, trephination has been resorted to with successful result. In this form of epilepsy described by Hughlings Jackson, and named after him Jacksonian, the disease depends on an affection of the cortex of the cerebral motor centre on the opposite side; and the trephine is employed to remove a portion of the cranial wall overlying the centre, thus permitting the removal of some of the cortex, by which the centre is reduced to subsequent inactivity.

In cases of epilepsy in which the disease could be traced to neither functional nor objective cause, trephining has been done with the report of successful event. In the accidental contingencies to which the developing head is exposed, it is conceivable that some injury in these cases may have deformed the wall which the trephine was able to modify to the benefit of the patient.

Before proceeding to the use of the trephine, one should take into account the anatomical character of the wall which is to be bored through; also the relation of the wall to the sinuses or channels for venous blood, which lie near it.

The wall in different persons, as has been mentioned, is of variable thickness; it may be only a line thick in cases of extreme thinness; and then again, it may be a half-inch thick; and this can only be discovered as the work of boring is being done. The operator must also consider the component parts of the wall, viz., the external and internal plates and the intermediate diploë. When the wall is thin, there is but little or no diploëtic structure; and, as vessels exist in this which bleed when wounded, the absence of blood in the bone-dust indicates that there is little or no diploë, and, consequently, that the cranial wall is thin. The diploëtic vessels are largest near the foramina, which partly or completely perforate the wall; these exist normally in the frontal, parietal and mastoid regions. The bone-dust from the sawing is commonly sufficient to arrest the bleeding from these vessels when wounded, yet they may reopen and the escaping blood may cause some trouble. A subjacent sinus is a contra-indication to using the trephine directly over it; for instance, the trephine should not enter over the superior longitudinal sinus, viz., in that region corresponding to the median line of the cranial vault, extending from the glabella to the external occipital protuberance. The superior longitudinal sinus lying there increases in width as one passes backward; at its posterior end it is nearly a half inch wide. To remove the bone lying over this,

it is better to trephine on each side, and then remove with forceps the bridge lying between the openings. And should it be needed to trephine behind the ear, as is sometimes done to give exit to pus developing in connection with the auditory apparatus, then the work must be done cautiously, so as to avoid the lateral sinus.

One would proceed with the greatest safety by first removing the external plate, and then completing the work with the curved chisel or gouge, worked without mallet, by the hand, alone; and if the work can not be done with one hand, then use as aid the other hand. In 1847 this plan of trephining was announced by Roux, who named it the method of trephining by evulsion. He employed it to avoid the vessels, and thinks that thus one might open safely over the lateral sinus, as well as the other sinuses. Roux says that one can also open into the cranial cavity above and below the petrous portion of the temporal bone, and thus enter the cavity above and below the tentorium.

The ancients in trephining carefully avoided the sutures; the counsel of Hippocrates preserved these lines intact for many centuries after his time; and as Hippocrates, through his imperfect anatomical knowledge, placed sutures in the skull where they do not exist, hence the field of trephination had extensive limitations. Some centuries later, Berenger di Carpi crossed the forbidden sutural line, and, finding that no injury followed, the suture has since been disregarded in trephining.

There are two forms of the instrument used for trephining; and these have doubtless been modeled from implements to be found in the shops of the smith and carpenter, the storehouses whence have been drawn the most of the instruments used in surgery. The one form of instrument is that which has its analogue in the carpenters' and joiners' bit and brace, and is propelled by a bow-like portion which lies between the handle and the boring end. This is the form used by the French, and which they name trepan. The second form of instrument is analogous to an auger or gimlet; this is propelled by means of a handle which is fastened at right angles to the upright staff that is fastened to the boring end. Instruments with other attachments for propulsion have been invented, yet their complexity renders them less easily used than the two forms mentioned, which represent the two species of instrument which have been used from time immemorial. The gimlet-like instrument commonly used by the American and English surgeon is properly designated by the name trephine, while the other is oftener called the trepan;

yet it should be observed that these distinctions are not always observed by surgeons and surgical writers.

Whatever may be the mode of propulsion, the boring or cutting end is similar in both trepan and trephine. This part is named a corona or crown; it is cylindrical in form, armed with teeth like a saw. These teeth, like those of saws, vary in form and disposition. They are sometimes disposed with vertical intervals between them which serve as spaces in which the bone-dust collects as the sawing proceeds. This crown is often made of poor steel, so that the teeth break readily, and the instrument becomes useless. The trephine is, in fact, a circular saw, that does its work in a horizontal plane, instead of a vertical one; and the work may be done by continuous motion in one direction, or the instrument may bore by half revolutions, each being the reverse of the other in direction; the latter is the common mode of propelling the trephine. The crown of the trephine rested uneasily both on the head of the patient, as well as in the hands of the surgeon, until it was provided with a central pin or pyramid for fixation. This addition was made by Guy de Chauliac and Bichat. The crown is so fastened to this pyramid that the latter can be made to ascend or descend below the edge of the crown; and when the descent is made, then the crown is fixed and forced to follow the intended line of cutting, instead of slipping from side to side. Another addition to the trephine is an external guard, which can be fixed at any point, so as to permit the crown to penetrate no deeper than is desired. From the writer's experience this part, which was attached to the trepan by Ambrose Paré, is more embarrassing than beneficial; depending upon it, the operator is more apt to bore too deeply than if he were to depend on his own hand and eye to measure the depth. There are crowns of different sizes; that of average dimensions is about half an inch in diameter; it may be much larger, as well as much smaller. The crown, instead of being cylindrical, may be conoidal in form, and the cutting end is the smaller portion. The outer surface of this conoidal crown is provided with cutting ridges with intermediate furrows, the arrangement being such that the crown cuts as much with its outside as with its free edge.

Sometimes it becomes necessary to trephine where there is a small opening which must be enlarged. In such a case the central pyramid for fixation can not be used, and one must resort to another means to retain the instrument in the desired place. This may be done by first boring with the trephine

through a piece of leather, or a thin piece of flattened wood, and then placing this over the point which is to be trephined: the work being thus done the instrument cannot glide from its place.

The operation of trephining after the scalp has been shaven and well cleansed, consists of three acts, viz., opening through the skin, then perforating the skull; and a third act is the important one of removing the clot growth, pus, missile or foreign body, which is lodged within the cranium.

The skin, if covered with hair, should be well shaven, and then well washed with dilute alcohol. The incision may be made with a scalpel or convex bladed bistoury. The form of this incision may be linear, crucial, triangular, quadrangular, or the arc of a circle. The crucial cut is the one usually recommended and made; of all the forms it is the most inconvenient, since by it four angular flaps are made, which must be drawn aside during the second act; by any of the other incisions, except the linear, there is but one flap. The semicircular flap is the one which the author, from his experience, especially recommends; it is easily held aside, and after the work is done, it is readily restored to its place so that healing is promoted. The linear is rarely used, since but a limited portion of skull can thus be laid bare. By the semicircular cut the scalp is wounded less than by the crucial; in fact, the wound of the scalp by this mode amounts to but little more than one-half of that produced by the crucial incision.

The primary semicircular cut is first made by fixing the scalp by pressure with one hand, while the other makes an incision that extends at once to the cranium. The flap should be so constructed that its attachment or pedicle is directed towards the summit of the head; thus made the wound will be best situated for the subsequent escape of materials that may be thrown off from the wounded parts. The incision must reach to the bone, so that the flap, including the periosteum, can be uplifted from the bone. In thus preserving the periosteum, the possibility of subsequent osseous repair is favored, and thus the bone which is removed may, perchance, be replaced by a new growth of bone.

If the work be done in this way, it is probable that the breach made would not be left so imperfectly closed as often occurs. The flap thus incised can be elevated by means of a blunt dissector, a thin chisel or the handle of a scalpel; and should any vessels have been divided, these should be controlled by means of torsion or ligation.

The sawing through of the bone is next to be done. The tre-

phine crown must first be adjusted for its work by causing the central pyramid to descend and project about one line beyond the edge of the crown; also the external guard if present should be fixed on the outside of the crown at a point corresponding to the depth which it is designed to bore. When the instrument is thus adjusted it is placed on the exposed skull, and by pressure and rotation, the pyramid is made to descend until the crown reaches the bone and its teeth so engage in the wall that a guiding furrow is traced. At this stage, the instrument is withdrawn and the pyramid is uplifted. Now the crown is to be placed in the furrow that has been traced, and the work of sawing continued. The work must be done slowly, and the instrument so held that it will do equal work on all sides. It should be removed from time to time, and dipped into a dilute solution ($\frac{1}{2000}$) of corrosive sublimate, which will have the effect of rendering the wounded bone aseptic, and also to wash the bone-dust from the teeth of the crown. This immersion has the effect also, of cooling the instrument. It was advised by Hippocrates during trephining to occasionally withdraw the trephine and dip it into cold water, for he taught, if this were not done, the bone would be burnt by the boring crown. When the outer plate has been severed and the diploë reached, blood will escape from the wound, due to opening the diploëtic veins. In the very old subject, in whom the diploëtic structure has disappeared, little or no signs of blood will be perceived; and in such, as the wall is thin, there is need of unusual care lest the dura mater be injured. During the work of sawing, the instrument should occasionally be removed, and the progress of the work be measured by the introduction of a wire or find sound. It is seldom that the part trephined is of uniform thickness; also the unequal pressure made on the instrument, which is difficult to avoid, causes the wall to be sawn through earlier at one point than at another; and when this is perceived, the sawing must be continued slowly and the remaining portion carefully divided.

The case of trephining instruments contains also an extractor, an elevator and a lenticular knife, which are used to finish the work, when the boring has been done. When it is found that the wall has been nearly perforated, which is perceived by the slight mobility of the segment of bone included in the crown, then the gimlet-like extractor may be bored into the piece to be extracted, and, perhaps, in this way it can be removed. Or, instead, a thin chisel can be fixed in the sawn piece, and made to

act as a lever on this, the edge of the sawn skull serving as a fulcrum. By these artifices, the work can often be completed more safely than could be done by sawing entirely through. When the sawn portion has been extracted, the edge of the opening must be examined, and if fragments or spicula remain adherent to it, these must be removed; the removal can be done with forceps, the lenticular knife, or a round edged chisel. Again, it often occurs that the opening made is insufficient for the purpose for which it was intended, and then it is necessary to enlarge it. The enlargement may be done by Roux's method of evulsion, before described; but if the wall be thick, this work is done with difficulty in this way. The exposure of more surface is better done by again trephining near the opening formed, on the side towards which one wishes to enlarge. And if need be, a third adjacent opening, and as many more as the case requires, can be made, and afterwards, the small bridges of bone left between the orifices can be exsected with bone forceps or chisel; and thus an elongated portion of the surface of the encephalon is offered to view; and through this the surgeon can conclude the ulterior work of extraction, which is embraced in the third stage of trephining.

There are but few cases in which there is required a larger opening than that which is obtained by one boring; however, an exceptionally large opening is sometimes required in the case in which the meningeal artery has been ruptured; yet even here, before enlargement of the opening is done, an attempt should be made to remove the coagulum with a small scoop passed inwards beneath the wall. This clot lies outside of the dura mater, unless the meningeal artery should be ruptured near its entrance at the foramen spinosum; then the blood might flow inside of the dura mater within the arachnoid sack. In this case, the blood would be hidden from view, and if its unusual site were not suspected, then the surgeon would be perplexed to explain the cause of the compression which must exist in such a case. Formerly, the dura mater was never opened except in very extraordinary cases: this rule is now often transgressed, in fact, so often that it has nearly ceased to be a rule. To enlarge the field of cerebral exploration, this membrane may be opened, and in the instance here considered, when a clot is not found outside of the dura mater, the latter should be opened, and the search prosecuted towards the base. Such clot, whether inside of or outside of the dura mater, should be removed; yet care should be taken not to

open the rent in the vessel which has furnished the blood. Some claim that it is impossible to avoid this, and on that account they would prefer leaving the patient to his fate rather than subject him to an operation of which the results, at best, could only be doubtful; they claim that the pressure on the brain will soon be tolerated, and later, the blood will be removed by absorption. It is, however, better to remove the coagulated blood, since even should the material be absorbed, this would occur slowly, and meantime cause derangement in the parts which are pressed on; and at best, a cyst-like cavity would remain in the site of the clot. The functions of the brain are so important that a grave perversion of them is a costly price to pay for the continuance of life; a bold effort should be made to escape, and to secure freedom from such fetters; risks are not only justifiable to be taken, but they become a duty to both the patient and his surgeon. If death is better than slavery of the body, how much more so is possible death occurring in an attempt to escape thralldom of sensation, motion and mentality, the noblest possessions of individual life. The author would then trephine exhaustively and sedulously remove the coagulum, and if there was difficulty in arresting the bleeding from the ruptured vessel, by pressure or ligation, then the external carotid artery should be tied, which would surely insure immunity from further bleeding; after such ligation the surgeon might prosecute the work of extraction more freely; and, besides, the cavity might be irrigated with an aseptic solution, so as to insure the entire removal of the extravasated blood. In this way the brain would resume its natural form and contour, and immediate recovery would probably ensue.

If the trephining be done merely to elevate bone that has been depressed by fracture, then the opening is usually made contiguous to the sunken bone; even the edge of the latter might be embraced in the opening. Sometimes the work has been done on the depressed bone itself; yet the want of uniformity of surface of the sunken bone renders it difficult to trephine there. This work can usually be done through a single opening, when the portion sawn has been removed, then the work of restoration of the bone to its normal level can be accomplished by the aid of the elevator or small lever that is inserted under the margin of the depressed bone, and the latter lifted into position. In this uplifting care must be used not to contuse the under surface of the bone that is acted on. Another precaution to be taken is not

to complete the fracture of the bone that is depressed. There is less danger of this occurring in the young subject than in the old; in the latter, fracture can easily happen. If the uplifted bone be yet covered by the periosteum, it is probable that its vitality will be maintained, even though it be marginally detached.

In the operation of trephining two important innovations have lately been introduced, differing radically from the former methods. In one of these, instead of sacrificing the disk of bone that has been excised, the latter is broken into small fragments, which, being asepticized by a dilute sublimated solution, are placed on the breach, and the wound in the scalp closed over the opening. Another plan recommended is to asepticize the disk and replace this entire on the trephined opening. Doing thus, it is claimed that the breach in the wall will be repaired and the continuity of bone restored.

In the second method, the work is an osteo-plastic procedure, in which the sawn segment is left attached at one end or side by a small pedicle, so that it can be uplifted like a trap door, and when the door has served its purpose, it can be lowered to normal site, and thus the continuity of the cranial wall can be preserved. To do the work in this way, a special saw is employed by which the wall is only partially divided, the division except the pedicle being completed by means of the chisel, mallet and elevator. This method is illustrated in figure 2.

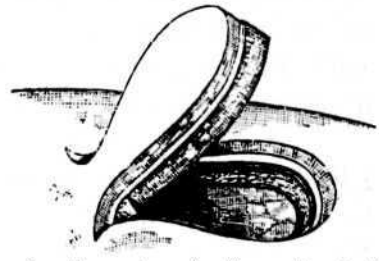

Figure 2, showing the osteo-plastic method of trephining.

Professor Linn has recently suggested, as material for reclosing the opening, decalcified bone, and Frankel has proposed the use of celluloid.

The writer has had no experience in closing the trephined opening by any of the methods mentioned, yet the osteo-plastic method appears rational and is worthy of trial; that of closure by osseous fragments is more equivocal and should be limited to employment in the young subject.

In the mind of the laity many half truths have lived for a

long time before they developed into whole truths; the methods of replacement just mentioned have such a correlate in the popular mind, and are answers to the question which every surgeon has heard. Are you going to close the skull with a gold or silver plate?

The work having been done, which was the purpose of the trephining, viz., the removal of a foreign body, clot, pus or tumor, the further treatment of the wound will vary according to the condition of the parts operated on. If they are entirely sound, as they must be when a blood-clot has been extracted, then after cleansing the parts well, the wound can be closed by means of two or more catgut sutures. In case the parts have been lacerated by the penetration of a foreign body, then the torn shreds of the meninges should be excised, and the wound should not be completely closed; an opening should be left for drainage through a fenestrated tube of medium caliber. If the work has been the removal of a cerebral tumor, then there should also be made provision for the free escape of excreta from the injured parts. And such a passage should be maintained open for a considerable period of time. And if the operation be done to evacuate pus, then a drainage tube should be inserted in the cavity, and through the tube the cavity should be cleansed daily. The patient should so lie as to favor the continuous escape of the excreted fluid. And the drain of outlet should be so placed and inclined as to favor escape. It is rare that there is closure by immediate union; even in the case in which the trephining has been done to relieve epilepsy, immediate union is rare, and, though it may occur, yet the wound sometimes reopens and a sero-purulent fluid is discharged, often, for weeks. Besides this, the absence of healing is sometimes caused by a fragment of bone which detaches itself from the wounded wall. Yet these cases of delayed healing will occur less frequently if the surgeon follows closely the best methods of treating wounds.

CHAPTER V.

MENINGES OF THE BRAIN.

WHEN the membranes of the brain are viewed by the surgeon in reference to their anatomical structure and disposition for practical considerations, the three normal meninges may be reduced to two, for the arachnoid is connected to and shared by the other two; and thus viewed, we have the dura mater, with an inner serous lining, and the pia mater, with an outer serous lining. The dura mater, a fibro-serous structure, bears some resemblance to an articular capsule. Galen, in his epode, as he names it, on the utility of parts, in which, as a *ne plus ultra* teleologist, he continually unveils the purposes of creative wisdom, teaches that the brain has three protective ramparts, viz., the cranium, the most solid of all; then the dura mater, firm and resistant but less so than the cranial wall; and, lastly, on the inmost side, is the pia mater, less firm than the dura mater; and Galen thinks that these are so disposed that each membrane, in its turn, lessens the shock of impact against the part which is next adjacent; and so at last, the solid skull is prevented from injuring the brain which may be carried against it by any violence.

Henle, the greatest anatomist in modern times, as Galen was in antiquity, finds a protective agent in the arachnoidean and subarachnoidean fluid. This liquid, about two ounces in quantity, rests on the outside of the brain, and besides leveling the inequalities on the surface of the brain, it is interposed as a thin film between the organ and the cranial wall covered by the dura mater. The prophylactic agencies mentioned are powerless against violent injury; they are only efficient against mild shocks, such as may arise from brisk or sudden movements of the head.

Besides its protective agency, the dura mater performs other offices in the animal economy; it is the periosteal investment of the inner surface of the skull; yet, different from other periosteum, there resides in it but little bone-producing power; and this is

contrary to that which might have been expected, since it is more vascular than normal periosteum. A third office of this membrane is to receive the blood from the brain in the sinuses or reservoir-like channels which lie in it. The blood is brought by veins from the subjacent brain, and emptied into the sinuses, and the course of the blood in these veins is opposite to that in the sinuses: the seeming effects of which would appear to be to retard the outward passage of the blood, and thus to avert sudden cerebral anæmia, which might otherwise occur.

The veins that convey the blood from the brain to the sinuses in the dura mater are valveless and remarkable for their fragility: conditions which favor the easy passage of blood as well as their rupture and effusion of blood.

To the dura mater the function of producing bone has been generally denied by anatomists: and hence the explanation of the fact that where portions of the wall of the skull have been removed by the trephine, or by accident, the breach remains afterwards unfilled by bone. From study of this matter by Ballon, of Strassburg, in 1864, it is probable that if more effort were made to preserve the integrity of the dura mater, there might be a reproduction of bone; in such cases Ballon refers to experiments which have been made by Ollier and Flourens, in which these men have proven that the outer surface of the dura mater can generate bone. From an examination of the specimens in the medical museum of Strassburg, Ballon is convinced that the dura mater can generate bone, both from its outer and its inner surface. This writer thinks that the serous epithelial lining of the inner surface of the dura mater must be unfavorable to the production of bone. And, furthermore, were bone developed in the inner surface, it could serve no physiological purpose; and, further, that its position then would endanger the contiguous cortical surface of the brain.

SURGICAL AFFECTIONS OF THE MEMBRANES OF THE BRAIN.

The meninges of the brain in their diseases and derangements offer a common field to surgeons and physicians, the greater share falling probably to Internal Medicine.

Inflammation of the dura mater, though pertaining rather to the province of the physician, finds, also, a place in the works of modern surgery. It has received the name of pachymeningitis; also of scleromeningitis; though the latter is the more appropriate, yet the former name is the more usual one. Pachymeningitis

may be caused by a wound, or external violence. A peculiar form of it is that which can originate from excessive and prolonged alcoholism.

If violence injures the cranial wall in its entire thickness, the dura mater must share in the lesion. The membrane may be contused, torn, or a portion of its structure may be lost.

The treatment of such injury must necessarily be comprised in the general management of the wound of the head of which it is but a part. Similar to the course recommended in the treatment of the scalp, it should be the aim to preserve all that is possible of the membrane, since, similar to the skin or mucous membrane, when a portion of the dura mater is lost, it cannot be restored again. The tissue of repair is at best but cicatricial structure, which here, as elsewhere, contracts, compresses, and changes somewhat the form of the parts with which it is contiguous. Here the rule must be to save some torn shreds of the dura mater, if it is probable that they will retain their vitality. As the membrane is vascular, and if wounded at certain points, hemorrhage must result, hence such opened vessel when accessible must be ligated; or if that be not possible, for example where the vessel lies partly imbedded in the bone as well as in the dura mater, then the torn vessel may be closed by plugging it with a small piece of sponge. Asepticised white wax might be used as closing material. The small mass of occluding material would afterward remain as harmless matter.

The dura mater can be injured by blows on the skull in which the latter is not fractured, and still the subjacent membrane is contused, and possibly detached from the wall. The result of such injury may be the opening of a blood vessel, and the effusion of blood between the membrane and the skull. Such effused blood may disappear mostly by absorption, yet the result will be a prolonged irritation of the part, and, as a consequence, a thickening of the membrane, and, sometimes, a production of bone. The osseous growth can be merely a thin plate on the outer surface of the dura mater, or it may be a spine-like development, which by its presence may maintain a local irritation of the adjacent surface of the brain. Such an irritant might become the cause of epilepsy. Again, a large clot of blood might not be wholly absorbed, the solid elements of the coagulum remaining, and deforming the surface against which the brain rests. Nature, in her efforts to restore parts to their normal form, is in most cases competent to remove, or compensate the results

of, the injuries just considered. Still, in the study of the diseases of the brain and nervous system in their protean forms, a possible origin from some lesion of the species mentioned should be borne in mind; and as means of relief, should there be a localized guide, exploratory trephination might be resorted to.

The observation was made some years ago that inflammation of the dura mater may originate from the prolonged use of alcoholic drinks. In such cases the inner face of the membrane is principally affected. Among those authorities who have particularly studied this disease may be mentioned the names of Griesinger, Lancereaux, Virchow, and Vulpian. Griesinger, in 1862, wrote on the subject from the observation of eight cases. In most of the cases there were headache, narrowness of the pupil, somnolence, and, in a few cases, palsy. But where effusion of blood occurred, the attendant symptoms were more obscure and complicated; for after such hemorrhage, there may be convulsions, anæsthesia, and idiocy, as the result of cerebral changes. He found the disease usually in drunkards who were over fifty years of age. The patient may recover, and then there will remain pigmentary traces of the preëxistent hemorrhage.

In 1863 Lancereaux published his studies and observations, and he is the leading authority on the subject. He assigns a varied causation for pachymeningitis, viz., that it may arise from alcoholism, traumatism, rheumatism, erysipelas, cancer, tuberculosis, scrofula, and rachitis. Old age and infancy are predisposing agencies. Continued encéphalic congestion caused by the excessive use of spirituous drinks seems to have been the most frequent cause. And that alcohol can act thus has been demonstrated by Kremiansky and Neumann in experiments on dogs, which were given large amounts of alcohol. In these animals it was found that the administration of alcohol for the period of four weeks, caused an inflammation of the dura mater.

The prominent condition present in the disease is, in some cases, a neoplastic formation rich in blood-vessels remarkable for the thinness and fragility of their walls. In other cases there is found clotted blood, as well as membranous structure.

From a study of the pathological conditions, which have been revealed by necropsies of fatal cases of pachymeningitis, it has been found that there results from the inflammation a connective tissue growth on the inner face of the dura mater. The usual site of this is beneath the cranial vault, and is near the falx major cerebri. The structure developed is analogous to that of

ordinary granulative tissue; it is extremely vascular. The fragile nature of these vessels disposes them to rupture and effusion of blood. The effusion, if small in quantity, may remain pent up, or inclosed in the new growth; but if it be larger in amount, then, after a time, a fine membrane is developed over it, which some observers think is a continuation of the adjacent arachnoid. There may be a large amount of blood poured out at once, or there may occur successive ruptures, so that coagula of different ages may be found. Possibly, these apoplectic effusions of blood may originate in spontaneous rupture of the vessels; it is more probable, however, that the vessels are opened through transmitted violence. The growth, in such near proximity to the cortex of the brain in which the motor centres lie, must induce some functional disturbances of these centres, and hence the patient will be liable to other injury from stumbling, fall, or some kindred accident. And for similar reasons, the apoplectic effusion having occurred once, predisposes to other attacks. And in this work it is clear that alcoholism is no mean adjuvant, both in causing meningeal congestion, and in toppling the patient to the ground.

Pachymeningitis presents, according to its stage, different subjective symptoms, viz., irritation and depression. In its early period the symptoms are that of irritation and excitation; and this stage, which may be long or brief, corresponds to the period when the neoplasm is developing. In this stage there is often a headache excruciating in character: such cephalalgia when unaccompanied by fever, and yet is continued for a long time, according to Abercrombie, indicates inflammation of the dura mater. The pain is located in the region of the new growth. There is also vertigo, with ringing of the ears, disturbed sleep, and nightmare. Sometimes there is a sensation of a floating wave in the head. The power of speech is interfered with in some instances. A symptom observed by Griesinger on which he lays much stress, is myosis, or narrowing of the pupils. The irritative period is of variable duration, viz., for only a few weeks, or it may continue for months.

The second period, viz., that of depression, is noted for the general adynamic character of the morbid phenomena present. It may appear suddenly, or its advent can be so gradual that it is unperceived. The apoplectic effusions can occur consecutively and in such slight amount that the brain tolerates them, and scarcely any depression is present. This rupture of the vessels and the pouring out of the blood causes sharp pain. Such pain

arises from the sensory function of the dura mater, which the author has seen demonstrated many times by Flourens, who first discovered this property of the dura mater; the great vivisectionist never referred to this addition to physiology without a visible display of vanity. The more recent observation of Vulpian that there are developed nerve fibers in the vascular neoplasm, furnishes an explanation of the pain felt when the growth ruptures. This stage is characterized by the somnolence which attends it; the patient often sleeps for twenty-four or thirty hours. And when he awakes there is still drowsiness present. During this stage the pupil remains narrowed, as in the first period; but, different from the first stage, when rupture has occurred, the pupil of the eye on the side of the rupture is more contracted than on the other side. When awakened the patient still complains of headache. The pulse is slow and irregular. And there is perceived still the same sensation of something floating in the head which was complained of early in the disease. The symptoms described are those arising from a diffused or extended clot, occupying a considerable space of the cerebral cortex; in another class the clotted blood occupies a limited extent of surface. In the diffused form the symptoms of depression reveal themselves in palsy affecting a large portion of the body. Yet certain parts may be less palsied than others. There may be complete hemiplegia of one-half of the body, and incomplete paralysis of the other side; this would indicate a clot on each side, one being larger than the other. Again, if the clot be definitely localized, then the palsy will be less diffused in its manifestation, viz., a certain part of the body will be affected. And in all cases the paralysis produced is less permanent and more incomplete than that which arises from an intra-cerebral effusion of blood.

Pachymeningitis has been seen in the infant; the neoplasm pursues the same course as in the adult; the vessels burst and a clot of blood is formed on the subjacent surface of the brain; more frequently, however, the growth resulting from the inflammation does not burst, but there is merely a serous effusion. Such disease in the infant falls more often to the care of the physician than to the surgeon.

The hemorrhagic effusion from pachymeningitis limits its action chiefly to a perversion of motion; the sensory function of parts is rarely affected by it. The morbid manifestations have, as a rule, occurred on the side opposite to the apoplectic effusion; still there have been noted exceptions to this observed by Virchow

and Wood; the paralysis and clot were on the same side of the body.

Pachymeningitis when it reaches the hemorrhagic or depressed stage, nearly always destroys life. Still in the necropsies which have been made in fatal cases, not unfrequently there have been found conditions of the parts which indicate that there had occurred a rupture, from which the parts were in process of recovery; through absorption an old clot had been nearly removed; there remained only pigmentary remnants. Such a favorable event is too rare to materially change the inauspicious prognosis usually coupled with this disease.

Treatment.—This may be medical or surgical. Along with the removal of any discoverable causal agency, as remedial means, one may give intestinal and renal derivatives. As a purge, calomel is one of the best. And to act both as diuretic and absorbent, there may be given the iodide of potassium. For the same purpose, the arseniate of soda is advised by Charcot. Local derivatives, as irritants and pustulating agents, may be tried.

Inasmuch as the means which have been mentioned have proved unavailing, and have scarcely cured, the question arises, Is this not a field where surgery may intervene and extend to the patient a more helpful hand than internal medication has thus far offered? As the trephine has pioneered the way by which cerebral tumors may be reached, so it may open the way by which an equally intractable malady may be directly reached and directly combated. The attack by means of remedies given internally is like that of besiegers, desultory and indirect, and like them the surgeon would act more rationally by opening a breach through the wall, even though it be at greater peril; for thus he could meet the enemy hand to hand. Perhaps it might be urged that the symptomatic evidences of the pachymeningitis are too obscure to justify a resort to the trephine. The symptoms are not more obscure than are those presented in the case of the intracranial tumor. One would not be justified in trephining before the second stage of the disease, in which the condition of the patient indicated rupture of the new vascular growth: viz., motor disturbances, general or localized, according as the effusion was spread out over an extensive surface or confined to a limited point of the cortex. The localizing of such a clot can be done more surely than in most cases of tumor. The neoplasm, and consequently a coagulum arising from its rupture, must always be on one side of the cranial vault. Hence should

this be one of those anomalous cases in which the clot and palsy are on the same side, the trephining could readily be repeated on the opposite side.

As trustworthy indications for operating, besides a continuous cephalagia, would be a persistent narrowness of the pupils, and a slow pulse. And some corroborative evidence might be furnished by the history of the case. The opening should be made with a large trephine through the parietal bone, just outside of the longitudinal sinus. As soon as the dura mater is reached, its condition might confirm the diagnosis, yet whether this be so or not, an opening should be made, and the clot, if discovered, should be removed. For this, a spoon-shaped curette may be used. Should no coagulation be found, in a patient in whom there were strongly marked signs of effusion, then one would be justified in operating on the opposite side; and should nothing be found there, still the surgeon would have the satisfaction of having neglected nothing for the relief of the patient.

External Pachymeningitis of Puerperal Origin.—A singular form of inflammation of the dura mater, of which observations were published by Rokitansky in 1838, is one associated with the puerperal female. The inflammatory action seems to confine its action to the outer surface of the membrane. This morbid process has been observed in every period of the puerperal subject, from the third month on to the close of gestation. Instead of the vascular growth, which from other causes we have seen occurring on the inner face of the dura mater, in this form, the neoplastic formation tends to ossification on the outside of the membrane. It has been observed in different stages of development, from a soft gelatinous material, to one in which the latter has become organized into cartilaginous, and finally into osseous material. It is evident that the dura mater when inflamed acquires a duplicate faculty; viz., on its inner side it can develop a vascular structure, while on its external face, it can discharge the office of a periosteum, in producing bone. How the puerperal condition can arouse this osteo-genetic action is unknown; perhaps it may be caused by the displacement of the blood towards the upper part of the body through the encroachment of the developing uterus on the abdominal cavity.

The new growth of bone appears along the regions adjacent to the sagittal and coronal sutures; it is especially abundant along the course of the middle meningeal artery. In some cases the growth is so extensive as to occupy the entire inner surface of the

cranial vault. A remarkable feature of this osseous product is that it is separated from the inner plate of the skull by a diploëtic structure. It is also found sometimes stratified, the different layers corresponding to and denoting a pregnancy. This osseous growth varies in thickness in different skulls from the thinnest lamella to a layer one line in thickness. There has been observed, in some cases, a similar growth of bone on the outside of the skull corresponding in site to that on the inside. These osteophytic enostoses and exostoses are singularly interesting, from the fact that they are the chronicles of pregnancy, the child recording its fœtal life in the enduring tablets of the maternal cranium. If nature in her structural handiwork had shifted to the side of paternity this recording tablet, she would have shown a fairer division of labor connected with the continuation of our species.

As clinical conditions of the puerperal state referable to the encroachments of these osteophites on the brain are the headache and vomiting which so often affect the pregnant woman; conditions dependent more on local congestion than on cerebral congestion; in fact, the growth of bone is too gradual in its formation, and too limited in amount, to cause compression of the adjacent brain. In those days when the lancet did not contract rust through disuse, the contributions of blood which the puerperal woman was accustomed to make, doubtless, in reducing the amount of blood, lessened or wholly prevented the amount of this osseous formation, in removing the materials for its formation.

As treatment which might be pursued against this osseous deposit, the most rational one would be absorbents; iodine in some form, and likewise mercury, might be employed. For this purpose, the iodide of potassium may be administered internally; externally, the tincture of iodine might be painted over the regions in which the bony material is deposited. A solution of the biniodide of mercury might be given internally. The author, however, would say that it is rare that it would be justifiable to interfere with the puerperal condition by way of the plans of treatment here referred to; only in cases of violent continuous cephalalgia in phlethoric subjects, would it be prudent to abstract blood, and check the neoplastic tendency by the use of iodine externally and internally.

Tumors of the Dura Mater.—It is rare that the dura mater is the site of tumors, whether benign or malignant. It is true that it is not infrequently penetrated or encroached on by growths which, originating on the scalp, grow inwards, or which, arising

from the brain itself, grow outwards and involve the meninges; yet the cases are much rarer in which the prime starting point is from the membranes. Nevertheless, in recent times, since Pathology as a science has become more accurate, frequent instances in which tumors have originated in the meninges have been noted.

Meningeal tumors differ in respect to their points of origin, their mode of development, their structure, and the symptoms to which they give origin. In regard to their classification there exists much discord among the pathologists; the leading generic names formerly were cancer and fungus of the dura mater. From these the sarcoma was afterwards separated; and from the latter, Robin detached the epithelioma, which, he claims, arises from the arachnoid membrane, while the sarcoma, consisting of fibro-plastic elements, originates in the dura mater. Others, as Virchow, deny that any of these tumors are of the nature of epithelioma.

From a study of these growths Jaccoud and Labadie-Lagrave have classed them under three general divisions: (1) Accidental, (2) Parasitic, and (3) Constitutional.

Those of the accidental class may be composed of elements similar to those whence they spring; or they may consist of elements different from the structures whence they arise. Subdivisions of this group are fibroma, sarcoma, epithelioma, myxoma, lipoma, chondroma, osteoma, and calcareous concretions.

The fibroma has its representative in the Pacchionian corpuscles, which are revealed to the necropsist in almost every case of autopsy on an adult. Besides these, there is a form, after vascular, which springs up on the inner face of the dura mater, beneath the arachnoid. The fibers of these tumors are arranged concentrically; it is round or oval in form, and may vary from the size of a pea to that of an orange.

The sarcoma occurs in the dura mater in a form designated angiolithic (Ranvier). This form consists of attenuated fibers, traversed by vessels which are varicosed; or its component elements may contain also sand-like material, similar to what occurs in the choroid plexus. This sand-containing growth is named by Virchow, psammoma. Gintrac, who has studied these meningeal tumors, finds that sarcoma occurs oftener in the membranes than in the brain itself. Of thirty-two sarcomata collected by him, nineteen were seated in the dura mater, and most commonly such tumor is seated at the base, and there presses on the chiasm of the optic nerves. The tumor often grows towards the skull, and it may perforate the latter and appear on the outside.

Epithelioma.—Some discord exists among pathologists concerning the question of epithelioma of the meninges of the brain; its existence is denied by some. It is clear that the growths which have been so classified do not conform histologically to what is commonly recognized as epithelioma. But, adopting the opinions of Cornil and Ranvier, there are two varieties of the growth, pearly or nacreous, and the papillary. The first species has a thin covering; it is vaguely fibrillated, and its content is disposed in concentric layers. When this structure, which is of irregular form, is examined it is found to consist of epidermal cells which have undergone fatty degeneration. Both the content and its outer coat contain no vessels. In the second form, the tumor is constituted of papillæ, and covered by a coat of epithelial cells. Again, tumors have been observed here which were composed of strata of pavement-celled epithelium.

The myxoma has seldom been seen arising from the meninges; it is found oftener in the brain itself. It is composed of mucous tissue, of which the constituent cells are large, pale, fusiform, and often anastomose. The myxoma is oftenest found on the convexity of the hemispheres.

The lipoma has been often observed arising from the meninges: more rarely it has been found in the brain. As Parrot observes, it is hard to explain the presence of fatty tumors in the brain when one remembers that there is no fatty matter in the brain, or in its membranes. Yet Parrot found a lipoma arising from the pia mater of a child. This growth was three inches long and a third of an inch thick. It was yellow in color, and proved to be fatty matter when analyzed. The lipoma has been seen arising from the meninges by Virchow, Home, and Meckel; still it is not of common occurrence.

The chondroma can arise from the inside of the skull; also from the meninges. Like the lipoma it rarely occurs. According to Gintrac, this tumor has been found usually in young subjects.

Osteoma.—Besides the osteoma of puerperal origin hitherto mentioned, the dura mater is the site of osseous formations, which may appear at any point; the membrane seems to undergo ossification; thus the tentorium has been seen almost wholly converted into bone. Again, the dura mater, where it lines the vault of the cranium, may become almost wholly ossified. Osseous growths may appear also in the cerebral falx. The osteoma may also appear on the arachnoid membrane; here lamellæ of

bone have been found, armed on their inner surface with stalactite-like processes. The arachnoidean osteoma is oftenest situated over the convex surface of the brain, and especially on the anterior lobes. The meningeal osteoma occurs independently of age, since it is often found in the young; even at birth it has been seen.

Psammoma.—Calcareous growths have been found in the meninges, and the formation as described by Virchow may appear in two forms; in one, the growth in cylindrical, spinous or globular form, is closely connected with, and ensheathed as it were in, connective tissue; but in the other species the sand-like material lies loose in the structure, and can easily be detached. Such concretion can attain considerable dimensions. Bergmann has seen one as large as a walnut. The tumor is hard, smooth, and of a reddish white hue. The action which such tumor can have on the brain depends on its situation; its influence is greatest when it lies at the base, where the superincumbent brain is caused to atrophy. Or functional disturbance of nerves can be caused by such pressure.

Parasitic Tumors.—Of this class of meningeal tumors there are two species: the cysticercus and the echinococcus.

The cysticercus occurs in the pia mater. Nineteen cases have been collected by Gintrac. The vesicular growth arising from this parasite may attain the volume of a pigeon's egg. The tumor finally undergoes a fatty change; and in this detritus there are found fragments of the parasite.

The cyst from the echinococcus is usually more voluminous than that of the cysticercus; and there are seldom found more than two or three cysts. The containing wall is fibrillated in structure, and contains vessels. This cyst in the cranium may be coincident with similar ones in the body. The author has seen an instance of echinococcus cyst on the convex surface of the brain. The tumor was somewhat larger than a cherry.

Constitutional Tumors.—Carcinoma occurs more rarely in the membranes than in the brain itself. When of meningeal origin, it can attain large dimensions, even some inches in diameter, and then it perforates the adjacent cranium. This growth, when it originates from the membranes, is commonly single, but if it appears there secondarily, then there may be several growths. Unless the growth appears externally, it does not soften or ulcerate; it may even undergo regressive changes and become smaller The stroma may become invested with calcareous deposits.

Tubercle.—Isolated tubercular deposit is sometimes found on the meninges; there are usually several found, and such growth may reach the volume of a cherry. When there are many, they are small in size. As an exceptional case, the growth sometimes, through the fusion of several separate masses, has become as large as an egg. The tubercular growth is yellow, with a tinge of green. The content is caseous in character. If such a growth be split open, the central portion will be found hard, opaque, and dryer than the cortical portion; the latter is semi-transparent, and is traversed by reddish lines, the remnants of vessels. And thus this tubercular growth can be distinguished from the sarcomatous growth, in which vessels enter and remain permeable. Wagner wisely remarks that the tubercular growth may be confounded with the syphiloma, since the two, when they have undergone the caseous degeneration, are quite similar.

Syphiloma.—This product of syphilis, commonly named the gummy growth, can appear in diffuse or collected form; as a rule, the gummy material presents itself as a circumscribed, well-defined tumor. Its site may be in the meninges alone, or it may be seated in the cortical substance of the brain. This growth is never encysted, but, at its limiting boundaries, it passes insensibly into the parts around. Though it may attain some dimensions, it never reaches the colossal volume which it does in the lungs and liver, in which the gummy tumor can become as large as an orange.

When examined microscopically, the syphiloma is found composed of cells and nuclei; the cells lie centrally, while the nuclei occupy the peripheral portion of the tumor. The cells are similar to those of the white blood corpuscles, with a single nucleus; and these are imbedded in a network of connective tissue, so that the whole presents an areolar structure with cells filling the interspaces. At a late stage the cells and nuclei undergo a fatty change, similar to that of many neoplasms.

The Effects of Meningeal Tumors.—The meningeal tumors have, as common effect, encroachment upon, and reduction of, the intracranial cavity, and from such encroachment they produce disturbances, which can be placed under two heads: atrophy and turgescence of the neighboring tissues. The result of atrophy of the structure of the brain is to compensate, in some degree, the encroachment of the enlarging growth. The other effect of the meningeal tumor, viz., turgescence of the parts impinged on, adds to the trouble, and this may be present in different forms; for

example, the growth may cause inflammation, congestion, œdema or hemorrhage, in the contiguous parts. The effect of the inflammation, even though it be mild, is to cause softening of the part acted on. The effect of œdema and congestion is variable, as the conditions themselves are variable; and hence the clinical symptoms must be variable. Hydrocephalus, and obliteration of the encephalic veins and sinuses, can result from such tumor. The nature of the tumor has a strong bearing on the condition of the adjacent structures; for example, certain growths are inert, and act passively through encroachment and compression; such, as a rule, are the accidental tumors. Other tumors are active in their efforts, such, for instance, as cancer; these modify deeply, and often fatally, the tissues which surround them. Tumors which compress the cranial nerves induce in these a fatty degeneration which often extends to the peripheral branches of the nerves. The results of such compression are easily seen and estimated by the ophthalmoscope, when the optic nerve is compressed.

Treatment of the Meningeal Tumors.—A few of these tumors may be treated by internal medication; especially, one may hope to do something in this way in case the growth is of syphilitic origin. When concomitant syphilitic disease is present justifying the diagnosis of syphiloma in the meninges, then the patient should be subjected to a thorough course of antisyphilitic remedies; for a month, at least, he should take the protiodide of mercury in doses of a half grain, three times a day. When this has been done, the iodide of potassium should be given and continued for some months. In this way grave subjective phenomena have been caused to disappear, within the author's observation; perversion of mental energy and motor function has been caused to disappear, and the seemingly hopeless invalid, within four months, has been restored to health. Even in case the tumor be carcinoma or sarcoma, the well-proven properties of iodine and mercury to disintegrate tissue, justify and encourage their employment, certainly for a period of six or eight weeks.

But where inward medication fails, or has no indication for its use, then the question of surgical interference arises. The experience of modern times justifies or permits work upon ground which was once forbidden; and especially is this true of the interior of the head, where surgical daring, Prometheus-like, has scaled the hitherto untrodden heights and brought thence to man the empyrean boon of relief of disease, which heretofore

seemed securely and impregnably entrenched within the cranial walls. It is well that this adventurous daring should not arouse a cohort of greater ills, which sometimes do follow the returning steps of the bold surgeon.

As said, in a few cases of meningeal tumor, surgical intervention is proper. Namely, the trephine may be used, and through an opening in the skull the neoplasm may be sought for, and if found it can then be extracted and the patient thus given an opportunity of recovery. Trephination should only be resorted to in those cases in which the diagnostic signs indicate conclusively, or with probability, the site of the neoplasm; and an additional condition must necessarily be that this site is accessible and can be opened without wounding vessels or veins which traverse the wall. As trustworthy indications of the existence of a growth would first be a continuous pain at one point of the head; and, secondly, perverted sensation and motion located peripherally, if their anatomical channels converged to the same source, might almost conclusively denote the location of the tumor. How much relief might be obtained would depend on the nature of the tumor; if it should fortunately prove to be a fibroma, a lipoma, a tuberculous mass, or a calcareous concretion, then one might expect that permanent recovery might follow the removal. But, on the contrary, if the growth were of a malignant nature, as sarcoma or a carcinoma, then the operation could only be followed by failure. But even in this unfortunate condition, the impossibility of making matters worse would grant unusual liberty to the surgeon. The surgeon and physician sometimes meet cases in which life is a burden and death a favor to the unfortunate subject; examples of such are incurable diseases which are coupled with continuous pain and a perversion of the functions of one or more of the organs through which life is maintained; and under this head no more apposite example can be cited than the intracranial growth, which by its volume interferes with the office of the brain.

Justified by the diagnosis of such conditions, the trephine should be applied over the probable location of the growth, and an ample section be uplifted. As soon as the dura mater has been opened to view, its color, tension, and upheaval would indicate whether there were a neoplasm underneath; or if the tumor had perforated the meninges, it would at once be evident to the eye. If the tumor were concealed, those membranes must be opened and the neoplasm enucleated, or excised from the parts

with which it is connected; that is, the work of removal will be done as the conditions suggest or permit. Stereotyped rules for guidance in such operative procedures cannot be formulated; ordinary mechanical ability best finds a method for itself. Inasmuch as in such operations the integrity of the parts must sometimes be disturbed greatly, hence immediate closure would rarely be advisable. After the tumor has been removed, the torn shreds or ragged edges of the membranes must be cut off, and the wound cleansed antiseptically, sprinkled with iodoform and then, a drainage tube being properly placed, the external wound can be closed by suture, except at the point where the drain lies.

The structure next in order, as we pass from above downwards, is the brain, of which the affections falling within the domain of surgery will now be considered.

Concussion of the Brain.—During the last fifty years the subject of concussion, or commotion, as the Germans and derivative Latin writers term it, has been the matter of careful study, observation and experimental research. It is caused by some external violence which communicates vibration, oscillation or minute movement to the anatomical elements of the parts acted on. In the causation all observers agree; but what occurs in the constituent elements of the parts affected cannot be said to be as yet satisfactorily settled. All parts of the body may be the subject of such action: bones, muscles, nerves, viscera; and some assert that the blood itself may be the subject of concussion. The study of the effects of concussion has been devoted chiefly to the brain; yet it seems certain that the same cause would be followed by like effects, no difference what part of the body should be the site, and hence that one common definition might be given of concussion founded on physical and physiological laws. In a classic article on this subject by Verneuil the able French surgeon and writer, after revealing to the reader the difficulties which perplexed him in his task, Verneuil offers us the following definition of concussion: "It is a series of phenomena occurring more or less suddenly which result from a mechanical shaking (jarring movement) of the anatomical elements, tissues and organs, characterized by a temporary excitation or depression of the properties, offices or uses of the parts which are shaken; and as a result there are caused anatomical changes similar to those which are normally seen in the successive phases of functional activity and functional repose." This definition is the embodiment of what

its author has derived from his own observation and that of others; and especially from the results which others have obtained in experiments on animals.

In the milder grades of concussion in the animal, the question has been whether there is any appreciable lesion to be discerned in the part subjected to experiment; the most admit that such lesion cannot be discovered; and since in man, in case of concussion of the brain, the subject soon recovers, hence there is no opportunity of searching for the evidence of such lesion. For, as Verneuil says, we derive our elements of the diagnosis of any disease from three sources: to wit, the causation, the symptoms arising, and thirdly from the direct inspection of the part affected. But in case of cerebral concussion one or more of these sources of information is often wanting. The inspection of the injured part is wholly denied to the surgeon; the extent of the violence done can often only be vaguely and imperfectly estimated; and not unfrequently it is wholly unknown, as where the patient is found unconscious or unable to explain how he was injured; and finally the remaining source of knowledge, viz., the symptoms, are often far from being clear and well defined.

Concussion, as will presently be more fully detailed, may be said to present itself in three grades, which we will designate the mild, severe and fatal. The second, which offers symptoms sufficiently durable to admit of deliberate consideration, presents as marked condition a depression of the cardio-pulmonary functions, in which pulse and breathing are slow and feeble; temperature is lowered as a result of the preceding; the functions of the sensory and motor nerves are temporarily abolished; the patient neither moves nor feels. The mental faculty is, for a time, reduced to a nullity; the patient is not conscious of existence, and in all this the animal for a time has lost his distinguishing characteristic, and lies at the verge of plant life.

Many explanations of these conditions have been offered, as will be seen from a brief review of the literature which during the last fifty years has been written on the matter.

In 1842 Haworth wrote on concussion of the brain, and claimed that the violence impinging on one side of the skull carried the brain against the opposite wall, and thence, rebounding, a vacuum succeeded, in which blood and gas collected, the phenomena being similar to those of contre-coup. Haworth thinks that a vacuum is also formed in the brain in those who ascend great heights, and thus he would explain the cerebral trouble

sometimes present in such cases. This explanation of the phenomena arising from concussion could only be applicable in those cases which had arisen from great violence, in which the patient dies at once from the violence done to the brain; and in such cases the organ is lessened in its volume, and into the empty space thence arising, blood escapes from the lacerated vessels. The filling of the space with blood is therefore a secondary effect of the injury.

In 1852 there were reports on concussion of the brain by Fano, Chassaignac and Haas; the former two find that where death has immediately followed a blow on the head, then there will be found effusion of blood around the pons Varolii; but if death occurs later, then in the cerebral structure there will be found disseminated small clots of blood, which these writers attribute to cerebral contusion. Fano and Chassaignac deny that concussion can injure without leaving some signs of violence: one always can find ecchymosis, or marks of cerebral injury. Haas, however, thinks that there can be concussion with or without ecchymosis. In each there is sopor with unconsciousness. If it be simple concussion, then these conditions may soon disappear, but if blood be effused, then these symptons may continue and even increase in intensity.

Continuing his studies in 1853, Fano combats the notion that in concussion there is no perceptible material change in the cerebral structure; but he claims that there will be found effusion of blood near the base of the brain. Fano, Chassaignac and Lawson have found in the brain small points of effused blood, not larger than millet seeds. In mild cases, Eisenmann thinks there is a shock which acts reflexively through the vaso-motor filaments on the capillaries, and produces a stasis of blood in the latter. And in more severe cases the stasis may be carried to the extent of rupturing the vessels. The order of the phenomena is as follows: The shock is first propagated from the vibrating bones to the nerves, and thence a recurrent, reflex action in and through the nerves; next stasis, and sometimes rupture of the vessels, and occasionally structural softening.

Paget, writing on cerebral concussion in 1863, made three stages of it. In the first stage unconsciousness occurs, and this may vanish, and the patient recover. In the third stage the violence is greater, and the condition may be sthenic or asthenic in character. The asthenic symptoms occur early, viz., within a day or two. The sthenic symptoms occur after a longer period,

viz., after ten or eleven days. Between the first and third, or inflammatory stage, Paget places a second one, in which there is almost a total absence of morbid signs. After surgical operations, for example, an amputation, Paget finds that similar conditions may arise, viz., one of excitement and one of depression. Paget estmates the chances of recovery to be very slight after severe concussion of the brain. In such cases not more than one in twenty get well.

Alquié, in Paris, made some experiments in 1865 on concussion, and concludes from them that through the injury caused, the functions of the brain are more or less interfered with, and, further, he believes that concussion and contusion do not differ much from each other in their respective actions. The lesion produced by slight concussion is so slight that it eludes the closest search with the eye. Its mechanism is not that of vibration, but of a blow that came and went at once. The causal violence carries the brain forwards in one direction, viz., that of the causal violence. Alquié concludes that concussion and contusion are convertible terms. Local and diffused concussion cannot be distinguished from each other in their action. The phenomena resulting from severe concussion are vertigo, fainting, weakness, drowsiness, and coma. The cerebral trouble caused may appear in remissions and exacerbation. From concussion one or many functions of the head, or parts dependent on it, may be impaired or annulled, and this disturbance may be brief or long lasting. Concussion in its action resembles grave mental disease.

In his treatment Alquié is in accord with Paget. Collapse and depression demand stimulants; active reaction demands an opposite course.

Beck, of Freiburg, in 1865, referred the effects of cerebral concussion to violence transmitted to the medulla oblongata, and to lesion of the centres which preside over the functions of the heart and lungs. He finds as common causal agency a blow with a blunt instrument.

Witkowsky, in 1877, made some experiments on animals, in which the head was struck with a hammer, and the pressure of the blood in the carotid arteries was noted in the meantime. The immediate effect was increase of blood pressure in these vessels. The increase commenced immediately after the injury, and reached its highest degree in from twenty to fifty seconds, and continued for from one to two minutes. This increased pressure followed both slight and more severe concussion. It was after-

wards succeeded by a slight descent of pressure below the normal standard. The pulse, as a rule, was not changed.

In cases in which the skull had been trephined so that the brain could be seen after removing sections of the dura mater, it was found that the strokes caused a perceptible contraction of the vessels of the dura mater. This continued for a moment or two, and then a slight reaction followed. Witkowsky decided that those alterations in the blood pressure were not due to the oscillations from concussion, but were the consequences of direct action on the nerve matter. Though Witkowsky offers this statement designed to explain the conditions present, yet it is probable that few readers can comprehend it.

Duret, of Paris, in 1877, made experiments on animals, in which he studied the effects of concussion on the brain. The violence done to heads of animals was produced by blows on the skull and also by violently injecting fluid into the cranial cavity through a trephined opening. He finds the leading results of concussion to be slowness of the pulse and respiration; and, finding an absence of all lesion in the cerebral hemispheres, he sought for injury in the medulla oblongata. In the experiment in which water was violently injected into the skull, the fluid in the lateral ventricles was caused to pass downwards through the middle ventricle and the canal of Sylvius to the fourth ventricle. In its passage through the canal, the fluid caused laceration of the walls of the narrow passage. In another experiment the skull was trephined above, and the posterier ligament connecting the axis and atlas was exposed when pressure was made through the trephined opening above; then an impulse could be perceived below from the descent of the fluid into the spinal canal.

Direct experiments were done chiefly by the injection of water into the cranial cavity. This fluid was forcibly thrown against the surface of the brain beneath the dura mater. It is evident that the action of such violence differs from that caused by a blow. It is not so instantaneous, the violence progressing from a slight grade to a higher one; and only when the fluid reaches a certain amount could it displace the intra-ventricular fluid. Such action must differ from that in which the violence impinges on the outside of the skull, and thence travels onwards to the less resistant cerebral matter. Hence the results of Duret's experiments may be deemed rather an approximation to, than an actual reproduction of, the action of concussion from direct violence

In 1878 Duret continued his researches on this subject, and divides the shock of concussion into three classes, viz., central, bulbar and medullary, according as one of these structures is most involved. In the case of a blow, the passage of the fluid downward acts most severely on the bulb.

Duret divides the action of concussion into two periods; in the first period there is a spasmodic and a paralytic stage, in which there are coma and depression. In the second period, there are congestion and inflammation. The site of the blow has an influence on the morbid phenomena; for when the forehead receives the blow, the pons and bulb are the most affected; but when the side of the head is the site of the violence, then the other hemisphere is more affected.

After this review of the subject of concussion, if the facts which have been drawn from so many quarters be condensed and conclusions be drawn from them, the following may be offered as an epitomized summary of the changes which are induced temporarily or continuously in the brain from concussion. In the mildest grade there is a brief diminution of the blood pressure in the part; its tension is temporarily lowered. As the result of this there is mental disturbance; the cells and the cortex of the brain, on whose normal condition the evolution of thought in some unknown way depends, are deprived, for a few moments, of their accustomed supply of nutrient material; the result is a brief perversion of intellect; memory is lost; the power to recognize surrounding objects is weakened or lost. As a personal illustration of this, from a fall from a carriage, the author once suffered temporary concussion of the brain; though he arose at once to his feet, on a street with which he was very familiar, yet, for a minute, all appeared to him as if he were in a strange city, and that picture registered on memory yet remains as an enduring scene of mental imagery. And though there was knowledge of what had occurred, and thought enough to search the head for fracture, yet the subject of the injury possessed no accurate knowledge of his surroundings. The author would attribute those conditions to a temporary disturbance of the circulation on the surface of the brain.

If the violence be somewhat greater than that here supposed, then, to the disturbance of blood pressure, there is superadded a disturbance of the cellular constituents composing the surface of the brain. A jostling or displacement of the molecular elements of those cells, even though it be microscopically minute, must

suffice to induce functional derangement. In such condition the patient lies unconscious to all that is around him; he breathes naturally; the pulse is commonly somewhat weakened and regular; the temperature is not increased, and sometimes is less than normal; the pupil is neither dilated nor contracted, and reacts somewhat to light. The patient may remain for hours, a day, or even a week in this condition, in which he is neither awake nor asleep; he is so nearly asleep that his condition is often taken for sleep. But it differs from sleep in this that the eyeballs do not occupy the upturned divergent position they have in healthy sleep; they are often in motion beneath the closed lids. There is an absence of snoring in the breathing; in fact, the patient breathes as one who is partly asleep, rather than as one who is really so. For the lack of a name, we will designate it the sleep of concussion.

In the grades of concussion just mentioned, its action is chiefly manifested in obtunding or temporarily suspending the functions of the mind; but if the intensity of the causal violence be still greater, then, besides the abolition of the thinking faculty, the cardio-pulmonary functions are disturbed, dependent, doubtless, on lesion of the centres at the base of the brain, which preside over these functions; lesions which were represented by the lacerations in that region observed by Duret. The pulse is soft and often irregularly hastened. The breathing is similarly affected; regular may alternate with irregular breathing, and so may slowness with acceleration. And these disturbances of the actions of the heart and lungs conjoined to unconsciousness, may remain for days and even weeks, and then consciousness may reappear suddenly, the patient arousing, as from a sleep, with a gradual disappearance of the other abnormal conditions. Such an injury of the head as here described often results from a fall, from a carriage or horse; it sometimes occurs in accidents from climbing. In such accidents the weight of the body, multiplied by the velocity acquired at the final moment of striking the ground, represents a high degree of violence, especially where the surface fallen on is a hard one. In such cases, when severe, there is a contusion of a limited surface of the brain, and thence results localized or isolated palsy of some part of the body. Or, as the author has observed, there may be partial hemiplegia of the arm and leg, and not unfrequently one limb is more affected than the other. And, at the same time, there may be restlessness of the limbs on the unparalyzed side.

In a still higher grade of concussion, the functions of life are permanently suspended, either at once, or death ensues in a few minutes after the receipt of the violence. Such fatal result has given the opportunity of necropsy, in which the condition of the brain could be suspected. Yet, singularly enough, there is far from agreement among observers in respect to these conditions, some asserting that the brain did not fill the skull; others have found the contrary state. Of the first condition there is a notable instance on record, an observation made and reported by Littré over a century ago. This case, cited by nearly all writers on concussion, was that of a criminal, who, to escape punishment, ran and struck his head so violently against the wall of his prison that he fell dead. The desperate energy displayed in the fatal act has had no small share in retaining the fact in history. In the necropsy of the case reported by Littré, the cerebral matter was found broken down, and to lack much of filling the cranial cavity; that is, a vacuum was found in the upper part of the skull. There have been reported a few other cases in which there was found a slight open space above the brain, in those who have died from cerebral concussion. There has been reported an effacement of the natural irregularities of the cortex of the brain. However, other observers contend that both the empty space as well as the alleged leveling of surface, is not present in the unopened cranium, but is caused by the escape of blood from vessels which are divided in opening the cranial cavity. Notwithstanding these discordant utterances, the predominant weight of observation is on the side of those who assert that there is some lessening of volume as well as effacement of the cortical irregularities of the brain. Besides these evidences of violence, the cerebral matter on being cut presents minute ecchymoses of blood, due to rupture of minute vessels. And it is probable that such rupture, in less extent, occurs in concussion of a milder grade.

Diagnosis.—The diagnosis of cerebral concussion is an easy matter in cases in which there is a history of violence acting on the head. Yet, in the absence of such history, the problem of diagnosis becomes, sometimes, difficult, since it must be wholly solved by the symptoms present; then the pulse, breathing, pupil, and color of the face give valuable information; stertor and narrowed pupil point to poisoning with opium; the fumes of spirits in the breath point to alcoholic excess. An instance of the latter kind came under the notice of the author: a man who was found prostrate by the side of the street was the object of

puzzling study to some physicians, when the coachman of one of the doctors solved the matter by saying that he would give a half dollar to be as sick as the man was.

There are cases in which the work of diagnosis is much embarrassed by the lesion not being a simple one of concussion; there may be conjoined to it contusion and compression, especially compression, which would greatly modify or change the usual symptoms of a case of concussion; in fact, concussion and compression present in a case would naturally interact and influence the symptoms of each other; and in such case the surgeon would find it extremely difficult, perhaps impossible, to determine all the conditions present; in such embarrassment, the most prominent symptom should receive attention and indicate the proper treatment. In the following chapter devoted to the consideration of compression of the brain, there will be presented the symptoms by which concussion and compression of the brain may be differentiated.

Prognosis.—From what has preceded, it is clear that the prognosis of concussion of the brain must depend on the grade of the injury. In the grades of slight severity a recovery may certainly be anticipated at an early period. But in the severe forms the prospect is more unfavorable; the patient may remain in an unconscious, half-dead state for weeks, and afterward slowly recover; or from his half-dead condition he may lapse into actual death. Also it is to be observed that after some concussion, though the patient may live, yet not unfrequently there remains some vestige or memento of the injury in the form of perverted motion, sensation or impaired mentality. From the observation of Griesinger and other alienists it has been found that the mental character often undergoes some change in those who have been the subjects of severe cerebral concussion. The memory, as has been observed by the writer, may be weakened or altered in some way; the recollection of proper names, of specific nouns and adjectives may be partly or wholly lost; from the framework of language may be plucked the most of its exuberant appendages, and the whole be reduced to a meager skeleton of generic headings and categories. Besides this the character of the individual may be slightly or greatly modified. The hitherto well-controlled temper may become vehement and rash; the patient has outbursts of anger, and may become the actor of lawless deeds. He becomes distrustful of those around him. These changes may be plainly manifest, or they may be so slight as only to be per-

ceptible to the subject's intimate friends. And whatever character these changes may assume, they will probably remain permanent, inasmuch as they depend on structural change, which will continue unchanged. In modern times when crime seeks for its defense that its subject cannot control his action, and consequently that he is not responsible for his offenses, the matter of concussion has assumed a special importance in Forensic Medicine. As the concussion of the spinal column from railway accident on account of real or assumed injury, seeks reparation from the pocket of the owning corporation, so the transgressor of laws often claims immunity on the ground that at some time previously he has been injured in his head, and as concussion leaves no tangible or visible mark, hence it conveniently serves the purpose of such subterfuge.

Treatment of Concussion of the Brain.—Since there are two totally different states in which the patient of concussion may be, namely, depression or excitation, so the treatment must be shapen as one or the other condition exists. As a rule, the first effect of concussion is to induce depression and exhaustion of the vital forces; and this condition must be met and counteracted by stimulants and excitants. The patient is often so prostrated that the reflex act of swallowing can only be imperfectly performed, a fact which renders it difficult to administer remedies by the mouth. If, while the muscles of deglutition are in a partly palsied state, liquid medicine be given by the mouth, the most of it will probably pass into the trachea, and add to the patient's perilous condition by partly asphyxiating him. In fact, the same precaution is required here as must be exercised in administering matters to a person moribund or near death; the wine or other thing thus given, as the writer has witnessed, can strangle and immediately end life. Hence, when the patient is greatly prostrated by depression, and cannot readily swallow, fumes of ammonia should be applied to the nose; also tickling the nostrils will often arouse the patient. Stimulants, as brandy and warm water, and black coffee, may be injected into the rectum. Hot applications should be placed over the præcordia, and the surface of the body should be well rubbed so as to promote the movement of the blood. In case of extreme prostration, syncope may be avoided, or rather life awakened by lowering the head so that the heart may be aided by gravitation in carrying the blood to the brain. After the patient has been sufficiently resuscitated to swallow, then remedies may be given by the mouth. The administration of stimulants must be limited to the period of depression;

afterwards the treatment must look to controlling the inflammatory symptoms which usually present themselves after a few days; the stage of excitement is ushered in about the eighth, ninth, or tenth day after the receipt of the injury. Should the patient be plethoric, then bleeding from the arm should be done; not less than a pint of blood should be drawn. The signal advantages of such depletion have been verified by the writer in several instances. If the subject be very robust, as much as thirty ounces can be safely withdrawn; thus inflammatory action, through the absence of material for its maintenance, is subdued and retained within tolerable limits. Depletion might be done by means of leeching; yet withdrawal of blood from an open vein is more effectual.

A valuable adjuvant in this antiphlogistic treatment is ice, which should be applied to the patient's head as soon as he merges from the primary stage of depression. The ice well crushed should be applied to the head in an India rubber bag; and this should not be heavy, lest it cause sloughing on the subjacent scalp. The head should be maintained in an elevated position, so as to favor the descent of the blood through the veins towards the heart. All constriction of the neck should be avoided. As a faithful ally in this work of derivation of the blood from the head is warmth applied to the lower extremities; for this, hot water contained in bottles or a rubber sack, may be used. As there is danger of freezing the scalp, so there is of burning the feet, unless the warmth be carefully used.

As internal treatment there should be given a purge; and for this none is better than calomel and jalap, ten grains of each. Besides this, to restrain or prevent the development of inflammation, there should be administered iodide of potassium, in doses of ten grains, repeated every four hours, for the adult. If the patient be a child of four or five years of age, the dose should amount to three grains, repeated three or four times daily. And should there be the usual restless somnolence, this must be controlled by bromide of potassium, of which an amount equal to that of the iodide of potassium should be given. By the use of this internal medication, the author has repeatedly seen the subjects of severe concussion pass safely through the inflammatory stage; the temperature was retained in low limits.

There should be mentioned a mode of treatment formerly much used in cases of severe cerebral concussion: this was vesication of the scalp. To do this, first let the hair be shaven off,

and then the whole covered with Emplastrum Cantharidis. This does not act entirely as an ordinary blister; only a small amount of serum is drawn out, but instead, there will form a coating of fibro-albuminoid material over the scalp, tenacious and adherent. This vesication was a favorite of Dupuytren; and it is claimed that good results followed its use. Yet when one considers the slight anatomical connection between the scalp and the encephalon, it is difficult to conceive how this external blister can act on the parts within the cranium.

Frequently, two or three months are required for entire recovery of the patient so that he can resume his usual occupation, and for a yet longer period, limitation in exercise of body and mind should be enjoined.

Compression of the Brain.—By compression of the brain is meant an abnormal condition arising from pressure acting from without inwards on the brain, or the compressive agency may lie within the organ. In the first case, the force acting centripetally may be caused by a portion of the cranial wall being pressed inwards; or from blood that is extravasated between the cranial wall and the dura mater, or between the dura mater and the cortex of the brain. Centripetal compression may also arise from a neoplasm springing from the dura mater, skull wall or scalp, which tumor and its development lessen the containing cavity and crowd against the brain. A subdural abscess may attain such dimensions that it can give rise to compression. A foreign body having entered the cranial cavity, and occupying a subdural position, may cause compression. Again compression can arise from an effusion of blood within the brain; from an abscess located there; from an intra-cerebral growth; from a foreign body that has penetrated the brain; and lastly, a not infrequent cause of compression is the swelling of the brain through congestion or inflammatory action.

The encephalic content is constituted of cerebral and cerebellar matter, of nerves, vessels and cerebro-spinal fluid.

The material comprising the cerebrum and cerebellum consists chiefly of water; the aqueous contents make up more than three-fourths of the whole; in this it resembles blood, of which water forms nearly four-fifths;* thus intercommunication and interchange of organic elements are provided for and happily facilitated A large part of this water is closely associated with the cerebral and cerebellar elements; a portion of it is the cerebro-

* Moleschott's Kreislauf des Lebens.

spinal fluid, which has no connection with the structure of the brain.

As is well known, water is incompressible within limits which can be tolerated by organized beings; hence, a compressing force acting on the brain does its injury by displacement; the fluid content is forced from the organic structure, and the latter is altered in its position and form. Should the compression come on slowly, then the cerebro-spinal liquid will be forced from the cranium, and the encroachment be compensated; this happens in cases in which there is a gradual outpouring of blood from the rupture of a vessel. But if the compressive force in its entirety acts instantaneously, then the rapid retreat of the fluids before the violence must injure the fragile structures through which the fluids are forced; and thus a slight or grave lesion results, proportional to the degree of violence.

To verify the effects of compression on the brain, experiments have been made on animals; this has been done in two ways: by the injection of water into the cranial cavity, and by directly pressing on the brain when the latter is exposed by trephining. The action of pressure when made directly on the brain has thus been observed in animals; and its effects on voluntary motion, respiration, pulse, and the pupil of the eye have been found to correspond to conditions arising in the human subject of cerebral compression. Some fallacy, however, may be mingled in these deductions from vivisection, since the violence which causes compression in man may be associated with concussion and contusion of the brain.

The following are the effects of uncomplicated compression as observed in the animals experimented on by Leyden, in 1866. The experiments were made by first trephining the animal's skull, and measuring by means of a dynamometer the amount of pressure which was applied. By pressure of a mild degree, pain was caused through the action on the dura mater. When greater force was used, there was produced a loss of consciousness, with coma; and, along with these conditions, in some cases there were spasmodic contractions of the muscles; and when the pressure was still greater, epileptiform convulsions occurred. In all grades of pressure the pupils were acted on; these were widened, yet not equally so on both sides. The pulse was altered according to the grade of pressure; in the commencement of compression, the pulse was rendered slower, but as the pressure was increased, the pulse suddenly changed, and from being slow it became rapid. These changes were referred by Leyden to action on the

vagus nerve. Respiration in the beginning was irregular and sometimes hurried, and later intermittent; during coma the breathing became slow and stertorous; and later it became irregular and intermittent with long pauses. Vomiting rarely occurred. Death was caused by paralysis of the respiratory nervous centre. The heart continued to beat for some minutes after the respiration had ceased. The action of compression of the animal's brain corresponds closely to that which has been observed in man. In the milder degrees of pressure there are conditions perceptible in the human subject which cannot be recognized in the animal; for example, disturbances of the special senses and of the mind can be noted in man.

In the experimental work on the animal, conditions of excitation and depression were induced, and these conditions vary according as the compression is made gradually or suddenly; for if made suddenly there is no preceding period of excitation, since that of depression is ushered in at once; but if the force is applied slowly, then there is an antecedent period of excitement. And sometimes the conditions of excitation and depression are commingled, since some parts of the brain are pressed on much more than others. Pus slowly forming may first be indicated by excitation, which is followed later by depression; and the same is the case in which a tumor slowly grows, for here obtuse intellect, somnolence, palsy and finally coma and stertor appear; yet only at a late period.

Hutchinson and Bryant, prominent surgeons of London, have written on compression from observations of it in surgical practice. Bryant, in writing on injuries of the brain in 1860, says that when symptoms of compression immediately follow a blow with a blunt body, there is probably injury of the base of the brain through contre-coup, and this injury and its effects cannot be reached by the trephine. The trephine, however, is especially useful in cases in which a fragment of bone has been forced into the skull and caused compression. Also, where compression has supervened slowly after the injury, it indicates rupture of a vessel, and here if the vessel can be reached, trephining may be done.

In 1868 Hutchinson writing on compression, as deductions from many cases observed that compression is sometimes suspected where it does not exist; and again it may exist without any indicative symptoms. Compression can originate from the effusion of blood between the dura mater and the skull; and unless this is soon relieved by operating, death ensues. The

cases here referred to are those in which some meningeal artery is ruptured; and it may be suspected where the patient has remained well for a time after the accident, and then signs of compression have suddenly appeared. From an effusion of blood on one side, the pupil of the eye on the same side is widened; and meantime on the opposite side of the body the arm and the leg can be palsied. Compression can occur from injury of the cerebral structure; the blood then escapes from the wounded part underneath the dura mater, and when the vessels torn are small, the compression may appear slowly. Compression can arise from pus which is formed inside or outside of the dura mater. When the pus is external to the dura mater, it may proceed from diseased bone or from an injury of the bone; and finally compression can arise from an abscess within the brain.

Hutchinson thinks that compression rarely arises from depressed bone, and though it may be requisite to elevate the bone, this is done rather to prevent inflammation than to relieve compression.

After this general review of the causes and effects of compression of the brain, the following, derived in part from the author's own observations, may be subjoined. Compression, the effect of violence acting on the head, in most cases results from the effusion of blood, which presses on the surface of the brain. Exceptionally it is caused by a portion of the cranial wall which has been broken and forced upon or into the brain. The patient is unconscious, one or both pupils are dilated; the dilatation is often unequal. The breathing is slow, measured, slightly snoring and often stertorous, with intervals between the respirations, similar to that occurring in narcotic poisoning. This breathing is characterized by the peculiarity that the inspiratory act is the one which is especially prolonged, while that of expiration remains almost normal in its duration. The interval between the breaths is long in proportion to the severity of the compression. The pulse is much changed from normal; it is slower and fuller, conditions which denote that the heart has undergone some change in its mode of action. The heart, in the uniformity of its work, has assumed the character of a machine; the pulse wave is propelled with the uniform motion of the piston of a slowly moving engine. It is a movement stately, measured, and rhythmical. The hardness or softness of the pulse will depend on the force which the heart is capable of exerting, and this again is somewhat dependent on the strength or weakness of the subject.

The pulse is so peculiar that it might be named the pulse of compression. The temperature may remain normal, but if the agent of compression develops an inflammation, as not unfrequently is the case, then the heat of the body is increased, and may rise to a high grade of temperature.

Diagnosis.—The foregoing symptoms present themselves in a case of compression uncomplicated with concussion or contusion of the brain; yet in nearly all cases one or the other, or both of these conditions are present, and thus it is difficult to determine the true nature of the case, unless one of the conditions greatly predominates. The confusing condition most commonly present is concussion, by which the pulse, respiration, and motor power are greatly weakened. And again when time enough has elapsed for irritation or inflammatory symptoms to arise, then the facies of the disease is changed, and the symptoms above described are essentially altered. From these facts it is evident that the diagnostic problem in such injury sometimes baffles solution, and thence has arisen the discrepancy among surgeons who have written on the subject of cerebral compression.

As aids, however, to the diagnostician in the case of perplexity which oftenest presents itself, viz., to distinguish concussion and compression from each other, the following collateral pictures may assist in their comparison and differentiation.

In a case of slight concussion there is some mental disturbance coupled with general muscular weakness. The action of the heart and lungs is debilitated, and, as result, the pulse and breathing are weak and slow, and the temperature is not increased, and sometimes it is slightly lowered. If the concussion be more severe, the patient is nearly or wholly unconscious, the heart and lungs act feebly; no snoring; the pupils are equally dilated; there is a universal reduction of the vital powers, and reflex action remains, though in limited degree; and the eyes move torpidly and aimlessly in their sockets; and the urine escapes passively. In a still higher degree of concussion the universal depression is still greater. The patient lies as if in deep syncope, with cold skin, inaudible breathing, and imperceptible pulse; in fine, in a moribund state.

Compression does not occur in such varying forms of graduated intensity as concussion presents. The patient lies in the position of deepest sleep, sleep in which he often loudly snores, and the lips and cheeks move as they do in the act of smoking the pipe. The tongue lapses towards the pharynx, and increases the

difficulty of breathing. The patient makes no voluntary movement, nor can reflex action be excited; the pulse is slow, full, and for a time regular; later, the pulse becomes irregular. The pupils are wide, and often one is more dilated than the other, and the urine dribbles after the bladder becomes distended.

As just stated, compression, contusion, and concussion of the brain are often combined in the same patient, and then the case may be represented by a symbol of the initial letters CCC, and as the accent or emphasis is on any one of the letters, or on two of them, so the character of the conditions present will be modified and shapen; and if two of the injuries be equally severe, then will the diagnosis be intricate, and the indications for treatment obscure.

Prognosis.—The prognosis of this injury is one in which caution dictates many reservations. For cause and effect seem here sometimes to have lost their wonted relations, since not unfrequently a slight injury may eventuate disastrously and a grave one may proceed rapidly to recovery, thus verifying the Hippocratic axiom that no cephalic injury is to be underestimated.

It has often been observed that the symptoms in cerebral compression may gradually subside; for example, this can happen where the cause is extravasated blood which is absorbed; also, when the compression is caused by a depressed bone to which the brain seems gradually to accommodate itself. Such tolerance may be brought about by the retirement of some of the fluid contents of the brain, viz., of blood and the cerebro-spinal fluid. Besides, it has been observed that where pressure is maintained for a long time on a portion of brain, this, similar to any part that is long pressed upon, atrophies or lessens in volume. Hence the tolerance of pressure is acquired through permanent structural impairment, a fact which should be considered in prognosis. In cases in which compression is caused by a neoplasm, or through an accumulation of pus, then the prognosis is entirely inauspicious. Improvement can only be gained through some perilous surgical procedure.

The prognosis is most favorable in cases in which compression has instantly arisen from a depression of bone. It is less favorable in cases in which compression has come on some minutes or a short time after the injury, for in such patients a rupture of a blood-vessel may be suspected, and a subsequent effusion of blood. There is a third class of cases, in which the symptoms of compression only supervene some days after the injury, and in

which it is due to the swelling of the brain through inflammatory action. In such cases, besides the afflux of blood, there occurs also an emigration of cells from the vessels into the adjacent tissues; and perhaps there is also a cell proliferation. Through these several agencies, the volume of the brain is enlarged and crowded against the unyielding cranial wall, and thus compression arises, of which the prognosis is very unfavorable.

Treatment.—In the treatment of compression, the question of operative interference is one which has been agitated and discussed by surgeons, and at different periods interference or non-interference has predominated. This matter is a part of the history of the trephine, and has been considered in a preceding section, in which this operation was treated of. The treatment is most properly considered under different headings.

First, in the case in which compression is produced by a smaller or larger portion of the cranial wall that has been forced inwards and crowded on the adjacent brain: though the brain may tolerate this violence, and finally, as it were, forget the intrusion, yet this is a case in which the trephine should be employed. The effect of trephining will be to place the encephalic structures in such condition that the blood will circulate normally, and thus a proper balance is restored between the defect at one point and the excess at another one; anæmia and hyperæmia both give place to equal diffusion of blood. And if the brain moves, as some contend, with the influx and efflux of the blood, then an operation is indicated to remove the encroaching portion of the wall, which must interfere with the normal influent movement. The operative work to be done will consist of trephining a small orifice, through which the elevator can be passed, and the wall uplifted and restored to its original position and level. When the depression has been great, after it has been elevated there sometimes remains a hollow space for a time; especially is this so where the depression has existed so long that the inherent elasticity of the structures has been partly extinguished. As, in such a case, there would be a tendency of the blood to exude and fill the vacant space, there should be provided drainage for the effused fluid, for a day or two; a drainage tube should be allowed to remain as long as there is any escape of fluid. The stage of inflammation, which is impending in every such injury, should be forestalled, curtailed, and, if possible, prevented by rigid antiphlogistic treatment. The ice-bag should be at once placed about

the head. The head should be somewhat uplifted, warmth applied to the feet, and the patient have perfect rest of mind and sense. If the subject be plethoric and have an ample endowment of physical strength, then he must be bled from the arm; not less than twenty ounces of blood should be withdrawn. As internal medicine, cathartics should be given in the commencement; also iodide of potassium, combined with the bromide of potassium, should immediately be commenced with, and continued for some weeks. The submuriate of mercury, once in so much favor as a controller of cerebral inflammation, should not be forgotten; the disrepute into which it has fallen in recent years is unmerited; the spectre of ptyalism which hovers in the popular mind as an objection to the use of mercurials, will be conjured away, if the remedy be administered with properly watchful precautions. The calomel may be given in doses of a half grain every four hours; and should signs of its specific effect appear in an increased flow of saliva, and swelling of the alveolar integument, then the remedy should be suspended for a few days. Another remedy, which rarely disappoints in its action, is the protiodide of mercury, which may be given in doses of a half grain three times a day.

The anticipated benefits of treatment in cases of cerebral compression from depressed bone are often not realized, since the injury is frequently associated with concussion or contusion, especially with the latter. The in-pressed bone can hardly fail to bruise the underlying brain, and hence the antiphlogistic remedies mentioned should have early and vigorous use; and they must be continued for not less than four weeks, and the administration should be continued much longer in cases in which motor, sensory, or mental disturbance points to organic lesion.

The next form of compression, of which the treatment is now to be considered, is that arising from effusion of blood from one or many ruptured vessels. The indication of such ruptures will be that the compression supervenes gradually; for its complete appearance, minutes or even an hour or more of time may be required; if it appears quickly, a vessel of considerable calibre must have been opened. As treatment where such vascular rupture is suspected, the bold prophylactic measure of ligating the vessel, which supplies the blood for ecchymosis, has been recommended; thus, it has been proposed to tie the external carotid to check bleeding from the meningeal arteries, and, as a more radical procedure, in 1863, Furneaux Jordan recommended the ligation of the common carotid artery; for, if this be done, effusion of blood from rupture

of the middle meningeal artery or of a branch of the internal carotid, would be controlled. This ligation would control the tendency to inflammation of the injured brain. According to Jordan, the results of ecchymosis of blood from the ruptured meningeal artery are hemiplegia, snoring, whiffing of air from the side of the mouth on the affected side; the pupil is insensible to light, and control of the rectum and bladder is lost; as soon as these symptoms appear, one should, according to Jordan, tie the carotid on the side opposite to the hemiplegia. And the author will add to this advice to bleed the patient freely. Without this precaution, the tension with which the blood is carried to the brain through the remaining carotid is abnormally great, and must cause disturbance of nutrition; the abstraction of blood would lessen such disturbance.

A question next to be determined is whether there are indications present which demand or justify the use of the trephine. The mass of surgical authority favors the use of the trephine; for none deny that the presence of a large clot of blood must be detrimental to the brain, and most agree that its removal is necessary. The opponent of trephination claims, however, that the work will be done by absorption. It may be conceded that this is partially possible, yet not wholly so; some remnant of the coagulum will remain as inert material, and, by its presence, will act the part of a foreign body which has become encysted. During the period of absorption the brain adjacent to the clot will be rendered anæmic, and must undergo some atrophic change; hence, it is manifest that the expectant method of non-interference has its disadvantages.

General Consideration of the Conditions which favor or contra-indicate Trephining.—A few years ago, Leon Le Fort, and, still more recently, Laugier have made an exhaustive study of the literature of cerebral injury, and each has endeavored to point out the indications for the use of the trephine.

Le Fort groups together the symptoms which can arise from lesion of the brain in three general classes, as follows: (1) Coma, insensibility, and stupor, that is often associated with stertor, which commence with and continue after the accident. (2) Fever, agitation, delirium, pains in the head, and epileptiform convulsions. (3) Hemiplegia with or without slight convulsions. When the first group of symptoms is present, and if the coma be deep, and there is a total loss of muscular power, then it is better not to operate; or if this be done, one should wait until the cerebral

depression has abated or subsided. Trephining in such cases has been followed by a mortality of twenty-five per cent. The second class of symptoms is indicative of a limited lesion of the brain, and of a limited or general inflammation of the organ; there is no satisfactory indication for trephining in such cases, and when the operation has been done, it has seemed to provoke or increase the inflammation. Should the convulsions occur immediately after the injury, then, as probable signs of some compression, they would justify the use of the trephine; yet if the convulsions occur at a later period, they indicate an inflammation which has arisen around a contusion of the organ; and trephining has resulted disastrously in such condition, viz., the mortality was ninety-four per cent. Finally hemiplegia, isolated or associated with spasms which are limited to the palsied limbs, is deemed a sign of compression, and an indication for trephining. This compression can arise from a depressed bone, yet it arises more commonly from an ecchymosis of blood.

To sum the subject up briefly, Le Fort says that there are three orders of morbid phenomena which result from blows and other injuries of the head and which govern the use of the trephine, viz., coma, convulsions, and hemiplegia. In coma, the rule is to wait; in convulsions, one should never, or almost never, trephine; but in hemiplegia, without or with limited spasms, the indication is to trephine, and to do this at an early period. And if the morbid conditions only occur secondarily, and there is the presumption that, with the effusion of blood, there is a fracture, then one should operate. And, finally, as an apothegmatic rule of guidance in conditions of uncertainty, Le Fort lays down the following: *In all cases where doubt exists one should act.*

Laugier discusses the points for and against trephining in those cases in which there is evidence or presumption of an ecchymosis of blood. He finds that almost all agree that the unilateral palsy is on the side opposite to ecchymosis; yet, before the trephine is used, there must be found some local injury which can serve as a guide for the point of opening the skull; in such cases, nearly all authority is unfavorable to operating. Van Swieten alone advises to open guidelessly the parietal region, since the leading vessels run beneath the parietal bone. Again, the local injury and the hemiplegia are exceptionally on the same side of the body, and, though a probable explanation of this is that there has been a rupture by contre-coup, yet there is too much uncertainty as to the site to justify one in trephining; in

such cases the operation is not justifiable. But when the local injury corresponds to a sinus of the dura mater, or to the middle meningeal artery, and the palsy is on the opposite side, then one may trephine at the site of injury. Again, when the causal injury is an open wound, yet too small to permit the effusing blood to escape, then some counsel to introduce a wedge of dry wood between the fragments, and thus to forcibly enlarge the opening; a much better plan would be to use the trephine and make an opening at once.

From the facts and opinions which have been presented there may be derived, as practical rule for guidance, to use the trephine in all cases in which there is unilateral palsy resulting from blood ecchymosed into, or upon the brain. The removal of the clot is especially indicated when aphasia is conjoined to the hemiplegia. The removal of the clot is not always an easy matter, even though it be reached; sometimes it is spread out over so large a surface that much of the clot is inaccessible. And, again, though it be removable through localized isolation, yet the clot may soon reform through the continuance of the bleeding, and thus the surgeon will be frustrated in the object of his work. In the former case, in which there is a widespread coagulum, besides the scoop, the syringe might be used, and a weak sublimated solution should be used for washing out the blood. Due precaution should be used in this injection not to detach the dura mater around the injury. And in the case in which the clot reforms, the external carotid artery, or the common trunk, may be tied; and thus both bleeding and inflammation will be controlled. In these operations the wound should be subsequently carefully drained; and if there be disintegrating clotted blood escaping, the exit of this should be favored by ablution, which will be most safely done by the use of fluid passed through a siphon, or irrigator held at short distance.

Compression, as before stated, can arise from a neoplasm, or from an accumulation of pus within the cranium. The recent advances in the knowledge of cerebral localization before referred to, have added much to the accuracy in the location of pus, or a neoplasm in the brain; the peripheral disturbance in limb, muscle, or sense, serves to determine with much definiteness the site of the encephalic disturbance, enough so, at least, to prevent the use of a half score or more of trephine crowns, as was the wont of old, to discover the disturbing agent within the cranium. It must be confessed, however, that much is yet to be learned;

and that, as in our earth large polar and equatorial regions are yet terra incognita, so in the cranial sphere there is much that is unknown, and, from its nature, it is destined to remain so.

When the location of a tumor can be determined, which from its volume is causing compression, the indication is clear that if the anatomical conditions are such as will permit the removal of the growth, the attempt should be made to do so; should the neoplasm, however, be intrenched in some anatomically inapproachable site, then the patient must be committed to his fate.

And similar principles should serve for the guidance of the surgeon in reference to the use of the trephine for the liberation and escape of pus from the cranial cavity. The operator here has generally the advantage of a local sign which will serve as a guide for his perforation; the pericranium overlying the purulent collection will be found loosely adherent to, or perhaps detached from, the skull. The skull itself will present some deviation from the normal appearance. A similar alteration in the appearance of the bone has been observed in cases in which there was subjacent ecchymosis of blood. This has been noted by several English surgeons. After the wall has been opened, sometimes the pus is not at once found; it may be beneath the membranes, or within the brain itself. Such subjacent pus is denoted by alteration in the hue and texture of the covering membrane. And, further, when the pus lies in the brain, the overlying stratum of cerebral matter is motionless; the pulsating movement that is present in the normal healthy brain is absent. With such signs for guidance, Dupuytren plunged his bistoury into the overlying brain, and discovered pus; the story of this case is universally quoted in surgical literature, and has since had a following in practice.

If pus be found, provision must be made for its ready discharge; viz., after opening and carefully washing out the pus cavity, a drainage tube should be inserted, and through this daily ablution should be made with a sublimated solution.

Contusion of the Brain.—It is only within comparatively recent years that contusion of the brain has been carefully studied, and this study has been embarrassed by the circumstance that, nearly always, there are associated with the effects of contusion also those arising from concussion or compression; in fact, it is difficult for contusion to occur without there being also some concussion.

As causes of contusion may be cited various kinds of violence

acting directly or indirectly on the cranium. The violence may drive the wall inwards for an instant, and then it may return as quickly to normal form again; that is, through the ordinary action of elasticity, of which, as early stated in this work, the skull has ample endowment. Through such momentary impression the adjacent encephalic structures, viz., the membranes and the underlying brain, are bruised to a limited extent. Such lesion, according to the degree of violence, may act only on the cellular cortex, or, besides this, the injury may reach into the subjacent fibrillated matter.

Again, contusion may result from violence in which the cranial wall is fractured, and the fragments, or fractured edges of bone, are driven against and bruise the underlying soft structures. In this form of contusion there may be an open wound through which the substance of the injured brain may exude, and the conditions are such that the wounded parts may be somewhat open to inspection with the eye.

There may be contusion affecting the cerebellum as well as the cerebrum; yet the latter, from its larger volume and greater surface, is more frequently injured. There may be single or multiple points of contusion. And when the violence has acted by contre-coup, it is probable that the primary point of impact is likewise contused as much or more than the one opposite to it.

The conditions found where the brain has been contused are the following: A few drops of effused blood lie in softened cerebral substance, which is easily distinguished from the surrounding unaffected cerebral substance. The softening is mostly superficial, or it may reach into the white matter of the brain. There may be several points of softened structure. The softening is such that the affected material can be washed away with a fine stream of flowing water. When the softened matter is washed away, there remain slight hollows or depressions of violet or slate-colored tint. Sometimes the arachnoid and pia mater are found torn. After some days in the course of the disease, pus forms and spreads out over the adjacent surface of the brain.

In all fractures of the skull, whether concealed or open through a wound of the scalp, contusion of the brain is to be feared; the agent which caused the fracture, may penetrate deeply enough to bruise the brain; and when the brain remains depressed, it hastens the disorganization of the contused structure.

To Dupuytren is due the credit of having first observed and described contusion of the brain; and according to him the

symptoms arising from the injury do not appear until the fourth, fifth or sixth day after the action of the causal violence; and the symptoms thus appearing are those of inflammation of the brain and its membranes; for example, there occur chills, fever, delirium, muscular contraction and spasms on one side of the body, provided the lesion is unilateral; later there are compression and complete palsy of one side, and in most of the cases, the patient dies. Dupuytren states that persons so wounded often walked to the hospital, and after their reception there, for a few days they exhibited no grave symptoms; then suddenly the conditions mentioned were ushered in. Sanson claims that there are evidences of contusion from the commencement of the injury. Such symptoms are the contraction of one lid, and the narrowing of a pupil, spasmodic movement of the lips and of one or more muscles of the face; besides there is a difficulty of pronouncing some words, with headache, and a general agitation of the body. These symptoms are at first without fever; but after four or five days, fever arises. Laugier, however, has seen contusion in which, as is asserted by Dupuytren, there were no antecedent symptons during the first few days.

Boinet, in 1848, on the subject of cerebral contusion, announced that the following conditions are present: There is strong contraction of the limbs, general agitation of the body, unconsciousness and stertorous breathing. In mild cases there is contraction of one eyelid, narrowing of one pupil and inability to pronounce certain words. There is also pain in the side of the head which is injured. These signs of contusion appear at once, or within a short time after the receipt of the injury. The symptoms of contusion are often concealed by those of concussion and compression.

Prognosis.—The chances of recovery in a case of severe contusion of the brain depend on whether there is associated with it an open wound or not; an opening to the contused structure is a condition greatly favorable to recovery, since the structural elements which are destroyed can escape. Cases have been treated by the writer in which the skull was fractured, a fragment of bone detached so that there was a free opening to the cerebral structure, which was severely contused and lacerated, and yet, despite the severe wound and considerable loss of cerebral matter, through the open state of the wound, the patient made his escape from a contusion of the brain that surely would have destroyed his life had the wound been a closed one. If the contusion be a severe

one involving the death of a small tract of the surface of the brain, then suppuration must result. Such pus must continue to increase in amount, and, necessarily, have a disastrous termination; only in mild cases of contusion, in which the mere surface of the brain is injured, is it conceivable that the injured elements can be absorbed, and the patient recover; but such absorption and resolution are impossible where there is extensive contusion with unopened cranial wall. Though cures in such cases have frequently been proclaimed, yet, as Laugier remarks, where is the evidence that the brain was severely contused? The unopened skull conceals the true conditions; the peripheral manifestations probably gave an exaggerated report of the intra-cranial injury; and what was deemed a severe contusion, was probably only a slight vertical bruise. In fact, the surgeon has been misled by the absence of peripheral manifestations which are usually present; a few cases have been seen which ended fatally, in which the necropsy revealed some cerebral contusion in which the peripheral manifestations had been wholly wanting. It may be predicted that cases will end in death, in which there has been severe contusion of the brain, in which the injury has penetrated deeply, and the skull was not opened; and the escape from death can only occur through an opening made either by the causal injury or the surgeon's trephine. But in superficial contusion, recovery may, with a fair degree of certainty, be predicted.

Treatment.—Since the effects of contusion do not reveal themselves immediately, there is an interval in which preventive or prophylactic measures may be used; among such measures, one of the best in the plethoric subject is bleeding, done with the lance from the arm, or with leeches from the temples or regions lying over the emissaries of Santorini or trans-cranial foramina. Boinet, to whom reference has been made, recommends that the patient should be leeched behind the ears. The head should be covered with an ice-bag, and the patient should be restricted to low diet, and the bowels well emptied. In this way the development of inflammatory symptoms may be prevented. Still, if the contusion be severe, and has penetrated deeply, these primitive measures will fail to accomplish this purpose; chills, fever, increase of heat, and the general symptoms of encephalitis, will appear about the fifth or sixth day, and portend great peril to the patient's life. Should these symptoms increase in gravity, then, at an early period, taking a lesson from the favorable course which is often seen where the wound is an open one, the surgeon

would be justified in using the trephine and making an opening to the contused structure, which is probably in process of suppuration. For this object, a small opening will suffice, and when made, the membranes if closed should be incised, and a free exit provided for pus and other disintegrating material; thus doing, the surgeon would open a door for the escape of a patient who, otherwise, was certainly destined to die.

CHAPTER VI.

ENCEPHALITIS, OR INFLAMMATION OF THE BRAIN.

PURE inflammation of the brain is a morbid process which is first concerned with the interstitial structure; next, the vessels become accessorily, or secondarily, affected. In paralysis in which there is found change in the cells and their nuclei, the condition is not an inflammatory one, and hence it is claimed that a parenchymatous inflammation, in which all the elements of the brain are involved, does not exist. Though, in nosological nomenclature, the terms encephalitis, cerebritis, and cerebral and cerebellar inflammation, are in use, yet it must be admitted that a purely isolated inflammation of the cerebrum or cerebellum cannot exist; the investing membranes must, also, be involved in an inflammation; hence the name meningo-encephalitis is often used to designate the disease; and when the development and cause of the disease are studied, since the membranes, especially the pia mater, are the first to be affected, the most rational name for the disease must be one in which there is reference to all the structures implicated in the inflammation.

Causes.—The chief causes are traumatic, in which the brain is directly injured. Examples of these are falls upon the head, or blows on the head; and in each case the cranium may or may not be broken. When there is no fracture, the inflammation can arise from both contusion and concussion; it can be caused by compression in which the in-driven wall injures the part against which it presses. Or the wall may be broken into fragments, of which one or more pieces wound and inflame the brain. In open wounds of the scalp coëxisting with comminition of the bone, fragments of the latter can be forced into the brain, and soon awaken an inflammation, which, local at first, soon involves adjacent parts.

A frequent cause is caries of bone forming a part of, or adjacent to, the cranial cavity; the bones most liable to such disease are those forming the upper and deeper portions of the

nasal fossæ, and also the mastoid and petrous portions of the temporal bone. According to Toynbee, the location of the disease in the auditory region determines the point of attack upon the brain; namely, when the external auditory canal is affected the disease is more apt to pass to the cerebellum. Affection of the tympanum oftener awakens cerebritis, while if the caries be located in the labyrinth the inflammation oftenest passes to the medulla oblongata. Other observers have met with frequent exceptions to the rules of Toynbee here stated.

According to the researches of Hayem, the inflammatory process pursues the same course in the structures of the brain as it does elsewhere. There is a proliferation of the constituent cells, and a structural development of which the component element is the embryonic or granulative cell. The terminations are similar to those of inflammation elsewhere, viz., suppuration or granulative tissue, which may end in a cicatrix. Or the process may recede through the vanishing of the hyperæmia and dispersion of the new bone-cells.

Encephalitis, when it assumes the hyperplastic form, may be diffused or circumscribed in character. The diffused form may involve a large part of the brain. This form is often seen in infants, and then does not fall within the domain of the surgeon. In the circumscribed form the hyperplastic product is limited to a small space. This form of the disease has rarely been seen.

The suppurative event of encephalitis may appear in three different forms, namely, purulent infiltration, abscess with infiltration of the adjacent structure, and, thirdly, circumscribed abscess.

It is seldom that one has an opportunity of observing in man's brain the condition of the parts which precedes the formation of pus; the most that is known has been learned from experiments that have been made on animals. If the brain of an animal be locally irritated, there will be observed a multiplication of cells, which spring from the stroma, named here neuroglia, of the brain. This cell growth is preceded first by a tumefaction of the cells of the wounded stroma. A similar action occurs in the constituent cells of the walls of the vessels. As the process advances, the new cells are infiltrated into the intercellular substance. Nucleated cells appear free or detached, and these are pus-cells. As occurs on the surface of the body in an inflamed structure, so here we have an exuberant development of cells, the most of which, not being organized, aid in the generation of pus; and these cells arise in part from the neuroglia, and in part through emigration from the vessels.

When the event is abscess, this is situated most frequently in the white matter of the brain, and it is found oftenest in the cerebrum. Still abscess has been found in the cerebellum, also in the pituitary body, and in the medulla oblongata. The abscess may be multiple or single. When multiple the volume is smaller than where but one exists. At first the containing wall is irregular and softened; later, a cyst-like wall is formed. The abscess may remain quiescent without change for a long time, or it may burst into an adjacent ventricle, or open on the surface of the brain; and in this change of site it can awaken an inflammation in the parts with which it comes in contact. An unusual event of such abscess is that it may ulcerate through the cranial wall and appear under the scalp. Such pus has opened into the aural cavity. In case the abscess becomes encysted, some months are needed for the formation of a firm containing wall. The pus cavity may contract through change in its contents. The pus does not putrefy or acquire an ill odor unless it comes in contact with the air.

Symptoms.—Inflammation here, as elsewhere, changes without abolishing the functions of the affected structures. And as the result of an increased supply of blood, the earliest change is functional exaltation; and as the inflammation exists in varying grades of intensity, so there are variations of excitation, from that which is scarcely apparent to that which is an entire perversion of the functions of the part. To formulate a description which will comprise the different phases of functional perversion is difficult, if not impossible; and this could hardly be otherwise when we consider the diversity of causation. For example, the presence of the inflammatory tract, or the continuance of the primarily exciting cause, will determine œdema or congestion in the parts contiguous; a serous effusion into the ventricles may thus arise; thence various shades of functional disturbance arise, which become mingled with those previously existing.

An antecedent, or milder stage, usually precedes the full development of encephalitis. In this period, which may be called that of congestion, the patient is disturbed with obstinate headache, vertigo, giddiness, and sometimes difficulty of speech; often the pupils are of unequal size; the face is alternately red or pale; sometimes there are spasmodic, jerking movements of the muscles of the limbs, face, and eyes; sometimes contractions and strabismus; there may likewise be disturbance of general sensation. The patient may have the feeling of formication and heaviness on one side of the body.

The symptoms mentioned gradually augment in intensity, and the disease soon appears in its full proportions. In a few exceptional cases the disease assumes the form of apoplexy, the patient losing entire consciousness; yet usually some consciousness remains, and the patient is capable of being aroused. The relaxation of the body is incomplete, and the limbs do not remain wholly motionless and passive. Instead of passive relaxation of the limbs there is often present in them some rigidity. In fact, such stiffness is one of the most common accompaniments of encephalitis. This rigid state, called contracture, may be limited to a small number of muscles, or it may occupy one-half of the body. Contracture may appear primarily, or it may be preceded or accompanied by convulsions, and in these cases the medulla oblongata is probably implicated in the inflammation. The convulsive action may recur rhythmically, or it may assume an unmeasured action similar to chorea. Paralysis may affect both sides of the body; and so may contracture. Palsy is seldom seen at the beginning of encephalitis.

The disturbances of intellect present endless variety. There may be only a slight exaltation, or delirium in its wildest and most acute form may be among the earliest manifestations of encephalitis. The mind may be tormented by illusions, in which the normal sensory impressions are wrongly interpreted. There may be hallucinations of sight, hearing, and taste. Faces and objects well known are not recognized, and familiar things are transformed into demons and other objects of fear. The ear may hear sounds which are wholly imagined; familiar sounds may be transformed into those which are humorously unnatural, wildly incongruous and monstrous. There are deceptions of taste. The patient may spit from his mouth what he conceives to be some foul or unnatural material. And the sense of smell, also, may convey false messages; that is, the eye, ear, nose, and tongue may carry false reports from their respective quarters. In short, the unfortunate subject has lost all natural relation to his surroundings, or, summed up briefly, the acts of mentality of the subject are those of misinterpretation or falsification; and the conditions in some way or another are similar to those which the alienist would name insanity.

There is an increase of heat in the commencement of encephalitis; the heat rarely rises above 103° Fahr. The pulse is frequent, and is sometimes unequal and irregular. One of the earliest and most constant symptoms of commencing encephalitis

is nausea and vomiting; the patient, at first, vomits any materials which may have been recently swallowed; then in limited quantity gastric mucus is expelled, and soon afterwards bile is vomited. This is often vomited in such large amount that it is probable there is some connection between the encephalic inflammation and the generation of bile. This constant vomiting has a tendency to augment the congestion in the head and to promote the development of the disease there. The emptying of the upper part of the alimentary canal, by lessening the content there, becomes the cause of the constipation, which is a constant accompaniment. There is also retention of urine; the inaction of the bowels and bladder may be due to contracture of the parts, as some authors have suggested; the writer, however, thinks fæcal and urinary retention is rather referable to the patient's mental perversion, in which he forgets to obey the summons of functions of which the accomplishment in normal health depends on active volition.

The primary period of encephalitis, of which the leading features are excitation and increased action, is succeeded in a few days by depression. The excitable and acutely active mind becomes obtuse and torpid; vision becomes dull, and the eye is no longer annoyed by brilliant light; the ear scarcely heeds sounds and is no longer disturbed by those which previously pained it; and so the other senses have become obtunded, and all have fallen asleep, as it were, at the portals where they previously received messages for the mind.

In this stage the patient soon falls into stupor; there is both retention and incontinence of urine; that is, the palsied bladder overflows and, instead of the excessive and violent movement of the muscles which required force of nurses to prevent the patient from injuring himself, he becomes partly or wholly palsied; the temperature soon rises to the highest abnormal limits; the eyes and face are suffused with redness approaching to a cyanotic tint. The pulse becomes small and irregular; the breathing lapses into irregularity, and sometimes it is temporarily suspended. The symptoms named precede and indicate an early fatal termination.

The duration of the disease varies greatly, and this depends on whether or not the disease implicates the portions of the brain which are specially the centres concerned in the maintenance of animal life; such centres are found in a limited region at the base of the brain, and particularly include the medulla oblongata.

Life may continue for weeks, as the author has witnessed several times, when the inflammation is chiefly limited to the anterior, posterior or lateral portions of the brain. On the other hand, the disease may run a rapid course, death occurring within a few days. Encephalitis may have a uniform course; or remissions of intensity and moderation may alternate with each other; also symptoms of depression and exaltation may be concerned, due to gradual involvement of parts adjacent to the primary focus of inflammation, and then the disease proceeds in such a manner that the inflammation does its destructive work at the site of commencement; meanwhile, in contiguous parts it is in process of early evolution. In this condition there may coëxist palsy of some muscles and spasmodic movement of others; or, as the author has seen, there may be irregular motion in one-half of the body, while the opposite side lies in passive hemiplegia; one pupil may be contracted while the other is dilated.

The disease sometimes has a chronic development, and then its changes are only apparent when some days, or perhaps weeks, have elapsed; in such a case the patient emaciates; there is occasional nausea, and food is ill tolerated; life may continue thus for months, and an autopsy finally reveals those changes in the brain which are produced by encephalitis; probably one or more foci of pus may be discovered, and elsewhere on the brain cicatricial changes may be found; since here, as in almost every case of morbid action which continues for some time, a close inspection of the part affected reveals the fact that there has been an attempt at repair, and which is often complete, so far as a limited portion of the affected part is concerned.

Encephalitis arising from a traumatic cause, or from disease of some portion of the cranial wall, remains isolated for a time; finally pus is developed, though so latently that it may not be suspected, if it does not involve some part of which the functional impairment is apparent; yet such unsuspected pus after a long period of latency may burst its containing walls and pass into the lateral ventricles; and such event is heralded by convulsions, from which the patient sinks into a coma, which may be terminated by a sudden or a lingering death.

Diagnosis.—There is some resemblance between encephalitis and the conditions which accompany rupture of a vessel and softening of structure. Yet in encephalitis there are signs of congestion early in the disease which are absent in the other two conditions. There is always an augmentation of temperature in

an inflamed brain, but in case of vascular rupture and softening, the temperature does not rise, but it may sink to less than normal. Contracture is more frequent in encephalitis, and it often persists for some time; it is less frequent after rupture of a vessel. In encephalitis there is a constant progress from bad to worse, but in case of softening and vascular rupture, there often occurs at an early period an amendment in the symptoms; tolerance of the condition is frequently seen. When the inflammation is purely meningeal, the temperature rises high, and the functional disturbances are marked by more acuteness and intensity than is the case in simple encephalitis.

Pus, the result of an encephalitis, can become encysted and then remain inert, and exert, for an indefinite time, almost no action on the brain; and even then, should it suddenly burst and cause apoplectic symptoms, the true nature of the condition could not be diagnosticated, since such apoplectic attack might result from a tumor encroaching on the brain. That it is pus might be inferred from the antecedents, viz., if there had been an otic caries, or one about the orbit or nose, then there would be satisfactory proof that pus, and not a neoplasm, is the causal agency.

As a brief summary of the diagnostic signs of encephalitis, the following may be offered: Temperature abnormally increased; acceleration and irregular pulse; pupils contracted or dilated according to the stage of the disease; twitching, spasm or contraction of the muscles, and perversion or alteration of mentality.

From the author's observation, inflammation of the brain occurs much oftener in the male than in the female, and in the latter the writer has seen cerebral and hysterical trouble so commingled that it was impossible to arrive at absolute definiteness in the diagnosis. In a young female who was the subject of hysteria, he saw encephalitis suddenly develop, and the hysterical symptoms continued so prominent that the real nature of the disease was not suspected until it had nearly reached its fatal termination. And in a second case, which originated in mastoid caries, the young woman sank into fatal coma before the nature of the disease was apprehended. Hence, to the conspectus of symptoms just presented should be added the precautionary mention, when the subject is a young woman, that encephalitis may be masked, obscurely veiled by, or commingled with, hysteria. In such a patient, elevated temperature would indicate the cerebral inflammation.

Prognosis infausta, or an inauspicious prediction, may be given in respect to most cases of inflammation of the brain; the

inaccessibility of the parts, and the important offices which they perform in the maintenance of animal life, have long since, even with the layman, caused this inflammation to be regarded as a matter of the greatest peril. Death, as a rule, is the end, and should the case not terminate in death, recovery is sometimes not a blessing to the patient, since there may remain some perversion of intellect, of the power of motion, or of special and general sensation. Of these contingent sequences the most disastrous is the partial or complete loss of intellect which encephalitis may entail. The individual may afterwards remain changed both in his reason and in his emotional nature; and the possibility of such change remaining as an entailment renders life of little value to the patient.

Treatment.—Encephalitis may end by resolution, in which there is complete recovery, the effused or newly formed material being wholly removed by absorption; or the disease may end by absorption of some of the material effused or formed. The structures of the encephalon then remain somewhat changed from their normal condition. There are alterations slight or extensive, through cellular neoplasm; and, thirdly, the new formed or effused material may die, a condition fatal to the patient in nearly all cases, unless relief be furnished by the surgeon. Of these three endings the first is the desirable one, and treatment to accomplish this should be diligently pursued. The elements which maintain the inflammation and, when morbidly changed, become instrumental in destroying the patient's life, are primarily derived from the blood.

The indications of treatment are to secure resolution, if possible, and, failing in this, to avoid the fatal ending by promoting and obtaining partial absorption of the material which, if unremoved, destroys life. These indications are fulfilled by lessening the supply of blood to the brain. The patient should be bled early, freely, and to the utmost limit of tolerance, and this abstraction of blood should be done with the lancet, and not by leeching or cupping. A vein in the arm should be opened, and while blood is flowing the pulse in the other one should be observed, and the flow should continue until the pulse becomes attenuated and feeble. In this work the patient should have the head elevated, so that if signs of approaching faintness appear, the head can be lowered and syncope averted.

The amount of blood to be drawn is better measured, as just said, by the impression on the pulse than by the amount drawn.

Yet, as a general rule in the robust subject of full habit the withdrawal at one bleeding of from thirty to forty ounces is safely borne. If this is followed by lowering of temperature, and the subsidence or disappearance of the general symptoms of exaltation, then it will not be necessary to resort to depletion again, since there is a fair probability that the inflammation has been overcome, and that recovery through resolution will ensue; if not entire resolution, at least dispersion of so much of the new-formed material that the remainder will be tolerated. But if the depletion is found not to have accomplished this, it must be repeated, and a quantity of blood again removed until an impression is made on the heart. As collateral aids in combating encephalitis are cathartics, sudorifics and diaphoretics. As a purgative calomel will act well; so, also, the saline aperients which in their action abstract fluid from the intestinal wall. As a diuretic and alterative the iodide of potassium acts effectively. To act on the skin pilocorpin in small doses may be used; full doses of this wonderful agent depress the heart too much. This is avoided if the pilocarpin be given in doses of one-eighth of a grain, repeated every eight hours. The author, in accepting this internal medication as an ally, will say that it is but dust in the balance when weighed against venesection. Internal remedies may be likened to arrows discharged over the wall of a besieged enemy, which fall aimlessly. But venesection acts as does the besieger, who deprives the enemy of his means of sustenance, and in so doing soon conquers him.

But this treatment may fail of its purpose. The inflammation then ends in suppuration; pus is developed as the final event of the encephalitis, a not unfrequent ending of the disease, whether of traumatic or other origin.

If pus develops as the result of a traumatic encephalitis (the form which is here being considered), the purulent matter may be situated between the skull and the dura mater, between the dura mater and the brain, or it may be lodged in the viscus. The pus may be collected within a circumscribing wall, in which there seems to have been an effort on the part of nature to isolate the morbid matter and protect the adjacent brain from it. Or the purulent fluid may be diffused and widespread as a thin stratum, the morbid material traveling in the directions in which it meets the least obstruction. The pus in this latter form is found between the dura mater and the brain, probably because this situation is more favorable for diffusion. The anatomical conditions here are unsuited to adhesion and occlusion.

Pus situated between the skull and dura mater is, from its site, necessarily small in amount. It is commonly but imperfectly circumscribed. The color is greenish, and the bone over it has a similar tint and presents the first signs of necrosis, and if the case has continued long, the bone is slightly eroded. Between the dura mater and the brain the pus is yellowish, and is closely adherent to the membranes subjacent. But if the purulent matter be developed in the substance of the brain, such collection is circumscribed, and may be in large or small amount, and has the characteristics of an abscess. Such abscess, which may be designated cerebral or cerebellar, according to its site, has been seen in all parts of the brain; and when in the cerebrum it may occupy one or both hemispheres; and in this situation the pus often bursts into the lateral ventricles. The amount has been so great as to convert one hemisphere into a capsular envelope; or it may occupy the upper part of one or both hemispheres, and have a portion of the cranial vault as its covering.

As stated before, the desirable ending of traumatic encephalitis is resolution complete, or nearly so, of the products of inflammation. The worst event is suppuration, since recovery is impossible without evacuation of the dead material, and, though this may be done by the hand of nature, yet this is rare. Art may essay to do it, and some progress has been made in this direction since modern surgery has claimed the interior of the skull as a field for legitimate work. Such cases unaided have recovered by the pus finding an outlet through an opening formed by the fracture, or the material may be near some naturally perforated portion of the cranial wall, and there find egress. Thus through an opening occupied by an emissary of Santorini, in the parietal, frontal or temporal region, pus may find a path for emergence. Again, such pus lying near the base of the skull, as the result of counter blow, may be so imprisoned that neither surgical art with its daring nor nature with her resources can find a way of escape.

The presence of pus may be suspected where, despite the active antiphlogistic treatment above detailed, outward symptoms still continue; where there remains perversion, either in the form of exaltation or depression of intellect, motion or sensation. Symptoms of depression are the more usual, viz., mental torpor. Muscular paresis or palsy, or anæsthesia, or paræsthesia of some organ of the body, points to central trouble, probably from pressure due to a collection of pus. A significant symptom is a rigor and continued high temperature.

If these symptons, one or all, are present, the presence of pus may be inferred with sufficient probability to justify the use of the trephine or some procedure by which the material may be evacuated, and here two classes of cases present themselves: one in which the causal agency has been a fracture, and another in which the causal violence did not break the bone.

Where a fracture exists and is of such a character as to expose the dura mater, the condition of the latter may clearly point to the existence of pus near by; thus a brown, ashy or semi-necrosed appearance denotes lowered or vanishing vitality, and the probability of pus near by, and warrants, if the foregoing general symptoms be present, the opening of the dura mater, and if purulent matter does not lie contiguous, the cortical layer of the brain should be explored by means of a small trocar; and if pus be thus detected, the overlying structure must be freely opened, and the dead material washed out by gentle irrigation; and this irrigation may be repeated until pus no longer appears.

In the second case in which fracture is absent, and yet the general symptoms point to localized purulent material, an effort must be made to discover and evacuate it. For this purpose at the site of injury the scalp should be incised and the bone examined. As intra-cranial extravasation of blood when next to the wall reveals itself by alterations in the pericranial lining, so changes occur in this membrane when pus lies directly under the intermediate wall; for example, if the pericranium be discolored or is detached from the bone, then, beneath such site, pus is probably located. Also, along with looseness of membrane there will be discoloration of the bone itself; the latter will be brown instead of a pinkish hue; such bone will be in the first stage of necrosis. In such conditions of the cranial wall and its investing membrane, the trephine should be used, and a free opening made; and should pus then not be in view, an incision should be made into the cortical stratum of the brain; and if pus be discovered, the treatment should be similar to that pursued in the case of an opening made by fracture. Also should there be a fissure in the wall without other visible changes, the trephine should be used at that point.

There is another class of cases in which the surgeon is nearly or quite without guide; here there is no lesion or change discoverable in the soft parts, and the cranial wall presents no abnormal appearance; in such there is no guide for the localization of the pus except that the patient received a severe blow at some point

of his skull, and subsequently symptoms of suppuration have presented themselves. In this case, though the pericranium and skull be found intact, yet in the existing state the surgeon should resort to a procedure similar to acupuncture exploration. For this purpose a small incision is first to be made through the scalp; then an opening is made through the bone by means of a small drill; through this canal a small trocar can be passed, and the pus, if present, is thus detached. Should nothing be found when the dura mater is pierced, then the instrument should be passed into the superficial or even deeper structure of the brain. Should no purulent material be found at the point first chosen, then another aperture should be drilled near by, and then another, until pus has been discovered, or the search for it proved fruitless. If the pus be thus located, then a larger opening should be made with the trephine, and the work of emptying and irrigating be done, in the manner before described. If the exploratory procedure here described be done with aseptic precautions, should one fail to find pus, the injury to the parts will not be a serious one.

Tumors.—When the brain is studied in its earliest stage of development, it is found, according to the observation of embryologists, to originate in the epiblastic layer of the embryo. In accordance with such derivation one might expect that neoplasms originating here would conform in type to those originating in the cutaneous tissue; and, hence, an epithelial neoplasm might be inferred to have its origin here. In the great changes which this epiblastic structure passes through to become brain, the latter seems to inherit in a slight degree the tendencies to neoplastic perversion which are prevalent in the surface of the body.

Tumors of both the malignant and benign type are found in the encephalon. As examples of the malignant type there develop here, carcinoma, sarcoma and glioma. These growths, when they originate in the brain, proceed oftenest from the cortical structure.

Carcinoma may have its primary origin in the surface of the brain, in the dura mater, or it may arise from the inner face of the skull, and the growth, springing from any of these sites, generally develops centrally and excentrically. It may attain a great size.

Sarcoma occurs more rarely than carcinoma; in its mode of growth it is similar to cancer.

Glioma may be characterized as less heterotopic or foreign, in

its site here, than cancer or sarcoma; for its stroma is analogous to the skeleton tissue of the brain. It consists of a thin web-like tissue in which the constituent cells are contained, and the whole is remarkable for its softness and fragility; and, owing to this want of firm union of its elements, the glioma is subject to rupture and effusion of blood. Glioma sometimes contains fusiform cells, and then the growth is called glio-sarcoma.

The benign growth is rarely met with in the cranial cavity. Examples of this are the psammoma, the lipoma, and the angioma and dermoid growth.

The psammoma arises almost always from the dura mater. It is constituted of particles of sand connected together by films of connective tissue. The tumor resembles a mulberry in its surface, and may attain the dimensions of a small walnut.

The lipoma is rare here; yet it has been found at sites where there is normally a small amount of adipose tissue. Such sites are the optic chiasm, the pons Varolii and the raphe of the corpus callosum.

Angioma is found in the cranial cavity; it does not present itself in a form that would demand, or be suitable for, intracranial intervention. Should surgical treatment be required, the better plan would be to ligate the common carotid supplying blood to the tumor.

A case of dermoid tumor situated in the anterior portion of the brain was discovered in a necropsy made in one of the hospitals of San Francisco. Hair and other components of the dermoid tumor were found.

Syphiloma.—The syphilitic or gummy tumor appears within the cranium as the product of constitutional syphilis. This growth may arise from the dura mater, pia mater and the structure of the brain.

Secondary syphilis may appear either on the outer or the inner surface of the dura mater. When on the external side it appears as a slow inflammatory process, whence there is a growth of bone, an osteoma of small or large extent. But the syphiloma proper arises from the inner face of the membrane and grows toward the brain, and may attain dimensions varying from that of a filbert nut to that of a walnut. Such growth may encroach on a vessel and then, obstructing the flow of blood, it may cause softening or atrophy of a limited region of the brain. Or it may encroach on a nerve in its course, or it may lessen the diameter of a foramen, and in each case the function of the nerve is altered

or abolished. The growth may arise from the pia mater, and produce troubles similar to those just mentioned. And finally, the gummy tumor may originate in the tissue of the brain itself.

The syphiloma is of a grayish red color, and, on section, its interior presents yellowish spots; these have originated in caseous change of the growth. When in the brain the growth is often surrounded by a layer of translucent, colloid material. The growth may become casefied, and is then fragile; or it may become dense and resistant in structure, and become surrounded by a cyst-like membrane.

The gummy growth is most often found at the base of the brain; generally contiguous to the sella turcica, and then by pressure on the optic nerve, or on the motor nerves of the eye, such growth is the occasion of some phase of impairment of the visual apparatus. Besides being an agent of compression, the growth awakens inflammatory action, and thus localized paresis and excitation may coëxist.

A growth having some analogy to the syphiloma is one in which the constituent material is tubercular matter; in situation, aspect and form the two are similar. Yet the external manifestations which accompany such growths are entirely different, for in the one case, the rashes of syphilis are present; in the other, the symptoms of tuberculosis present themselves in some other part of the body; and the tubercular bacillus may be found.

Osteoma and chondroma may develop from the inner surface of the cranium and cause trouble through pressure on the brain or encroachment on nerves arising from it. Exceptionally, the osteoma has been seen to spring from the inner face of the dura mater, also from the surface of the brain itself.

Parasitic growths occur within the cranial cavity; the content, then, may be cysticerci or the echinococci. The cysticercus cyst may be situated in the central or superficial parts of the brain; it occurs oftenest in the convolutions. Such cyst, in multiple form, is found also in other parts of the body. The echinococcus cyst is found in or on the hemispheres, commonly but one or two in number. The parasitic cyst can attain the volume of a pigeon's egg. These cystic growths may cease to grow and their parasitic inhabitants die, and the content undergo fatty metamorphosis.

Symptoms of Intra-cranial Tumor.—The location of an intra-cranial tumor is a pathological problem which is often extremely difficult of solution; in fact, large tumors have existed without having been suspected, and were only discovered by necropsy.

And this may occur for the reason that certain encephalic structures are highly tolerant of invasion, whether this be from a growth, effused blood, or an abscess; such tolerance is possessed by the white structure in the commissures, and in the interior of the hemispheres. Tumors located at the base of the skull are distinguished from those arising at the sides or summit of the brain through causing functional disturbance of some of the nerves which arise from the base. Where indications of basial tumor are present, and yet there is no peripheral index of exact location, then among the possible sites which may be suspected is one near the body of the sphenoid bone, since the structures reposing on its intra-cranial, as well as its pharyngeal surface, in their primary development undergo great morphological transformation; and if located here the tumor would lie beyond the surgeon's reach. The writer is pleased to state that with the light which has been furnished by the recent revision of the chapters of neurology, the surgeon, aided by the physician, can often locate the intra-cranial tumor, and, if it be anatomically accessible, he is able to penetrate to and to remove it.

A general character of neoplasms of any type whatsoever, located in the skull, is slow and irregular growth, and sudden or paroxysmal appearance of the morbid phenomena produced by the growth. Such irregularity in morbid movement is referred to the appearance and disappearance of local congestion. In some instances the volume of the growth may lessen, as has occurred with the syphiloma.

The intra-cranial tumor is the cause of functional trouble arising from lesion or disturbance of the parts primarily compressed or acted on; also from disturbance of parts adjoining; and, lastly, functional alteration in peripheral structures. This functional disturbance appears in different forms; examples of it are spasmodic contractions, convulsion, augmented sensation, delirium, febrile reaction, localized palsy and coma. These symptoms are classifiable under two heads: excitation from increased supply of blood, and depression from anæmia due to compression caused by the growth. These phenomena usually occur in the order here described; yet there are many exceptions; symptoms of excitation and depression may be commingled, here due, probably, to multiple development; a large growth may compress parts, while another is in its initial period of evolution; and a single large tumor may compress subjacently and adjacently; it may cause an afflux of blood, and thus spasmodic contraction and paralysis may coëxist in adjacent peripheral parts.

The symptoms caused by intra-cranial tumor are not exactly alike in any two cases; the resemblances are only general. The most common symptom is headache, which may be diffused over the whole head, or it may be local, and when confined to the occipital region the lesion is probably cerebellar. It may be so acute as to awaken cries of anguish when intensified by sound, light, movement or vomiting. As a great part of the structure of the brain is insensible, the cephalalgic pain must be referred to lesion of the dura mater, of the crura and the pons Varolii. In such condition the patient is restless, peevish and easily awakened to anger; it is with difficulty that he sleeps and, when he does so, he is disturbed by frightful dreams.

Another common symptom is vertigo, arising from changes in the position of the body, in which the head is raised or lowered. In such vertigo the patient imagines that objects about him are whirling around him; or when lying on his bed, as in a case seen by the author, the subject fears that he will fall upwards, and to avoid doing so, he clings violently to his bed. In walking, the patient may suddenly become worse, and he may fall or be forced to support himself against a wall or other object.

Singular sensations are felt in the head; the patient fancies it will burst or that it is filled with fluid that moves; one patient had the feeling that his head was filled with bran.

These symptoms are usually concurrent with impaired intellect; if an intelligent patient, he observes that he thinks more slowly and with more difficulty than he formerly did; the attention can scarcely be fixed; facts committed to memory are incorrectly recalled; for example, the multiplication table or prose or verse once learned is inaccurately recalled. This clouded condition gradually merges into indistinct twilight of intellect, and this again into total mental darkness; oblivion, in which the subject divested of any psychical endowment lies in a torpid condition, with rectal and vesical incontinence.

Another symptom of such tumor is vomiting, which occurs when the stomach is full, and if empty, there is retching; assuming the erect position may arouse such action, which subsides when the subject is recumbent. Such is the case when the tumor presses on the cerebellum or the crura cerebelli.

Encephalic tumor at an early stage may cause epileptiform convulsions, which may come on instantaneously and cause the patient to fall. These attacks may recur often, and soon end life. Such convulsions appearing in the adult without other assignable causes should awaken the suspicion of tumor.

Limited contracture and localized hyperæsthesia, continued or recurrent, are symptomatic of encephalic tumor. The most unerring indication, however, is disturbed function of cranial nerves, especially when this is associated with hemiplegia. Physiological exploration, which in recent years has been so diligent in its work, has discovered that the cranial nerves have a cerebral as well as a nuclear origin. The nuclear origin is from a nucleus situated in the floor of the fourth ventricle, or in the pons Varolii. In this respect these nerves are so similar that a description of the facial nerve will serve for the history of the whole. Primarily, it may be stated that this nerve may be palsied by pressure on the same side as the palsy is; or this pressure may be on the side opposite to that of the palsy, as herewith is explained.

The facial nerve, having entered the bulb of the cord, proceeds to a nucleus located on the surface of the fourth ventricle where the bulb is just entering the pons; above and beyond the nucleus a radicle in the form of a band passes upwards into the brain. As is known, a tumor pressing on some part of a hemisphere causes hemiplegia on the side of the body opposite to the compressed hemisphere; and meanwhile the cerebral branch of the facial nerve may be so implicated that there will be palsy of the face on the same side as the general hemiplegia. But a tumor acting on the facial nerve beyond its nucleus, causes palsy on the same side as that on which the pressure is made. Thence it results that when multiple tumor exists there may be hemiplegia on one side and facial palsy on the other. It has been found that pressure on the cerebral radicle of the facial causes much less palsy than when the pressure is on the nerve near or beyond the nucleus; and such limited facial palsy concurring with a hemiplegia would indicate that the site of the tumor is in the cerebral or superior portion of the skull; but a facial palsy on the side opposite a hemiplegia might denote multiple tumor, one above, and one near the base of the skull pressing on the facial, and which is situated on the same side as the tumor above.

Several cranial nerves are often implicated at the same time, and as each has a nuclear origin, the resultant paralysis will obey the laws just mentioned as obtaining in the case of the facial. Vision is often disturbed by an intra-cranial tumor, and such a symptom would be perceived by the patient at an early stage. A tumor acting on the tubercula quadrigemina may cause partial or entire blindness. Pressure on the cerebellum

causes feeble vision; for this no explanation has been given. The auditory nerve may be acted on, yet impaired hearing is seldom thus caused; more often there is awakened some subjective sensation, such as ringing, roaring, buzzing, etc. The sense of smell is seldom disturbed by an intra-cranial growth.

In some cases the encephalic tumor does not impair the nutrition of the patient; he may even improve in flesh. On the contrary, should there be nausea, vomiting and other depressing conditions, the subject may become emaciated. If the tumor be cancerous in nature, then the usually attendant cachexy may soon appear, and greatly reduce the patient's body.

The tumor may perforate the cranial wall, and then it usually makes its appearance through one of the natural openings of the skull, as at the orbit, or the upper part of the nasal fossæ; or it may perforate the wall and uplift the scalp. Such perforating tumor may be hard or soft. The protruding portion may pulsate with the pulse, and sometimes it rises with expiration. If pressed on, coma may result. The appearance of the tumor through the cranial wall is attended by diminution of compression and, hence, an amelioration of the symptoms caused by compression.

The course of intra-cranial tumor is usually of long duration, and it is characterized by remissions, accessions, and exaggerations of the symptoms; a course in which there is an absence of uniformity. Death comes in many cases from palsy of the medulla oblongata.

The prognosis is extremely unfavorable; the greater number of intra-cranial tumors end fatally; the exception is where the tumor is of syphilitic origin. Tumor from this cause, in its early stage, if not curable, at least is controllable. The cancerous and aneurysmal tumors destroy life; yet the time in which the tumor does its fatal work depends greatly on its site. The rule concerning this is that growths located in the upper part of the cranial cavity are tolerated much longer than those in the base. A tumor pressing on the medulla oblongata, or the pons Varolii, does its fatal work swiftly. The prognosis of the syphilitic tumor, if the case be seen early, is favorable; but if the syphiloma be allowed to develop without treatment, it encroaches on and occasions lesions of the contiguous parts, which sometimes are irreparable.

Treatment.—Until recently the intra-cranial tumor was combated chiefly by internal medication, and this treatment was

limited to remedies which merely relieved symptoms, and mainly that of pain. Pain was controlled by the use of opium and other narcotics. Treatment which aimed at a cure or removal of the cause was only pursued with hope where the growth originated from constitutional syphilis.

To relieve the headache morphia in a third of a grain doses should be given and repeated every six hours, or in larger doses if the dose mentioned does not give relief. The alkaloid of hyoscyamus may be used, viz., one-sixtieth of a grain of hyoscyamine may be injected hypodermically; thus sleep may be obtained when morphia fails. Atropine in similar amount may be used hypodermically. Aconite may be used; the fluid extract may be used externally, or an ointment or solution of the alkaloid aconitine. A weak solution of the cyanide of potassium may be used externally over the focal point of pain. The headache may be palliated by the local use of ice. As anodyne remedies these may be administered: the bromide of potassium and the tincture of gelsemium.

As mentioned before, the only hope of curing by internal medication is where the tumor is the product of syphilis. Here the administration of the protiodide of mercury, one-half grain three times daily, will not only arrest the development of a syphiloma, but favor its absorption. With this agent the writer has obtained the most satisfactory results; intellect on the verge of imbecility has been restored to normal state; a staggering walk has been changed to a steady gait, and vertigo relieved. The remedy, however, must be commenced as early as the cephalic symptoms manifest themselves. For the same purpose Hydrargyrum cyanuretum may be used with benefit. To use this, prepare a solution as follows:—

℞. Aquæ .... .ʒi
Hydrargyri cyanureti ....gr x
Misce.

Inject this hypodermically, commencing with five drops, and increase the dose to ten drops. Ten drops, the maximum dose, will contain about one-sixth of a grain of the salt. This compound of mercury has been found by the writer to act more efficiently than any other. The gummy nodule in iritis is sure to literally melt away before this treatment, and in case the tumor be cancerous this treatment promises some relief in retarding growth. The writer has verified that this is so in cancerous growths seated on the surface of the body.

As known, within the last few years, surgery, emboldened by the success attained by the antiseptic method, has invaded regions hitherto untouched by instrument; the cranial cavity is fearlessly laid open, and disease once impregnably entrenched there, is exposed, attacked, and sometimes removed; it must be said with some reserve, *sometimes*, since surgical aggression here has more often been attended by defeat than success. Yet, when the fatal character of the intra-cranial neoplasm is considered, great risk in the adventure is justifiable; and should failure, coupled even with the death of the patient, be the result, it may be reckoned as a gain to the sufferer; for what human being would not prefer death to life coupled with dementia?

The rule of procedure should be to first determine whether the growth is so located as to be accessible; namely, if at the summit or the sides of the brain, it can be reached by means of the trephine, saw, chisel and mallet. Or, as a preliminary, the wall may be opened by the exploratory drill mentioned before, and a small section of the subjacent soft part withdrawn and examined microscopically. Guides to location are to be found in the affection of speech, motion and sensation. By means of the saw, sections of the wall may be uplifted on a large scale; and the dura mater being opened, the surface of the brain can be seen, and a neoplasm discovered, can be removed; and the growth being extracted, the uplifted osseous bridge can be lowered to its former site. Should the growth be a cyst, or benign in nature, it would be possible to thus cure the patient. Where the growth lies in contact with the base of the skull, that is, springs from the inferior surface of the brain, conservation would pronounce the word *inaccessible.* This warning, however, is quite unheeded by the *gens audax omnia perpeti;* for example, by such as announce that they think operations for the removal of tumors from the base of the brain are feasible; such daring characterized a specialist in cerebral surgery, whom the writer heard say that he believed it possible to so open the skull and lift up the brain as to catch a view of the foramen magnum. The reader may ask, Did he mean this of the living subject? The well-known inefficiency of medicine against these growths in nearly all cases, has lured on the surgeon's hand, and encouraged and emboldened work here which elsewhere should not be permitted. For death is a cheap price with which to purchase exemption from helpless palsy and hopeless amentia.

The operative course advised by Horsley, Macewen, Keen,

Lanphear and others to be pursued in the removal of a meningeal, cerebral or cerebellar growth is to select the part towards which the diagnostic indices point convergingly, and there to remove, by means of the trephine, saw and chisel, enough of the cranial wall to reach and uncover the tumor; and, having exposed the growth and determined the connections, the surgeon continues with the removal, at which work vessels must be avoided or ligated if they be opened. Macewen fearlessly attacks the dural sinuses; and finally the wound made in the scalp and dura mater must be closed by sutures, a drainage tube inserted, and the part covered with aseptic lint, and retained cold by a thin ice-bag. By the perseverance of the treatment here briefly indicated, an occasional patient may be cured; the majority, however, will probably fall by the wayside.

Meningocele and Encephalocele.—By meningocele is implied a protrusion, hernia-like, of the encephalic membranes through an opening in the wall of the cranium; and the content of such tumor is cerebro-spinal fluid; but if the content be cerebral or cerebellar, then the tumor is named encephalocele.

Some surgical authorities, for instance, St. Germain, deny the existence of uncomplicated meningocele; on the contrary, others, as Spring, as determinedly contend for its existence.

Encephalocele may appear congenitally; more rarely, it is acquired; a few examples of the latter have been seen, in which some defect of the cranial wall, due usually to a wound, permitted the escape of the adjacent meninges, along with a portion of brain. Such hernial protrusion has appeared where a portion of the containing wall has been removed; the membranes with fluid and a portion of brain have protruded, and afterwards the protruded brain receded and the patient recovered.

More often the case is congenital, and from its containing a portion of brain along with the meninges which cover this, it is properly named meningo-encephalocele. The site of such tumor may be frontal, orbital, occipital and basial.

The frontal tumor is rarely seated wholly in the os frontis; more often it appears between the frontal and nasal bones.

The orbital variety presents itself behind the eyeball, near the lachrymal bone, through the sphenoidal fissure, or at the spheno-maxillary fissure.

When occipital in site, it may contain the posterior cerebral lobes, or the cerebellar lobes; or the tumor can contain both cerebral and cerebellar lobes.

When basial in location, the tumor may traverse the ethmoid bone, the body of the sphenoid, or it may traverse the temporal wings of the sphenoid bone.

The meningo-encephalocele is composed of the following constituents: There is a cutaneous wall, in which the skin is thin and the hair partly or wholly disappears. This may inflame and open. Beneath this lie the aponeurotic structures in attenuated form, thicker in the occipital variety than in others. The next structure is the dura mater, which may present an irregular surface, stretched and uneven, from elevations and depressions. This membrane may contain a section of a sinus. The arachnoid membrane that is protruded, continues its serous secretion, which may be so large in quantity as to form a cyst-like structure. The prolapsed portion of brain may be altered in character; and if it be a part containing a ventricle, the latter may be much distended.

Spring and others think the primary cause is encephalic dropsy; and the part is protruded through some abnormal or accidental opening in the wall. Others refer encephalocele to hypertrophy of the brain. The tumor is sometimes transparent, and its content can be caused to fluctuate. When the protruded part contains a ventricle, the latter may be swollen with fluid, and a layer of fluid exist between the cerebral structures and the meningeal wall.

This tumor has commonly a disastrous course, and the life of the subject usually ends in a few years, and this depends on the fact that the tumor continuing to grow, morbid changes in the nerve centres are induced, which soon destroy life; such patients have reached the age of from seventeen to fifty-five years; yet they usually die much earlier.

Encephalocele has been mistaken for a benign tumor, and an operation on such encephalic growth done inadvertently, has caused death. A distinguishing characteristic is that such tumor may be reduced in volume by compression, yet the pressure causes coma, nausea, convulsions, etc. It need scarcely be remembered that diagnostic verification by such pressure must be done with much care.

The prognosis is, in all cases, inauspicious; and more so in proportion as the tumor is larger in volume; when small as a walnut, possibly a cure might be obtained; but when of enormous size, in which the volume of the tumor almost equals the remainder of the head, an early fatal ending is the only possible event.

The latter cases, which fall within the domain of Teratology should not be interfered with, but left to the care of nature, whose hand having illy molded them, soon finds a way to remove them.

Treatment.—As stated, it is only when the tumor is of moderate dimensions that it becomes a proper subject for surgical treatment; and this may consist of one of the following plans: Simple aspiration, aspiration combined with compression, compression alone, ligation, or excision. Aspiration is the simplest and safest of the several plans here enumerated; and if it be often repeated, possibly a cure might be accomplished by it if the tumor be a small one. The plan is rendered more effective if along with the aspiration there be combined compression; for this purpose a compress may be maintained over the part by means of an elastic band or bandage, or a truss-like appliance may be employed, or the treatment might consist of simple compression of the tumor maintained by one of the plans just mentioned. The tumor has been removed by ligation, by which it is tied tightly around its base, and the part beyond being strangulated, dies and is detached. And, lastly, the removal has been done by excision of the protruded part.

The report of the results obtained by these several methods of treatment is unsatisfactory; a majority of the cases died. In view of this, the writer would hesitate to choose any of these plans, and were he called to treat a case, his course would be as follows: After making an incision by which the protruded parts could be inspected, let the prolapsed brain be restored to place and the wound be so closed as to retain the brain in its normal site. To aid in this work, a compress should afterwards be retained over the part; such pressure should be maintained both during the time of healing, as well as some time afterwards.

Hydrocephalus.—In early embryonic age the cephalic terminal protuberance is a simple capsule of water; the watery content is gradually displaced and replaced by parts constituting the normal brain; and remnants of these primordial water-cavity are the ventricles of the brain. From disturbed equilibrium of the forces contained in development, the watery content may acquire the ascendent, and the morbid condition called hydrocephalus, or better named hydrencephalus, results. The causal agency which disturbs the balance of normal development is thought to be an inflammation. As it is sometimes coincident with tubercular heredity, the causation is referred to tubercular affection of the cephalic membranes. As the fluid is

formed within the residual cavities or ventricles of the brain, it may also be designated ventricular dropsy. The disease usually is congenital, dating from an early period of intra-uterine life; yet it may commence and develop after the birth of the child. Hydrocephalus developing in utero may attain a great size, so that the child cannot be born without lessening the volume of the head; in such cases, if the head does not spontaneously burst during labor, the accoucheur is often compelled to tap the head and thus reduce it to a smaller volume.

Writers on this subject have mentioned numerous causes which may predispose to the disease; among these are the following: Great age of the child's parents, their abuse of alcoholic drinks, excessive sexual indulgence, compression of the abdomen during gestation, and compression of the child's head during delivery; these things mentioned have probably but little influence in originating hydrocephalus; more probable causes are disturbance of the circulation in the fœtal head, for example, some agency which prevents the ready escape of the venous blood, and, as a consequence, the serous formation predominates, and arrests the normal evolution of the brain. Where cretinism is endemic, hydrocephalus appears in the offspring as the alternating disease. In a cretin family several successive children have had the disease. Transmitted syphilis has probably been a frequent causal factor, the gummy growth awakening an inflammation in the membranes; or such growth may impede the return of blood along the venous routes.

The quantity of the hydrocephalic fluid varies according to whether it is formed before or after the ossification of the cranial bones; before the completion of ossification the quantity may become very great, amounting sometimes to over twenty pounds of fluid; but the quantity is small, if it be formed after the bones are ossified. Examples of enormous hydrocephalic enlargement are to be found in pathological museums; in the collection of crania made by Retzius, at Stockholm, the writer saw a specimen of marvelous dimensions, greatly excelling anything of the kind seen elsewhere. The fluid content of such head is remarkable for the small amount of solid content; this content, albuminoid in character, amounts only to one or two parts in a thousand.

The ventricular cavities of the brain in the hydrocephalic subject are found enlarged; the dividing walls between these cavities are attenuated, and sometimes torn so that they become one common space; thus the lateral ventricles may present

one single cavity. The covering of the lateral ventricles may atrophy until, finally, they assume the form of a cystic cavity; the upper thin wall of this being ruptured, the flattened remnants of the hemispheres entirely differ from normal form, and, on their leveled upper surface, one finds no trace of the third ventricle; the striated bodies are also compressed into flattened shape. The deformed cerebral matter is histologically changed.

Sometimes the development is limited to one-half of the head; as a rule, however, the entire head is involved, and then the enlargement is principally in the frontal and occipital regions. The forehead, in height and breadth, is such as would have delighted the eye of a Gall or Spurzheim, whose ignorance of anatomy would have permitted them to mistake water for brain. The excessive growth of the frontal bone encroaches on the orbit so that the supra-orbital arches are pressed downwards, the palpebral slits are narrowed and the eyelids are rendered œdematous. The temporal fossæ are effaced. The face is strikingly small when compared with the overlying head; and though it is natural in form and outline, the countenance of the child is remarkable for the utter effacement from it of all the lines of ordinary intelligence; the usual mental light belonging there has been extinguished, so that though the pathologist's eye may be delighted in the morbid and atypical which are present, yet the parent scarcely finds interest in the picture of his demented offspring. The bones of the skull, especially those of the cranial vault, become thin until they are as flexible as parchment and are separated by large interspaces; but if the subject survives for some years, ossific centres appear in these spaces, and developing as Wormian ossicles, they finally complete the osseous case. The auditory meatuses are shallow from the crowding outwards of the middle ear.

Hydrocephalus is often associated with other deformities, such as spina bifida and harelip, each referable to a common cause, viz., arrested and ill-directed development.

The child may be born with the head apparently normal, and soon after birth, the head enlarging, especially in the frontal region, gives signs of hydrocephalic change. And, later, the child shows dullness of intellect; the nutritive functions are illy accomplished; the gustative sense is impaired or lost, since the child swallows with equal indifference ill-tasting matters or proper food. The arms and legs are retarded in their growth and are moved sluggishly or awkwardly, or they may be the subjects of spasm or contracture. Should the patient learn to walk, the

gait will be hesitating and uncertain. Sometimes there are epileptiform or jerking movements of the limbs. The eyes do not act in unison, but often move divergently. Vision and the other special senses are impaired, as might be inferred from the morbid changes in the brain.

The disease is ordinarily chronic in its course, which may be varied by sudden exacerbations; from paresis of the limbs the subject may be forced to lie in bed; and epileptiform attacks may supervene. Or should the dropsical fluid cease to form, the subject may so far improve in general condition that he may live for many years, though he remains the subject of arrested or obtunded intellect. In the worst cases, the fluid continues to augment until it bursts the wall, and then it may pass into the tissues; or it may rupture the integument and escape externally. It has escaped through the nose. Where the fluid has thus found exit, recovery from the disease has been reported. The most unfavorable cases seem to have been those in which the cranium did not continue to enlarge, yet the fluid continuing to augment caused atrophy of the brain.

Treatment.—The disease has been combated by internal medication; as remedies used have been calomel, iodide of potassium, nitrate of potash, cantharides, acetate of potash, digitalis, and turpentine; also by cathartics which act as derivatives on the bowels. Mercurial ointment has been applied to the shaven scalp. All impediments to the free return of blood from the cranial cavity should be removed. An attempt has been made to promote absorption of the fluid by compression of the skull; thus strips of adhesive plaster may be so used as to form a cap which will maintain constant pressure on the head. Roux in 1859 announced the cure of a case by the aid of compression continued by means of adhesive plaster; this was applied at first tightly, and later, loosely. All the methods of treatment enumerated have failed to cure the disease, though they may have retarded its progress. If the writer were to select a plan of treatment from those mentioned, the most rational would seem to be that by compression; and for this he would use, instead of adhesive strips, a rubber bandage, so applied as to maintain slight and uniform pressure on the head. Such compression should be commenced in the early stage and continued for a long period. Such peripheral pressure would counteract secretion and promote absorption. The general health of the child should be diligently maintained.

As mild operative measure, that of capillary drainage might be resorted to. For this procedure, first cleanse the scalp with an alcoholic or sublimated solution; and then, having made a small incision at a point where the fluid could readily be reached, and where vessels would not be endangered, introduce through this incision a tube of fine calibre, and cover this with borated or sublimated absorbent lint; and thus an outlet for the slow escape of the fluid is furnished, and provision is made against inflammation of the structures within the cranium. By this means, the slowly escaping fluid becomes an ally of absorption; the minute vessels which are the agents of absorption are thus relieved of pressure, and their functional activity is promoted. As an ally to this capillary withdrawal, compression with the rubber bandage may be made. This treatment, to be successful, should be continued for some weeks; and then, if the disease is not controlled, the procedure may be repeated at another point.

The treatment, however, which is oftenest pursued is that of tapping; this method, though far from being always successful, has so often been followed by success as to entitle it to commendation. According to West, who has collected fifty-five cases treated by tapping, forty died and fifteen were cured; and this was in the days of infectant surgery.

Tapping, which is best done by the method of aspiration, should not be resorted to in cases in which there is but a small amount of fluid; nor in those in which the amount of fluid is stationary, or is becoming less in quantity. Nor should it be done in cases in which the head is enormously enlarged, and where there are grave defects elsewhere in the body. It would be improper where the subject has become idiotic and will continue so. The cases in which it is indicated and proper are those subjects of hydrocephalus who are well nourished and otherwise in good health, and in whom conservative methods, as compression and capillary tapping, have failed to cure. The procedure which has been followed by the best results is that in which the fluid has been drawn off at intervals, in moderate amount, and after each tapping the head has been compressed.

The operation is most safely done by aspirating; yet a small trocar will answer for the purpose, if care be taken not to allow air to enter. The proper site is where fluctuation is evident, and the wall to be penetrated is thin. Such sites are at the lateral angles of the anterior or posterior fontanelle, where neither venous sinus nor meningeal artery will be imperiled. A small

instrument should be used, and having displaced the skin, the trocar is to be forced towards the middle of the lateral ventricle, from a quarter to a half inch in depth. The fluid should not be removed in such amounts as to permit the walls to fall together; only enough should be withdrawn to remove tension and swelling. If the content be entirely withdrawn, then the unsupported walls sink in a distorted manner. After the withdrawal of the fluid, the wound should be closed with adhesive plaster, and the walls compressed by a rubber bandage, or adhesive strips. In cases which have been cured the quantity of water, which has been withdrawn, has been from one and a half to three ounces; and when the fluid reformed, it was withdrawn again.

As before stated, this plan of treatment has been so rarely successful that some surgeons have abandoned its use. Among those who sanction its use may be cited Bruns and Malgaigne, who have formulated the conditions in which it should be resorted to. According to Bruns it should only be done in cases in which the fontanelles and sutures are widely open, the cranial bones are freely movable, and the child, being well nourished and not paralyzed, possesses a physical and mental development corresponding to its age; and, finally, that the hydrocephalus is continually augmenting. Malgaigne would only operate when the child is less than three or four months of age, and the disease seems stationary; exceptionally, however, he would do it if the child were over four months old, and the disease was manifestly progressing and threatened to destroy the child's life.

As a modification of the mode of tapping above described, Langenbeck, in 1850, did the work through the orbit. He thrust the trocar beneath the upper lid, and thus reached and entered the anterior horn of the lateral ventricle; thus the venous sinuses and the meningeal artery are avoided, which are endangered when tapping is done through the coronal suture or the anterior fontanelle. Through the wound left in the orbit the fluid continues to drain away. Langenbeck would evacuate from three to six ounces, according to the volume of fluid present.

There are cases in which the enormous accumulation of fluid has so separated the bones of the skull and enlarged the cavity that, though the fluid were removed and did not reform, the conditions of the head would not permit the continuance of life. Some years ago the idea suggested itself to the author, and has probably done so to others, that the unoccupied space might be lessened by removing a portion of the cranial wall. The toler-

ance of the normal skull of the removal of sections of the wall, and the impunity with which the hydrocephalic skull can be pierced in tapping, justify the belief that portions of the latter might safely be exsected. A few years since the writer proposed such an operation to the parents of a hydrocephalic child; and it was on the eve of being done when the mother interrupted the matter by her decision that she would rather have her child continue an imbecile than incur any risk of losing its life. Doubtless, however, such an operation, if it has not already been tried, will erelong be done, and, the writer predicts, with successful event.

As before stated, hydrocephalus developing in utero may render delivering of the fœtus impossible, unless the volume of the head be reduced; in such cases, when the condition is discovered, as soon as the uterine mouth is sufficiently dilated, a trocar is to be plunged into the lateral portion of a fontanelle, and the fluid evacuated. In these cases the child seldom survives birth more than a few hours; exceptions, however, have occurred in which the child survived for some time.

This disease has been treated by a combination of tapping, injecting tincture of iodine, and compression. The writer has recently treated a case in this way; the infant's head, which was enormously distended, was relieved of a large portion of its contents, when there was injected a twelve per cent aqueous solution of the compound tincture of iodine. This being introduced, the head was strapped with adhesive strips so as to maintain compression. Despite this course the fluid soon returned and filled the cavity. The treatment was repeated, with the same result, and the case, uncured, returned to its home in the country. The curative results obtained by injection of iodine into other serous cavities, as the pleural and peritoneal, encourage further trial of this means in the treatment of hydrocephalus.

Microcephalus.—It is a fact of common observation that a diminution of the volume of the cerebrum, such as is witnessed in congenital hydrocephalus, is accompanied by mental imbecility; as the bodies of such children grow, their intellect does not develop correspondingly. The microcephalic head at birth usually presents closure of the sutures; the regions of the fontanelles are also found completely ossified; the pulsatile fountain no longer exists, for its site is occupied by solid bone, and, in some cases, the osseous formation has proceeded so far that the sites of the fontanelles are elevated above the contiguous wall of the skull. It is clear that in such microcephalous head osteo-genesis has

proceeded more rapidly than is the case in the normal skull. The skull, then, at birth is a solid bone case, and it and the contained brain are abnormally small. In such an infant it is easily observed that the ordinary signs of developing intellect are absent; the child is not observant, or but little so, of what is occurring around it. Objects brought before its eyes are scarcely looked at; and if the object be moved away, the eyes do not follow it. Accurate fixation of the eyes is absent, and the two eyes do not coöperate in the act; in fact, there is a condition of mental torpor which marks the subject as idiotic, or but slightly removed from idiocy.

In another class of cases, in which there has occurred intra-uterine closure of the sutures and fontanelles, there is not present the condition of torpor or inertia just described. The infant, as it grows, is often abnormally quick in its motions; it is attracted by sounds, and fixes its eyes accurately and quickly on objects; it makes purposive and well-coördinated movements with its hands and feet, smiles, and is pleased with the caresses and attentions of its nurse; still, the child presents none of the common signs of infantile mind; it is in a stage of mental imbecility, from which it does not emerge as its body grows.

To relieve such unfortunates, the aid of surgery has been invoked, and the procedure which is resorted to is to reopen the closed skull, and, having removed sections of bone, to provide open spaces which will permit the encephalon to develop. By the operation, it is sought to place the infant's head somewhat in the condition of a normally formed infantile head.

The first work in this new section of cerebral surgery was done by the author in May, 1888, and the idea did not originate with him, but in the mind of a mother who had the misfortune to have such an infant. This child was born with complete closure of the cranial bones, and in a few months after birth it betrayed signs of mental defect. The mother referred its condition to the closure of the skull, and she was so sure that this was so, that she wrote to me from her home in the country, and asked me if there was any means of relieving this by an operation. In her graphic language she said: "My child's brain is locked up, and can you not unlock it?" The author advised her to bring the child to him, which she did. The infant, then fifteen months old, was well nourished and perfect in every respect, except that it was markedly microcephalic, and evinced but few signs of mentality. The fontanelles and sutures were firmly ossi-

fied; the site of the anterior fontanelle was somewhat convex. The child had free use of its limbs, and could make purposive movements with them. In view of the hopeless state of the child, it was decided to operate on it, and, in the mother's language, make an effort to "unlock its brain," and this work was done as follows: An incision was made in the median line of the hairy scalp from the summit of the forehead to somewhat beyond the posterior fontanelle; the skin with the periosteum was uplifted and dissected laterally, so as to expose an oblong section of the skull over an inch in width and some inches in length. At the posterior end of this space two openings were made with a small trephine, through which a blunt dissecting instrument could be passed, and the dura mater separated from the bone. This detachment was done between the openings and also for a short distance in front of each orifice. In the space provided by this separation one blade of a pair of blunt scissors was passed, and the bridge of bone divided which separated the trephined openings; also in front of each opening a similar division of the bone was made anteriorly for nearly an inch in distance. There remained, then, a portion of bone attached in front, lying over the longitudinal sinus. With the blunt dissector, it was then found an easy matter to separate this bridge of intermediate bone from the underlying sinus, and, when detached, it was uplifted and cut off.

Proceeding in this way, by lateral division and detachment of another section of bone, the work was done without difficulty, in which an oblong section of bone, an inch wide, reaching from the posterior to the anterior fontanelle inclusive, was excised. There was found no difficulty in detaching the bone from the longitudinal sinus by the use of the blunt dissector cautiously manipulated. Some small drops of blood oozed from the sinus through the opening of minute vessels, which passed from the cranial wall to the sinus. Besides the longitudinal section of bone removed, there was exsected a portion transversely, corresponding to the site of the coronal suture. This transverse section on each side extended one inch beyond the border of the longitudinal one, and was a half inch broad; the vacant space left after the bone was exsected was cruciform.

The work of exsection being completed, the wound was dusted with iodoform and closed by sutures, and the whole covered by aseptic lint. During this operation the anæsthetic acted badly; the child was greatly depressed, cyanosed, and was nearly

lost from this cause; it was only by persevering efforts that the child was resuscitated, and, though rescued, it never fully rallied from the anæsthetic.

The anæsthesia was induced by a mixture of chloroform, ether and alcohol. The child lived nearly forty-eight hours after the operation, and death resulted rather from the ill action of the anæsthetic than from the operation. This operation was the first work done, as far as the writer knew, in craniectomy performed for relief of mental imbecility due to microcephalus and premature closure of the sutures and fontanelles; and the originating thought which led to the work was awakened in a mother's mind by her love for her unfortunate offspring.

Since this operation, which was not published at the time, craniectomy for the relief of mental arrest due to microcephalus has been proposed and done by Lannelongue over twenty times; it has also been done by Keen, of Philadelphia, and others. Though time enough has not elapsed to show to what extent it may be beneficial, yet the reports on the subject are favorable, especially those of Lannelongue. Unfortunately, every new procedure in surgery has the fault of awakening undue expectations in those who originate it, and this one may share the fate of many others which have failed to accomplish for subsequent operators what has been announced by those whose vision was obscured by the bias of paternity. It is scarcely probable that a brain which has been primarily molded according to a microcephalic type can afterwards be much changed, for such brain is as perfect in all the detail of parts as is a normal brain. These parts are lacking in volume; there is not present the field of sufficient amplitude for the growth of the precious germs of intellect; the latter consequently develop as dwarfs. And it scarcely seems probable, though the containing rampart be enlarged, that this can have a material influence on the cerebral content. A larger bowl held before a flowing stream will not enlarge the stream; so it may be predicted that craniectomy, done in the best manner which can be devised, will afford but temporary or limited relief for the unfortunate subjects of mental imbecility. The plan, which was sketched by the predetermining hand of organizing Nature, must necessarily remain as primarily traced; the attempt, however, to rectify or improve such imperfect sketch is permissible, if not laudable.

A few weeks prior to writing these lines, the author was consulted in reference to an infant whose head could scarcely be des-

ignated microcephalous, yet the sutures and fontanelles were closed at birth and there were signs of mental inbecility or vacuity, and, as in the former case, the parents asked to have something done for the assistance of their child. They had been told that some operation, for relief in such cases, had been done abroad, and they wished an attempt made in the case of their child. The child was normal in other respects, yet it had ceased to observe what was passing around it, and remained, for the most of the time, in a condition of listless torpor.

The operation was done somewhat differently from the former case. The infant, aged five months, was placed under the influence of the mixed anæsthetic previously mentioned, which acted well in every respect. An antero-posterior incision, over the left parietal bone, was made connecting and reaching somewhat beyond the anterior and posterior fontanelles; this cut reached to the bone, and was followed by bilateral uplifting of the scalp and pericranium for over an inch on each side of the lateral incision. Next, a small opening was trephined through the bone near the posterior end of the bared surface, and, through this, one blade of a pair of scissors was passed, and an oblong section of bone was cut out from behind, forwards. This was a half inch wide and over two inches long. The work of dividing the bone was always preceded by the separation of the dura mater from the bone; in this way the scissors did not catch or injure the dura mater. This oblong section was not excised in one piece, but in fragments about three-quarters of an inch long. A similar oblong section was excised from the right side, through a longitudinal cut in the scalp. These sections of bone were removed so as to leave an interjacent bridge of bone lying over the longitudinal sinus; this bridge was an inch and a quarter in breadth. There was next excised a portion from this interlying bridge, corresponding to the anterior fontanelle; the exsection resembling an H. The removal of the lateral portions of bone was accompanied by but little hemorrhage, since the endings of the middle meningeal arteries were so small that almost no blood escaped from them.

Besides the work of osseous exsection here described, the blunt dissecter was passed in between the remaining bone and the dura mater, and the latter was separated to the extent of an inch and a half beneath the remaining fragmentary parietal bones. The wounds made were cleansed by a twenty-five per cent solution of alcohol, which had been warmed to the temperature of the body; thus, in its contact with the dura mater, the cleansing fluid did

not cool the part and render anæmic the brain underneath. In the operation done three years previously, this precaution was neglected, and this cause should, perhaps, be added to the ill-acting anæsthetic, to explain the syncopated state into which the child lapsed during the operation, and remained so afterwards. The wounds closed by silken sutures, in the second case, were covered with lint, moist with the alcoholic lotion, and they healed most rapidly; only where the bone was removed from the region of the anterior fontanelle, did a slight degree of suppuration occur; the healing was complete within ten days. The skin was slightly depressed over the site of the bone which had been removed, and, at the position of the anterior fontanelle, there was the pulsatile movement which characterizes the infantile fontanelle in the normal head. Little or no movement was perceptible in the region where the oblong exsection had been done.

The most remarkable thing in this operation was the slight impression which it made on the child; the temperature hardly ever rose above the normal one; food was taken and digested as usual, and there was no nausea or vomiting, as is usually seen as the accompaniment of injury of the head.

The ameliorating result of the operation was more than was expected; there was a visible improvement of the infant's mental condition; the condition of apathetic inertia and vacuity of intellect, which previously stamped the child as destined to idiocy, were changed somewhat; the child, during the period of healing, commenced to look at what was passing around it; it would follow a moving object with its eyes, which it did not do before the operation, but whether the improvement will continue, time will prove. The results already obtained fully justify further effort in this newly-opened section of operative surgery, and here, as in other departments of surgical work, discretion should be used in the selection of proper subjects for the work. Subjects of microcephalus in whom other incurable facial deformity exists, as is sometimes seen, should be discarded. Also, cases of teratological monsters, in whose construction nature has forgotten her sublime dexterity and, in her embryonic sketch, has abandoned those archetypal lines with which we are so familiar in the ordinary infant, should be eliminated from the list selected for craniectomy.

In many cases, it is easy to foresee that the operation will be sought by unfortunate parents who would prefer to lose the life of their imbecile waif, rather than preserve it. However desirable

death may be in this case, as well as in others which fall within the physician's and surgeon's observation (and desirable it indeed is), yet our profession has no such power; the right to take life is only delegated to another profession, whose code, formulated from precedent and old usage, grants authority to take the life of him who has taken life. If such a right or power can be exercised towards the murderer, why not towards him whose life has become a curse to its possessor? When Mirabeau was suffering inexpressible agony from a mortal disease, and he begged Cabanis, the celebrated physician, to give him an euthanasic nepenthe, the friend replied that such an act was not permitted. The great statesman rebuked the refusal by saying: "If my dog were suffering and going to die, you would not hesitate to do something which would end his misery, and in so doing you would say that you were doing a favor, a blessing; am I not better than my dog? can you not do as much for me?" Cabanis had all the endowments of the tender-hearted physician, as was manifested in his endeavors to prove that death by the guillotine was a painless one, in a work written to solace those who had friends who died by that instrument in the French Revolution; yet, in answer to the suffering statesman, he said: "The world has not yet reached that stage of civilization."

CHAPTER VII.

SURGERY OF THE EXTERNAL EAR.

THE auditory apparatus is claimed by the specialist in the treatment of disease or disorder seated in any portion of the apparatus; the general surgeon, however, has not wholly abandoned this region. His services are often invoked in affection of the external ear, in which are embraced the pinna, or external ear, and the auditory canal; his work commonly lies outside of the tympanic membrane, and to this section of the subject the present chapter will be confined. As preliminary knowledge, necessary to a correct understanding of the subjects to be treated, the writer premises a brief survey of some of the anatomical characteristics of the structures comprising the pinna and meatus.

The external ear is movable, and at the same time it is so strongly attached to the head that one, grasping the ears, can lift the entire body.

The ear presents a multitude of forms, and may vary in size so that the smallest, as well as the largest, becomes an element of deformity in the subject's figure. The condition of the middle ear seems, sometimes, to be indicated by the conditions of the pinna; for if this be very flat, dry parchment like, angular, and with a dwarfed lobule, there may be inferred to coëxist sclerous otitis. Whether the imperfectly formed ear corresponds with an imperfect brain, and whether the assertion of Joux be justified by facts, viz., "Show me your ear and I will tell you who you are, and what you are," we will leave for the otoscopist and psychologist to determine. The supporting framework of the pinna, instead of being bone, as is elsewhere found, is of cartilage, and this is lined by skin which adheres closely to the cartilage, except on the posterior side, and to this close adherence is due the peculiarity of form which characterizes the abscess, hæmatoma and cyst sometimes occurring here; but on the posterior side, the skin is loosely adherent, and this condition permits the swelling which is seen in erysipelas, seated here. The lobule, from its pendent

position, retains its form and site without the intervention of the cartilage which maintains the form of the rest of the outer ear, and this absence of cartilage enables the surgeon to solve a plastic problem, in case of defect here, more readily than elsewhere in the ear; defect in the cartilage-bearing portion may be restored from parts adjacent, yet from the absence of the cartilaginous framework, such plastic work rarely retains its proper form, and, to counteract this in some degree, much ingenuity is needed.

The external auditory meatus, more properly named a canal, is the continuation of the external ear to the tympanic membrane. This passage is very short in the new-born child; in the adult it varies in length, and among those who have stated its length there is but slight accord. Buchanan says it is from an inch and a quarter to an inch and a half long; according to Comparetti its length is nine lines, while Tillaux makes its length vary from nine and a half lines to fourteen and a half lines. Its breadth varies also greatly, and the outline of the transverse section varies from a nearly circular figure to almost an elliptical form. Its long axis reaches from behind forwards, and from without inwards, and these directions correspond with those of the petrous portion of the temporal bone. The auditory canal is not straight, but is curved, so that a longitudinal section of the passage is convex above and concave beneath; that is, the canal at its middle is curved upwards. As a result of this curving, if one introduce a straight speculum which fills the canal, it will strike the upper wall in its inmost third and awaken pain. Such pain may be avoided by pulling the pinna directly upwards, as thus the canal is somewhat straightened.

The walls of the canal are composed of cartilage and bone. The outer part is constituted of cartilage; the inner portion for more than one-half its extent is of bone. The bony wall forms a very obtuse angle with the tympanic membrane above; below, it forms a correspondingly acute angle. The ceruminous glands are seated chiefly in the skin which lies on the cartilage.

The superior, posterior, inferior and anterior walls of the canal may, from their external relations, be respectively named the cranial, mastoid, parotidean and temporo-maxillary walls. The cranial wall is so thin here that a wound or disease in the canal may easily traverse the bone and affect the contiguous dura mater. Indirect violence having primary impact on the chin can reach the brain through this wall and produce cerebral concussion. Those whose brutal profession is to deal blows on

the bodies of their fellows are well aware that violence applied here is most certain of its intended effect, for a blow from a weak man administered to a powerful man's chin will fell the victim to the ship's deck, which, as the writer has been a witness of, was once no infrequent scene of such violence.

The posterior wall is contiguous to the mastoid process, and caries of this latter bone, as seen in the scrofulous subject, may lead to suppuration of the soft parts and discharge of pus into the canal. A more frequent and a graver trouble, which is seen here, is where a deep-seated inflammation commences in the periosteum lining the osseous portion of the canal, and extending outwards and backwards, appears in the mastoidean region; this will be treated of more fully in another section.

The inferior wall lies in contact with the parotid gland, so that swelling in this gland may partially or wholly occlude the external meatus; the parotidean growth is a frequent cause of such closure. Thus, as the author has seen, unilateral deafness may arise from the development of a malignant growth in front of the ear, though the deeper portions of the organ remain unaffected. By an extirpation of the growth in such a case hearing in the ear was restored. The close contact of the parotid gland and ear explains the tinnitus and pain in the ear present in parotitis.

The temporo-maxillary or anterior wall is in contact with the temporo-maxillary articulations, and this proximity is the cause of the pain which is caused by masticating when the anterior wall is inflamed.

After birth the auditory canal becomes deeper, and the tympanic wall changes its position as the cranium is developed. This change in position is as follows: At birth the membrane is elevated but slightly above the plane of the horizon; the membrane makes with that plane an angle of ten degrees. As the child grows, the membrane rises towards the vertical plane, and ends normally, in making with the horizon an angle of forty-five degrees. In the cretin and non-developed head, the tympanic membrane occupies the position of that of the infant; hence, according to the anthropologist, this angle is an index of the grade of intellect; so that, if this be true, with the quadrant one might measure the height of the sun of reason and the latitude of the understanding. This matter concerns the surgeon less than the fact that this disposition of the membrana tympani renders the upper wall of the auditory canal shorter than the lower

one; and the inclined membrane is thus made to form a recess on the lower wall, in which small foreign bodies may lodge. Drawing the pinna upwards tends to lessen this recess, and to bring what may be lodged there into view.

Defects and Affections of the External Ear.—Congenital defects are met with in the pinna and auditory canal. The pinna may be wholly or partially wanting. When wanting, if one palpates the site, as the author has verified, there may often be felt traces of cartilage buried beneath the surface; and in one case portions of the cartilage cropped out and were visible above the surface. In two instances of such defect the meatus was closed, and so effectually that it was difficult to precisely locate its proper site. In these two cases the writer attempted by a plastic operation to remedy the condition. The buried cartilage was uncovered, and, along with a portion of integument, it was so uplifted as to present the appearance of an ear. Unfortunately for satisfactory form and aspect the cartilage found was very imperfect. The operative procedure consisted in first marking off a portion of skin in outline similar to an ear, yet longer; next was incised and dissected up the skin until the site of the cartilage was approached; then the knife was carried deeper, so as to include and pass beneath the cartilage at two or more points. In this way the material for the new aural formation may be prepared, when the uplifted integument is to be infolded about the cartilage, and fixed in place by fine metallic sutures. Along with this work an attempt must be made to open the closed canal, and this is easily done if the passage be merely closed by an external operculum, for the meatus is restored by crucially incising the covering, and then, having seized each hanging portion, cut it off, so as to fully restore the outlet. And, to render and preserve the orifice permanently patent, the hanging flap of the divided operculum may be dissected up at its attached base, and thus a small cutaneous covering be made and sutured to the wounded circumference. Thus, in such congenital closure, the opening may be restored, but if the occluding material reach inwards still deeper, an effort should be made to restore the opening; but if the canal should be found occluded, or rather obliterated, throughout its entire length, then the operation must fail in its purposes.

A duplicate auditory canal has been seen by Velpeau; alongside of the normal one there was an abnormal canal which penetrated to the mastoid process. In such a case the surgeon's interference would not be necessary.

A singular anomaly was seen by Birkett, in which there were two pinnæ on one side; the surplus one was removed by a simple operation.

Congenital cleft or fissure in the external ear has been seen; Schwabach, who has given study to the matter, refers the origin of such fissure to the embryonic bronchial cleft, which, not properly closing, leaves a fissure. Such fissure has been observed by Paget and Urbant-Schitsch. In several cases the defect was transmitted from parents.

From diminution, as well as excess of volume, the pinna may be deformed. Besides being too small, the ear may be ill-formed; such dwarfed auricle might possibly receive some plastic aid, yet, in such effort, the surgeon should not try to do too much, lest he make that which is bad still worse.

In case of excess of volume, in which the parts are in proper proportion, the surgeon has intervened with advantage. In

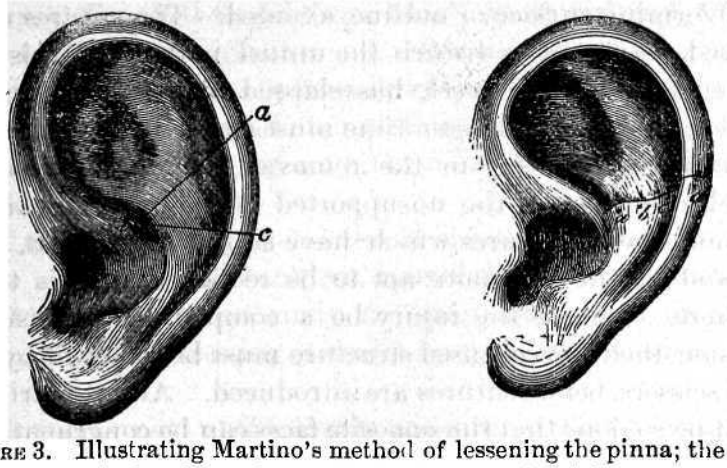

FIGURE 3. Illustrating Martino's method of lessening the pinna; the section *ac* being removed, the closure is seen in the figure at the right.

such ear enlarged to deformity, the work may be done as was done by Martino, who removed a cuneiform section from the middle third of the pinna (as shown in Figure 3). Such a section should traverse the concha, ending near the meatus, and should embrace as much of the convex border of the ear as is requisite to reduce the part to better shape. The opposite borders of the remaining gap must be accurately brought together, and retained so by fine metallic sutures, which should remain in place for not less than two weeks. The part should be immobilized by aseptic lint placed between the ear and the head, as well as on the ear; the whole to be permanently fixed by adhesive plaster encircling that side of the head. In this way, the wounded parts

would unite; and if accurately coaptated, the remaining scar would not be an unsightly one. Wounded cartilage does heal, despite the contrary opinion which was taught by the medical writers of antiquity.

Wounds of the External Ear.—The external ear may be the subject of a piercing, incising or contusing wound.

A penetrating or piercing wound here will readily close, if placed in proper conditions of cleanliness, and covered by an occlusive dressing.

An incised wound may form a flap, or the detachment of a portion of the ear may be complete. When there has been no loss of structure, the wound, if one of even surface, should be closed by means of metallic sutures, immobilized and covered by an aseptic dressing. In the use of sutures, these should be so introduced as to maintain complete coaptation and adjustment of the wounded surface; thus done, the reunion will be secured, and deforming surface or outline, avoided. The sutures must be removed so as not to disturb the united parts; and this should not be done until a week has elapsed since the sutures were inserted; and even a longer time must elapse if the union seems yet incomplete. Delay in the removal is more necessary here than elsewhere, since the unsupported position of the ear, differing from other structures which have subjacent support, renders a wound in the ear more apt to be reopened than is the case elsewhere. In case the injury be a compound of incision and contusion, then the contused structure must be removed by sharp-edged scissors, before sutures are introduced. And this trimming should be so done that the opposite faces can be congruently fitted to each other. If this precautionary preparation be neglected, then the wounded parts may unite imperfectly, with, perhaps, one or more perforating gaps through the ear.

In case there be detachment of a portion of the pinna, then it has been repeatedly demonstrated that the separated part can be made to reunite again: examples, even of the reunion of the entire ear after its detachment have been seen. A noted instance of this kind is that of Prynne, a member of the English Parliament, who, on account of some writings then adjudged libelous, was condemned to have his ears cut off; though this was over two centuries ago, yet surgical art in this field, from repeated opportunities, had reached such proficiency that the excised ears were successfully restored to their places again. The rebuke of mutilation failed of its effect. After three years his pen repeated its

offense, and Prynne was again condemned to have his ears cut off; the cruel work was repeated by the bailiff; yet surgery was denied the privilege of another trial of replacing the parts, since this time the ears were confiscated. As the era has fortunately passed in which the conscience, private judgment, and religious opinions of men are controlled by the lash, pillory, stocks and mutilating instruments, surgery has less opportunity of testing its resources in this field of restoration, than in the much-vaunted "good old times." Accidental injury, however, does sometimes furnish an opportunity for work in this line, as shown by the monograph in 1870, of Bérenger-Ferraud, in which there is a collection of cases of restoration, in which there had been partial or complete detachment of a portion of the ear. In one case told by Manni, the ear had been cut off for hours, and carried in the man's pocket; this ear, properly replaced by sutures, reunited without any necrosis of cartilage; in this respect differing from a detached finger, from which when restored, the bone is apt to die and be thrown out. Bérenger-Ferraud hints that there may be some benefit for a short time elapsing, between the cutting off of the ear and its restoration; for thus done, there is time for the bleeding to cease, and no intervening blood prevents adhesion.

To restore a detached portion of the ear, coaptate accurately by the aid of metallic sutures, immobilize the part, retain the patient in recumbence, apply moderate warmth without moisture and let the dressing remain unchanged for three or four days.

Erysipelas not unfrequently appears on the pinna; and it may arise here primarily, or the disease may appear first in the scalp or face, and emigrate then to the ear. It may run an acute course, or it may be chronic in duration; and in the latter case, it may appear, vanish, and then reappear on the same site. This chronic form can end in shriveling and contraction of the pinna, thus causing marked deformity. In its acute form the disease usually enters the meatus, and passing inwards it causes tinnitus.

Treatment.—Mercurial or iodine ointment, or one containing quinine, two grains to the ounce, may be used locally.

Othæmatoma.—Since the othæmatoma is sometimes, if not always, of traumatic origin, it is proper to consider the subject here. The name othæmatoma or hæmatoma of the ear was applied by Weiss, of Coblitz, to a soft fluctuating tumor which suddenly

appears on the pinna. It has also been named auricular erysipelas, blood-cyst of the ear, and shriveled ear. It occurs most frequently in the insane. This tumor, which usually appears on the outer face of the ear, within depressions bounded by the helix and antihelix, may attain such dimensions as to interfere with hearing; and in the beginning, it is somewhat painful, and soon manifests symptoms of inflammation in being hot, red and swollen.

There have been assigned two modes of origin of this tumor; in one it is claimed that it originates from a constitutional or general cause; and in the other, it is contended that the tumor is the result of local injury. Hasse, who has seen six cases, espouses the latter opinion; he thinks that it is caused by pulling the ear, or by frequent blows on the part. From such violence the lining of the cartilage can be cracked, or so injured that the blood can insinuate itself into the fissure and uplift the lining membrane. Such violence might be done by the patient himself. The tumor has oftenest been seen in the inmates of asylums for the insane; and hence the origin of an othæmatoma has been discussed in courts of law, at whose bar the managers of such institutions have been arraigned under accusation of cruelty to the inmates in their charge. On such occasion the question has been mooted whether the subject may not have caused the violence himself by striking his head against some object.

That the tumor may be caused by violence, voluntarily or otherwise inflicted, is shown by the fact that it has often been seen among the knights of the arena whose ears are the subject of many blows; and in such it occurs oftener in the left ear. This tumor was not unknown to the ancients; and the artist who chiseled the ears of Hercules, and those of Castor and Pollux, has delineated those famous athletes of the mythic age as bearing ears deformed by this affection.

Others, again, contend against a traumatic origin; this opinion is espoused by Ludwig Meyer and Virchow. Meyer, in 1865, in an essay on this subject, claims that othæmatoma arises from a chondromatous degeneration of the aural cartilage, which is succeeded by the vascular development in the part so changed. He finds three kinds of alteration in the cartilage, the hyaline and fibrillar degeneration, and the formation of hollow spaces in the cartilage. Virchow, likewise, though admitting that the tumor may have a traumatic origin, still claims that it can arise from changes which primarily occurred in the cartilage itself, and

which were afterwards followed by the vascular effusion. Pertinent to this matter is an interesting observation made by Brown-Séquard, that from injuries of the restiform columns of the medulla oblongata in the guinea pig, there soon appeared vascular effusion in the animal's ears, consequent, he thinks, on the impairment of nutrition produced by the injury to the cord. The author of this work suggests that it is possible that the animal, in his wounded condition, injured himself.

As summary then of the causation which has been assigned to explain the origin of othæmatoma are the following agencies: from local violence of the part frequently repeated, from troubles of general nutrition; and, thirdly, from a disturbance of the local nutrition of the ear.

When the othæmatoma is slight and multiple in site, it resembles somewhat erysipelas, differing, however, from the latter in being a fluctuating tumor, and nearly always seated on the external face of the ear. It may slowly grow until the tumor occupies the entire outer face of the pinna. The tumor may also penetrate through the ear, and then it communicates with, or forms, a tumor on the inner face of the pinna, looking towards the scalp. The content, though clotted, is liquid in its centre.

The othæmatoma presents a varied course; sometimes it vanishes through absorptive dispersion of its contents; it can inflame, suppurate and open, and disappear in this way; or the tumor may remain an indefinite period, and, as it is then painless, it is chiefly objectionable from the deformity which it causes.

When the tumor disappears through spontaneous absorption, or, through suppuration and evacuation of content, it entails some change in the form of the pinna; the affected part shrivels, and the concha is deformed through contraction. The final deformity, in the main, is one of shriveling; and this, as above stated, has not been forgotten by the ancient sculptor.

Treatment.—In the early stage, inflammatory action should be controlled, and absorption promoted; for the former, lead water, and for the latter, some compound of iodine may be topically used. If reduction is not accomplished by these measures, then the knife may be used; and through proper incisions, the blood may be forced out, and tincture of iodine, or iodoform, introduced into the emptied spaces. As the blood soon refills the cavity, other means have been resorted to for relief: viz., there may be passed a seton through the tumor, which is allowed to remain there permanently. In this way it is claimed that the blood finds

escape as soon as it forms, and the cavity gradually closes. Wilde treated the tumor by freely incising it, emptying the contents and filling the cavity with lint.

The sebaceous cyst occurs on the ear, oftener on the outer surface. Such cyst commonly remains of diminutive size, though it may become as large as an olive. It is treated by incision and removal of the sebaceous material by compression or curetting. The spoon-shaped end of the grooved director is a convenient instrument for scooping out the contents in most cases. Akin to the sebaceous cyst is the chalky concretion sometimes found here. The English writers associate this with a gouty diathesis. Such material may be removed by curetting.

The fibroid tumor occurs in the pinna; its origin may be spontaneous, or it may arise from some previous injury. The usual site is the lobule, where it has arisen from the irritation excited by an ear-ring. Such growth can attain the size of a small cherry. It may partake of the nature of keloid structure, and then it is the site of an itching sensation. Such growth being in the female and an offense to her eye as well as to the eyes of others, its removal is urgently solicited by the patient. This is done by extirpation, which should be done from the inner surface of the lobule; and in the work two points must be observed: one, to remove the fibromatous structure in its entirety, and the other to preserve the skin and remove as little as possible of the lobule; and these rules are so much in conflict with each other, that it often occurs that the work is not thoroughly done, and sooner or later there is a recurrence of the growth, as has happened in the writer's experience. Should there be a return, another removal may be more successful.

Malignant growths appear in the external ear; carcinoma, sarcoma and epithelioma are found here. Such growth may have its original site here, or it may invade the ear as an immigrant from some adjacent part. Epithelioma is oftener seen than the other forms of malignant growth just mentioned. It commences usually in the folded border of the pinna, or in the prominent portion of the antihelix. Owing to the defective vascularity of the peripheral portions of the pinna, the epithelial cell-growth makes but slight progress before ulceration ensues; in the central portions of the concha, the growth is greater, and proceeds to such an extent that, as in a case treated by the writer, it occluded the meatus, and deafened the patient on that side. Carcinoma is more rare here; in fact, the structure

of the ear is but little favorable to the development of this type of malignant growth; still, Sédillot and Duplay have observed cases in which carcinoma rapidly destroyed the external ear, and attached and destroyed the subjacent bone. The pinna is histologically ill adapted for the development of sarcoma, and the writer has seen no example of it there.

Malignant neoplasm seated in the ear should be attacked early and radically; if thus treated, the case can be cured, as has often been verified. If, however, the disease has made such progress that it has appeared in the adjacent glands, which are connected with the part by lymph-vessels, then recurrence is almost inevitable, though radical means be used. If the disease have an isolated site, this should be so circumscribed as to surely include the affected structure. And the excision should be done in such a figure that the wound may be closed and leave no conspicuous gap or deformity in the ear. This is only possible when the affected part is limited in extent; for example, when it is on the border of the ear, and the excision can be done triangularly. But if a great portion of the ear be the site, then a large portion of the pinna must be excised; if, however, a part of the circumference can be saved and attached to a portion of the concha, then the deformity will be much less than if the entire ear be excised. In a case operated on by the author, in which the concha and entrance of the canal were the site of epithelioma, the affected parts were removed, including the derm for an inch around the meatus, which was likewise implicated; there was left remaining the upper fourth of the pinna, along with the greater portion of the helix, which was not affected. The part which remained was falciform, being broader above and gradually tapering to a sharp point behind and below; the posterior cutaneous face of this was removed, and the part then fixed by metallic sutures to the dermal edge of the raw surface which remained behind the meatus after the excision of the affected structure. The parotidean sulcus behind and below the ear, from which affected structure had been removed, was next covered by a flap, which being uplifted from over the upper fifth of the sterno-cleido-mastoid muscle was turned across the large raw gap. By the work thus done the wounded surface was in a great degree covered, and the portion of the ear which remained, though less than one-fourth of the original part, was so utilized as to greatly lessen the deformity. In healing, the meatus tended to close cicatricially, yet this was prevented by the

insertion of a rubber tube. There was no recurrence in this case.

The pinna is sometimes the site of a lupoid ulceration, cognate in feature and behavior to epithelial cancer, and, like the latter, it occurs oftenest in the aged subject. It would seem to appear most frequently in persons in whom the skin is dry and the site of freckles and other pigmentary marking. In the senile period of general lapsing vitality, this structure, which is rendered especially non-resistant by its pe ipheral situation, becomes the favorite site of lupoid development. Histogenetic weakness, the result of such condition, favors the development of both cell or microphyte to which the causal agency of this disease is attributed.

For the extirpation of the disease, the curette and escharotic are oftener resorted to than the knife. The diseased structure should be scraped off and the raw breach opened should be cauterized with potassa fusa, or it may be covered with a paste of sulphuric acid and charcoal; such paste is allowed to dry and remain in place until an eschar is detached. Or a paste composed of salicylic acid and liquid carbolic acid may be used and left in place until the resulting eschar drops off. Multiple lupoid points may thus be treated at the same time.

Adherent Pinna.—Adherence or fusion of the pinna with the adjacent surface of the head appearing congenitally has received sufficient mention; the acquired form will next be considered.

From burns, eczematous ulceration, and from the surgeon's instrument the adjacent and opposite surfaces of the ear and scalp may be denuded, and if brought in continuous contact, the surfaces will cohere. Improper head-dress of the infant has caused it, viz., one by which the ears are forced against the head.

This condition of coherence is not easy to completely remove; though detachment be done, and separation maintained by some intervening material, still there will occur reunion in the deepest part of the normal sulcus. To oppose such union, a flap of cutis from the contiguous sound structure may be lifted up, and twisted in and sutured to the floor of the sulcus. In this way the deeper part of the normal interval will be maintained open, and when this is done, the remainder of the work is easily accomplished; for if parts unite beyond, it suffices to simply separate them and maintain the surfaces apart by some intervening lint. The process here is similar to that done for the separation of webbed fingers. Skin grafting might be resorted to for the same purpose; and then the grafting might be done on one or both surfaces.

Rents, Fissures and other Defect in which there is loss of structure.—The simplest case of this kind, and not unfrequently seen, is that in which the lobule has been torn by the ear-ring. Such rent occurs oftener from accident, by which the ring is torn out, or from continuous ulceration from the ring, a rent arises. In all such cases restoration to normal form, or at least fair relief from deformity, is obtained by paring the edges evenly and uniting them by means of metallic wire; such wire must be verv fine.

Sometimes a surgeon is consulted in reference to the repair of a larger or smaller loss of structure of the ear. Such loss may be in the marginal or in the central portion of the pinna, or in the lobules. The material for restoration is to be taken from the dermal integument, which is most conveniently situated, and this should always be selected, by preference, from a part where the subsequent scar will not be visible; and in accordance with this, the material behind the ear is best suited for replacement.

The difficulty encountered in this plastic work is the retention of form. Since the cutaneous material used for restoration contains no cartilage when it is transplanted to the border of the ear, it soon shrivels, and if this be at the upper border, the latter soon shrinks down into a shapeless figure. To avoid this, the cartilage already remaining may be utilized; to do this a strip-like section may be cut with nutrient connection at one end, while the free portion is lifted and placed arch-like on the border. Into the open space thus left, a flap of skin, uplifted from behind, is inserted, and fixed by sutures. In this work the epidermal side of the flap should look outwards. The vascularity of the flap will aid in maintaining alive the newly formed cartilaginous border. After three weeks the flap can be cut asunder at its base, or it might be left unsevered, since its site is quite concealed. In operative work of this character, the author has verified the advantage of thus using the existing cartilage for constructing a border.

If such expedient in the technical work of restoration be omitted, though the ear be well repaired, the added material will soon shrivel and the operation be a disappointment. In an attempt by the writer to restore a large breach in the upper half of the ear, caused by the bite of a beast in form similar to the patient, the primarily well-restored section afterwards shrank to unsatisfactory form; and thus a double lesson was taught: the limitations of plastic repair, and the inestimable value of cartilage in

the architecture of the ear. In case the defect be central the repair is less difficult, since if the peripheral framework of the ear remains, the newly-added material will be retained in its central position. And in such a case the restoration is done by trimming the margin of the opening and uplifting a flap and adjusting it to the breach, with its epidermal surface looking outwards.

If the defect in the ear be from a lost lobulus, the work of repair can be satisfactorily done by uplifting a flap with attachment below. This flap should be so broad that it may be folded together and thus present a skin-covered surface on all sides; and the whole should be broader and thicker than the part which it is to replace, since it will afterwards diminish in size.

Affections of the Auditory Canal.—Inflammatory action may arise in the surface of the canal, originating in the glandular structure which abounds there; such inflammation may be limited to a small point, viz., a sebaceous or ceruminous gland may be the origin, and thence a diminutive abscess can arise. Such abscess, though painful, is not a serious trouble. As application, there may be used camphorated oil, or almond or olive oil. Also warm carbolized water should occasionally be poured (not injected) into the passage, so as to remove any material which may be emptied into the passage. The suppuration will be hastened and the pain lessened by placing over the ear a poultice of hops to which laudanum has been added. By such management, the ordinary aural abscess is satisfactorily treated. It has, however, a tendency to recur; the first one often having several successors.

Besides the circumscribed glandular inflammation just mentioned, there is another form of a much graver nature, which has been studied by Tillaux. According to him, the inflammation commences in the periosteum which lines the deeper portion of the canal, and travels inwards, and follows the periosteum that covers the mastoid process behind the ear. Pus forming, opens into the canal, but much of it remains confined underneath the thick structures which cover the mastoid process; and from this fact Tillaux names the purulent collection, mastoid abscess. It is probable that instead of originating as Tillaux thinks, in the periosteum, it commences in the deep glandular structure of the canal, and thence penetrates to the periosteum, and pursues its course backwards, and being pent up beneath the dense and inelastic structures there, it causes excruciating pain, as the

writer has seen in two cases of the kind. The protracted contact of the pus with the surface of the bone, tends to destroy the latter, and, as result, there may occur necrosis of the surface of the mastoid bone, and penetration of pus into the mastoid cells.

Treatment.—As soon as this osteo-periosteal inflammation of the deeper portion of the auditory canal is diagnosed, which may be done through the swelling and the acute and widespread pain about the ear, Tillaux counsels to locate the pain by examination with an aural speculum, and to freely incise through the swollen wall of the canal to the bone; thus proceeding, the inflammation may be checked, and prevented from extending further. Such prophylactic incision can rarely be made early enough to arrest the inflammation at its primary site of appearance; as a rule, the surgeon is only consulted after the disease has extended its sphere, and has appeared behind the ear. At this stage it must likewise be met by a free incision by which the swollen structure will be divided to the bone, and free escape provided for the pus. As Tillaux warns, such division of the parts endangers the posterior auricular artery, which normally lies in the bottom of the furrow between the ear and the wall of the head. Dissections made by the writer of this region have shown that this location is not unvarying. The vessel is sometimes of diminutive calibre. If opened by the incision, the firm and resistant tissues in which the vessel lies, renders it difficult to tie or twist it; and hence, as Tillaux directs, if it be opened, it is better to seize the divided structure in which the artery lies in its entirety with a pair of compressing forceps, and let the latter remain in place for some hours. A plan which the author has pursued is to make a vertical cut, somewhat behind the site of the vessel, reaching to the bone. Then with a chisel or blunt dissector, dissect the soft parts from the bones towards the ear. In this way a free outlet is made for the escape of pus, and if the dissecting chisel be kept in contact with the bone underneath the periosteum, the artery will be uplifted with the soft parts, and will not be opened.

After this incision has been made, the parts which are the seat of suppuration, should be washed out with an alcoholic sublimated solution; and such injected fluid will commonly escape through the meatus by an opening in the wall of the canal, through which the pus, unaided, has established an outlet for itself; an outlet, however, too small to give free vent to the material. The connectien between this opening in the canal and

the purulent collection behind the ear, often eludes detection until thus verified by injecting fluid from the incision. The relief which is afforded by the treatment here indicated is immediate; the excruciating agony in which the patient writhed, vanished in a few minutes. The wound made must be kept open for some days by means of lint and a drainage tube, and the whole covered with lint saturated with an aseptic solution. And if the dressing be warm, it will be more agreeable to the patient than if it be maintained cold. If this osteo-periosteal inflammation be treated early in the way here detailed, the middle ear will escape implication; but if it be allowed to pursue its course untrammeled, it can enter the tympanic cavity and pass thence into the mastoid antrum; and in this form it attains such intensity that it passes from the aural apparatus through the intervening wall to the cranial cavity, and there becomes the cause of fatal disease; hence the lesson taught of early and thorough surgical intervention in such cases of osteo-periosteal inflammation.

Occlusion of the Auditory Canal.—The canal may be closed by growths adjacent, which coming in contact with the canal, finally close it; in such case the removal of the growth must be done to restore the opening.

The meatus has been closed by the violent use of nitrate of silver, by which granulations were caused to grow and become organized, and occlude the orifice. Weintrach, of Vienna, described such cases in 1879, in which the closure had thus been intentionally done to induce deafness for the purpose of avoiding military duty. In these cases a little patriotism might be prescribed as a prophylactic against such mutilation.

The meatus may be closed by an osseous growth developing there and finally occluding the canal. In 1879, Delstanche (fils) of Brussels, wrote an essay on such exostosis, of which he collected twenty-five cases.

Delstanche finds that this growth can appear both before and after the ossification of the ear is complete. As causes assigned are heredity, and spontaneous or traumatic inflammation; also primary or secondary inflammation of the periosteum and bone. The growth occurs in all parts of the canal, yet it is oftenest noted on the posterior wall. Symptoms of such growth are deafness and subjective auditory sensations; likewise, the feeling of pressure and vertigo; all of which is due to closure of the meatus.

The treatment is surgical in character and consists in the occasional introduction of dilating sounds, and tents of laminaria. One may also bore through the exostosis and chisel it off; or the removal may be attempted by means of the galvano-cautery, or electrolysis. In one case Delstanche removed the bone by boring a part of the way; and he then softened the remaining wall with chloride of zinc, and thus removed the whole of it. Some months were occupied in the work, yet finally the bone was entirely removed, and hearing perfectly restored.

Polypus in the Auditory Canal.—A polypoid growth may arise from the wall of the canal, from the outer face of the tympanic membrane, or from the wall of the tympanum itself; the first site is very rare; the third is unusual, while the polyp springing from the membrana tympani is the one commonly seen. These growths are highly vascular, as a rule, and bleed when their surface is broken; a fact to be borne in mind when their extirpation is undertaken. Methods which have been pursued for their removal are excision with small curved scissors, cutting off by means of a snare-like wire, and plucking out by means of small forceps. Excision is rarely practiced, while removal by means of a snare devised by Wilde, or by forceps, are the methods in common use. Simpler cases of aural polypus may be treated by the surgeon; since the work of removal is easily done by carefully seizing the growth with forceps, and detaching it by traction and slight torsion. But cases which are deeply seated, or present other complication, are more properly committed to the aurist, whose special training has given him dexterity in manipulation of forceps or snare in the auditory canal.

The syphiloma has been seen in the auditory canal; its nature would be indicated by symptoms of secondary syphilis in other parts of the body. Gruber, in his study of syphilis of the auditory apparatus, finds that the disease more often attacks the deeper than the superficial aural structures. In all such cases the constitutional remedies against the disease should be administered.

Occlusion of the Canal by Cerumen or Foreign Bodies.—Cerumen, the normal secretion of glands seated on the cartilaginous or outer portion of the auditory canal, may accumulate to such amount as to close the canal. Though the ceruminous matter is generated in the outer two-thirds of the passage, yet when found in large amount, it is always situated in the deeper part of the canal in close proximity to, or in contact with, the tympanic

membrane. A large mass may exist and not be suspected; and it is only when the closure is complete that the ear is deafened: a small crevice of open passage to the membrana tympani suffices for the purpose of normal hearing; let the closure become complete from matter added to the mass, or let the walls of the passage swell from some cause, and at once the power of hearing in that ear is suspended. Ceruminous occlusion of the ear passage occurs only in the adult; the child frequently supplements his exemption by closing the canal with some foreign body just suited, as the child thinks, to stop the ear.

The history of the case as told by the patient, often enables the surgeon to suspect the nature of the trouble before he has examined the ear; by the aid of the speculum, or by looking into the ear, when the pinna has been drawn upwards, the dark mass of cerumen is seen. This may be removed by means of a minute tenaculum, which, being hooked into the outer face, the mass is drawn out. As there is danger in thus proceeding, of forcing the matter against the tympanic membrane, a preferable method is to inject a stream of tepid water into the open portion of the canal; thus doing, if the current of water be continued for several minutes, the mass will be loosened and will float out. The water should not be thrown in with too much violence; for by such imprudent work the membrana tympani has been injured. If the impacted material still remains immovable despite the syringing, then an effort should be made to dissolve it by pouring into the passage an alkaline solution; for this, lime water or a weak solution of carbonate of potash may be used. The solvent power of the solution will be increased by the addition of glycerine.

In persons in whom there is a disposition to frequent recurrence of ceruminous impaction, the trouble may depend on an abnormal activity of the producing glands, and an attempt should be made in such cases to counteract the tendency; for this purpose, an alterative remedy should be locally applied. We may select one of the following recipes, and apply it in the canal with a camel-hair brush, making the application once in two days:—

℞. Tincturæ Iodi Compositæ.....ʒss
Glycerini.....ʒiv
Misce.

℞. Olei Amygdalæ Expressi.....℥ss
Olei Cadini.....♏j
Misce.

℞. Unguenti Hydrargyri Nitratis .. ..ʒss
Petrolati..... ....℥ss
Misce.

℞. Extracti Ergotæ Fluidi.
Ichthyol... .. ..aa ʒi
Glycerini... ... ...ʒx
Misce.

℞. Chrysarobini..... ... .gr. iij
Petrolati.. .. ..℥ss
Misce.

The topical use of one of these compounds, applied once to the passage in two days, with irrigation to the canal with warm water on the intervening days, would act alteratively on the glands, and lessen their abnormal activity.

Foreign Bodies in the Auditory Canal.—The canal of the outer ear is a site of lodgment of small foreign bodies, which enter usually by accident in the adult; but children, inspired by the instinct of curiosity and the desire to explore the passage, push small bodies into it; examples of such foreign bodies are beads, peas, beans, leaden shot, pebbles, grains of wheat, in fact, any small object with which the child is accustomed to amuse itself. Among adults such accident occurs oftenest with those who handle hay or grain; the grain of oats, the beard (arista) of wheat, oats or barley, and fragments of straw are not unfrequently found in the ear; and remaining there, may cause much pain. The adult, commonly a male, may be quite ignorant of the cause of the trouble of his ear, for which he seeks advice, and he is astonished when the body is removed and shown him.

In both the child and adult, the foreign body is first introduced into the outer portion of the canal; and situated there, it is readily removed by the surgeon; yet usually before he has been consulted, through inadvertence or mismanagement, the body has been thrust to the bottom of the canal.

Various methods of extracting foreign bodies from the outer canal of the ear were known and practiced by the Latin physicians, as is evident from the following chapter of Celsus: "Now and then something is accustomed to fall into the ear, such as a pebble or some living thing. If a flea has entered, there should be introduced into the ear a little wool; and if the flea enters this, the wool and insect are to be withdrawn together. If this has not succeeded, or there be some other small animal in the ear, a probe wrapped in wool is to be dipped into some resinous

or very glutinous material (and for this a terebinthinate substance is the best); and the probe thus armed is to be introduced into the ear and twisted around; thus the object will be caught and removed. But if the object be something inanimate, then it is to be drawn out with an ear probe, or by means of a curved hook; and if the extraction cannot thus be done, the removal may be done by means of resinous matter, as before mentioned. Agents which provoke sneezing being used, may force out the body; also, water thrown into the ear with an aural syringe may force out the object. Or a table with wings adhering to each side may be placed in position, and the patient tied to the table, with his head lying on one of the wings, and the affected ear turned downwards; while the subject lies thus, let the wing which is at the feet be violently struck; thus there is concussion of the ear and what is contained in it drops out." The surgery of modern times gives many rules for the removal of bodies from the ear, the suggestions to which may be found in these lines of Celsus.

Should the patient be a child, the facility and security of the work will be promoted by first administering an anæsthetic. And before commencing the work of extraction, it should first be certainly determined that a foreign body is in the ear; and this can be done by the aid of a speculum and direct or reflected light. When the object is once seen, there is no risk of a fruitless search for something, as has occurred when such precaution was neglected.

Before resorting to instruments, the Celsian plan of concussion should be tried; for this, place the head horizontally, with the ear directed downwards; then by gravitation the body may fall out; and to aid this, the head may be shaken.

As instruments used for this work are a common syringe, a minute curette, and a small tenaculum, similar to that used in ophthalmic surgery.

In almost all cases, the injection of water into the passage will dislodge a body lodged there; this painless and simple method should be tried in the child, in preference to any other; for, in this way, without even a resort to an anæsthetic, the object can be removed, especially if this be of inorganic material, which cannot enlarge by moisture. As has previously been intimated, the syringe should be used cautiously; the violent force of water against the membrana tympani has caused fainting, which might be perilous if the patient be under the influence of an anæsthetic: likewise, as the author has known, the violent action of

the water can wound the membrane itself. If the body be a seed or grain which swells in germinating, then it may become so wedged in between the walls that the removal is very difficult. If the injection of water fails to remove the body, other means must be tried. Itard, a writer on this subject, advises to let the seed sprout, and then extract by means of the projecting roots; he has omitted to state whether he had tried his plan; his advice is probably an awkward attempt at witticism. To remove an impacted seed, anæsthetize, if a child, and then through a bivalve speculum, insert a tenaculum in the body and extract. If an attempt be made with a curette, pass this along the upper wall and insinuate it above and behind the upper end of the object. This is facilitated by the obtuse angle which the upper wall makes with the membrana tympani.

In the adult the object, according to the writer's experience, is oftenest a bearded grain of oats, or the beard from the barley or wheat spike, or a fragment of straw, and such object is often held in place by becoming entangled in cerumen. As a rule the object can easily be seized with a pair of forceps and withdrawn; failing thus, one can resort to the syringe. In both adult and child, if there have been failure to remove by the methods given, the receiving end of a rubber syringe, which would fill the meatus, might be introduced and a vacuum formed by which suction could be made on the body, and the same possibly withdrawn.

In the work of removing objects from the auditory passage, the careless or ill-adroit hand has often forced the body against the tympanic membrane and perforated it, or otherwise injured its delicate structure. Also the continued contact of the intruded body can open the membrane; and in such case the body may enter the cavity of the tympanum. In this condition, especially if the body be still lodged in the canal, the method mentioned by Celsus of inducing sneezing might be resorted to, thus the air, being forced backwards through the Eustachian tube, might dislodge the object. Or sneezing being induced and the mouth and nose being closed, as directed by Paul of Ægina, the object might be sneezed out through the ear. This old writer says, if one has not succeeded otherwise, let an errhine be placed in the nose, and then close the mouth and nose. Thus it is evident that in Celsus, one has a part of, and in Paul of Ægina, the whole of the procedure of Valsalva, of forcing air through the Eustachian tube.

Should one fail to remove the body by the methods described, the plan advised by Paul of Ægina might be resorted to, viz., to partly detach the pinna posteriorly, and thus form a shorter road to the body. This is approved by the anatomist Hyrtl, the aurist Tröltsch, and the surgeon Tillaux. To do this Tillaux counsels to incise posteriorly and superiorly, in the furrow between the ear and the head, keeping close to the mastoid bone. By this incision the canal is opened at the junction of the cartilaginous and osseous portions. Though one has not shortened the passage much, yet a more direct view of the object is thus obtained. Some advantage may result from the hæmorrhage from the cut, as thus the inflammation caused by the body is combated.

In case the body has penetrated the middle ear, as a means of removal it has been proposed to open the mastoid process, and thence forcing air or water into the tympanum expel the body. It is scarcely probable that this adventurous method will be tried.

Hæmorrhage from the Auditory Passage.—When blood flows from the ear after the head has been the subject of violence, as from a blow or a fall, it is a matter of importance to determine the origin of the blood: is its source extra-cranial or intra-cranial; or does it issue from parts both inside and outside of the cranium? If its source be from inside of the head through a fissure from fracture, the injury is one which menaces life; yet if the source be external, the injury is an unimportant one, and it then can arise from injury of one or more of the following structures. Violence that is first received on the chin may be transmitted along the lower jaw to the anterior wall of the auditory canal, and rupturing the lining of the bone, can cause bleeding. The violence may also reach and act on the tympanic membrane; this membrane contains, both in its outer and inner surface, arterioles, derived chiefly from the internal maxillary artery, and in the membrane they lie alongside of the handle of the malleus. From a rupture of these vessels as observed by Tillaux and Duplay, a considerable bleeding can originate. Also from a rupture of the mucous lining of the walls of the tympanum hæmorrhage can arise. And finally from fracture of the mastoid portion of the temporal bone blood may pass into the tympanum and escape through its membrane if that be torn; or if the membrane be intact, the blood may flow into the throat through the Eustachian tube. Le Bail, Duplay and others have made a

careful study of these points, and have shown that after injury of the head, bleeding from the ear may proceed from some of the superficial sources here enumerated. It must however be mentioned that though it arise thus superficially, the bleeding may arise from a fracture of the cranium at or near its base; thus a fracture of the petrous bone may open the carotid artery, and violent bleeding take place into the middle ear; such injury would be perilous, and would probably soon be followed by grave encephalic trouble; yet if the hæmorrhage originated superficially, it would soon cease, and be accompanied by no symptom indicating danger.

In fracture of the base of the skull in which the petrous part of the temporal is broken, though primarily there may be an escape of blood, yet this may soon cease, and instead, a serous fluid may continue to flow from the ear; the origin of the serum-like fluid has been a matter of discussion.

This discharge of fluid resembling serum has been carefully studied by Laugier, and his observations have been confirmed by Nélaton, Chassaignac, Guthrie and others. The fluid is at first stained with blood, yet later it becomes nearly colorless, and may vary in amount from an ounce to as much as two pints. A similar escape of fluid has been observed from the nose in injury of the cranium. The hearing may remain intact while such fluid is escaping.

Some five theories have been offered to explain this discharge. It has been claimed that it originates from the internal ear, and is the liquid of Cotunnius; the enormous quantity often seen disproves this opinion, and especially so when the escape is from the nose, as often occurs. Laugier erred in referring the source to a clot of blood lodged between the meninges and the adjacent bone, whence the serous content escaped; and this was again disproven by the small volume of such clot, and the absence of compression, which such coagulum must cause: and the analysis of the fluid made by Chatin, which revealed a great difference between the composition of this fluid and the serum of the blood, quite disproved the notion that such fluid is derived from a clot. And a similar objection can be urged against the opinion of Chassaignac that the fluid is from veins of which the walls have been thinned by stretching or tearing. Guthrie believed the source of the fluid to be the arachnoid membrane. The true source of this fluid is the liquor cerebro-spinalis; the arachnoidean cavity containing this is opened at a dependent point, where

the auditory nerve enters the internal auditory meatus, and thence through a fissure it may reach the middle ear. Besides this route ingeniously traced out by Bérard, it is probable that the thin bony roof of the tympanic cavity might be fractured and the fluid find egress there.

Concerning the intra-cranial source of such fluid, there can be no such doubt as is often the case concerning blood escaping from the ear, since in respect to the former there is no other fluid with which it could be confounded.

Mastoid Cavity.—The cellular antrum of the mastoid portion of the temporal bone is an important appendage to the middle ear, which in recent times has become one of the added fields of surgical occupation: or it may more properly be said, a section which having once been abandoned, has been reclaimed; for, as early as 1770, Jasser opened the mastoid antrum, so as to have a shorter road to the tympanum, through which injections could be made to remove obstruction in the Eustachian tube: and, at the same period, it appears to have been done to obtain a more direct opening into the tympanum than the Eustachian tube, in case of deafness from closure of the latter; and with this object the mastoid cells were opened by Jasser, in the case of Just Berger, the royal Danish physician; but as the operation caused his death, the procedure was quickly abandoned, and for more than half a century afterwards, there are recorded but three cases in which the operation was done. In 1847 Dieffenbach speaks of trephining the mastoid process as an operation which has been abandoned, and he says that it should be stricken from the list of surgical operations. About 1860, however, the operation was resumed again; and, due to the efforts of Schwartze, Péan, Buck, Schede and others, it has been given a merited and an enduring place in operative surgery.

Some anatomical description should be premised of the bony structure in which the mastoid cells are lodged.

Externally, the cells are bounded by a wall of bone which separates them from the skin, and the thickness of this wall varies from one to three lines; and according to Huschke this difference is not dependent on age, sex, or the volume of the mastoid process. Tillaux, however, finds it dependent on age, and that in the old person, it may be reduced to extreme thickness. The inner wall, a thin glass-like plate, has close relations with the lateral sinus; relations which have been fatally learned by the indiscreet trephine; for through this wall venules pass to the

sinus, along which disease may travel from the affected cells, and cause phlebitis and thrombus. The sinus lies on the inner face of the mastoid process, and nearest to its anterior border. (Tillaux.)

In front, the mastoid cells are separated from the auditory canal by a layer of compact tissue, and the relations with the canal and tympanum are such that pus can escape from the antrum into the auditory canal without entering the tympanum; and conversely, pus developed in the canal can pass through this anterior wall into the mastoid antrum, and thence travel into the cranium.

With these topographical conditions, as Tillaux has pointed out, pus in the mastoid region may have the following situations: pus may originate on the outer wall of the mastoid cells and afterwards traverse the wall and appear inside. In a second form, the pus may pass from the tympanum into the cells. Or the pus from one of these sources may penetrate the inner wall and attack the encephalic structures: hence, as to site, the pus may be extra-mastoid, intra-mastoid or intra-cranial.

Whatever situation the purulent collection may occupy, the proper treatment is to make a free opening through which the pus can be evacuated; and for this work the services of the general surgeon will sometimes be invoked. The indication is urgent and imperative; for if the diseased material once traverses the thin plate which separates it from the brain, the patient's life is often lost. All those operated on, however, do not recover: Poinsot has made a collection of ninety-one cases in which the mastoid bone was opened for the liberation of pus; of these fifteen died and seventy-one were cured. These figures justify the operation, even though some of the cases might have recovered without surgical intervention. Still non-interference is unwise, for nature, possessed as she is of unlimited time for her work, too often appears too tardily on the scene with relief; the lethal work of disease has been completed through the pus seeking an intra-cranial route rather than an extra-cranial outlet.

The work of opening the mastoid cells has been done with the gouge, the drill, the trephine, and the chisel and mallet; the gouge, chisel and mallet are the best; though in cases in which the wall is very thin, the opening might be made with any species of cutting instrument.

The operators, though in accord in reference to carefully shunning the lateral sinus, do not agree in reference to the point

at which this can best be done. Hyrtl directs to open the external face of the mastoid process, and not to open behind this, though the latter structure is properly the mastoid portion of the temporal bone. This is directly the contrary of the advice of Tillaux, who says that the lateral sinus corresponds in the cranium to the anterior border of the mastoid process. Poinsot, who has written extensively on this subject, counsels to do the work by first making a crucial cut through the soft parts; namely, a vertical cut over two inches long, is to begin at the temporal ridge, and thence downwards; this is to lie about a half inch behind the concha. The vertical incision is to be intersected by a horizontal cut which lies on a level with the superior wall of the auditory canal. In this work a branch of the posterior auricular artery may be severed and require torsion or ligation.

At the point of intersection of the two cuts, according to Desarénes, one finds near the posterior root of the zygomatic process, a slight depression in the bone, which, he thinks, is the proper point for opening the wall. Should, however, there be discovered a disease point in the wall elsewhere, this, of course, should be selected for the opening. But whatever site may be selected, the orifice made should have a direction inwards, forwards, and slightly upwards, a direction parallel with the auditory canal. The opening must be made with care, especially as one reaches the inner wall. With whatever instrument it is done, the outlet must be sufficient for the free escape of the purulent matter: and this enlargement of the opening is readily done with small exsecting forceps, of which a good one may be found among forceps used in dentistry. Since the cells, the site of suppuration, do not intercommunicate freely, these should be broken down so that the part can be perfectly evacuated. The cavity thus opened must be irrigated daily with some aseptic fluid; carbolized or alcoholized water may be used. During the period of separation, a drainage tube must be retained in the opening. A number of weeks, or even months, may be required to complete the cure. The wound, during the period that it is kept open, is the site of an exuberant granulative growth, which must be repressed by potential cauterization. Nevertheless, after the closure, a fibrous neoplasm may appear on the site of the previous wound: a neoplasm resembling keloid and very difficult to remove; for, as the writer has verified in a case treated by him, despite radical removal by the knife, like a keloid growth, the neoplasm soon reappeared. In such a case non-intervention would

be the better course, especially as the post-auricular site of such growth conceals it from view.

In the scrofulous child suppurative action of lymphatic glands seated on the mastoid process may implicate the latter, and terminate in necrosis of a large part, or of the entirety of the mastoid process. The author has seen instances of this: in one, the entire process became necrosed and was removed. The hearing was not affected; but there remained a slight degree of torticollis.

The mastoid process has been fractured by a bullet; such a case was seen by Dupuytren. The sterno-cleido-mastoid being inserted into this bone would tend to displace the fragment downwards; acting similarly to the triceps extensor cubiti, or quadriceps extensor cruris in fracture respectively of the olecranon and patella. There would be, after such displacement, much difficulty in maintaining coaptation of the parts. A bandage, as suggested by Hyrtl, would not accomplish the purpose. A plan which might succeed would be myotomy done near the upper end of the muscle. A more certain means of maintaining union would be by metallic ligature. This could be used here more easily than in the case of fractured olecranon and patella, in which it has been employed; in the former fracture, there is no joint which would be endangered, like that of the elbow or knee. For metallic suture, first drill a canal from above downwards, which beginning above in the mastoid process shall traverse a section of this bone, and be continued longitudinally through the fragment below; through this canal, a wire may be passed by which coaptation can be effected, and union secured: treatment analogous to that sometimes pursued in cases of ununited fracture.

Emphysema, called also Pneumatocephalus, situated in the mastoid region.—The external wall of the mastoid portion of the temporal bone is often extremely thin, as has been pointed out by Hyrtl; and to an opening through this is due the occasional appearance of a collection of air beneath the scalp, which is similar to a gaseous accumulation in the soft parts elsewhere, and has been named here pneumatocephalus, and also pneumatocele.

Though air may escape from the mastoid antrum in consequence of a fracture of the wall, and insinuate itself beneath the scalp, yet pneumatocephalus proper is that form of trouble in which a tumor containing air has appeared without any antecedent fracture. In such case, through a weak point, or an opening

in the outer wall, existing congenitally, the air is forced from th throat into the middle ear, and thence into the mastoid antrum and through the defect in the mastoid wall the air appear beneath the soft parts. For this to occur, strong expiratory effor is required, as in coughing, sneezing, and blowing the nose.

Costes of Bourdeaux, in 1859, seems to have first observe pneumatocephalus; in 1865, Thomas of Tours described it as tumor of irregular surface, situated behind the ear, and which by pressure, is reducible, and can thus be caused to disappear As it disappears, the escaping air can be heard in the ear, an perceived passing into the throat. A similar collection of ar can appear on the frontal region, arising from fracture or defec in the outer wall of the frontal sinus. By far the greater numbe of cases of pneumatocele which have been recorded were situate in the mastoid region. In all these cases, the tumor occupie only the upper portion of the mastoid bone, and extended thenc upwards towards the summit of the cranium.

Besides deforming the head by its volume, the pneumatocel becomes a source of inconvenience to its possessor through th whistling sound which arises from the escaping air when th patient rests his head on the affected side. The variable volum of the tumor, its temporary disappearance under compression and the roaring or whistling sound which arises from pressure are symptoms which denote the character of the tumor.

Treatment.—As the tumor tends to advance rather than t recede in volume, an attempt should be made to obliterate it: a methods to effect this, the following have been tried: compression seton, incision, and the injection of iodine. Compression i similar to all other means in medicine which cannot harm, ye are incapable of doing much good; pneumatocephalus has beer relieved, but not cured, by pressure. Adhesion must be obtaine between the bone and the uplifted scalp, else the air will ente and refill the cavity. Some inflammatory action must be awak ened. The seton has been tried; but here, as in other cases, th irritation excited is too limited. To do the work more thoroughly the cavity has been laid open by a free incision, with the view o obliteration through suppuration and granulative action. Th work thus done was too thoroughly done; a case thus treate ended fatally, through the inflammatory action extending throug the cranial wall, and causing meningo-encephalitis. Henc incision is perilous and, as a safer method, recourse has been ha to injections of the tincture of iodine; in this way pneumato cephalus has been successfully treated.

In the concluding section to this chapter on the surgical affections of the ear, the writer will refer to a class of cases in which suppurative action beginning in the tympanic cavity, or mastoid cells, has passed into the cranial cavity. Such pus in its intra-cranial immigration might pass upwards and appear in front of the petrous portion of the temporal bone; or it might appear external to or contiguous to the lateral sinus; or it might travel behind the lateral sinus, and affect the cerebellar portion of the brain; that is, pus forming in the middle ear might enter the middle cranial fossa, and involve the contiguous cerebrum with its membranes; or it might appear in the posterior fossa and involve structures beneath the tentorium. Pus in these positions, if in large amount, would cause symptoms of cerebral compression: there would be mental unconsciousness, coma, a slow full pulse and probably dilatation of the pupils. With such symptoms, if trephining the mastoid process did not detect pus, one would be justified in pursuing the search further, viz., to seek for pus inside of the skull, by opening the wall. For this purpose, lay bare the skull above the mastoid bone, and apply a trephine above the superior root of the zygomatic process, viz., above that ridge which is continuous with the temporal ridge. An opening could be safely made here; and through such fenestra one could examine and determine the condition of structures which lie in the petroso-squamous interspace; and also the search might be continued inwards over the roof of the tympanum, through which disease sometimes passes into the skull. Such explorations can readily be done by detaching and uplifting the membranes with a blunt dissector. Should no pus be found, and yet the membranes present signs of disease, an opening should be made in the latter, through which, if pus be discovered, an outlet will be provided through which the concealed material can escape. If the search for purulent material prove fruitless at this point in the squamous portion of the temporal bone, then an opening should be made through the suture which separates the mastoid from the occipital bone; here there would be some risk of injuring the lateral sinus. By such exploratory trephination, intra-cranial pus whether of tympanic or mastoid origin might be found, and an outlet for it furnished. If pus be found, the site of it should be antiseptically irrigated, and free drainage be provided through a tube, and downward lateral position of the head. In this unusual manner of proceeding some opportunity would be offered to the patient of saving

his life, which, without surgical interference, would certainly lost.

In former days, when penetration of the cranial wall a search for disease were forbidden or neglected, the writer rec fatal cases in which the procedure here advised would h offered the patient a chance to escape from death. Some work this, but little trodden, field has successfully been done by M Ewen: work original and of great interest, and reflecting h credit on its author. Under his guidance, no one need hereat dread the dural sinuses.

CHAPTER VIII.

SURGERY OF THE FRONTAL REGION.

Frontal Region.—The frontal region, bounded above and laterally by the hair, and below by the occular cavities and the nasal region, is the seat of a number of surgical affections, and these, proceeding from without inwards, are located in the skin, the periosteum, and the bone.

In the skin during the evolution of puberty, and continuing a few years afterwards, the sebaceous glands are often the site of abnormal activity, in the form of acnaceous eruption. Sebaceous acne bears a resemblance to the atheromatous cyst; the former is a miniature model of the latter; and the opening which may be found in each, is of similar size. Acne, though occurring on the cheeks, is especially conspicuous on the forehead, and from the unsightly appearance which it gives the forehead, it becomes a source of sorrow to its youthful possessors: a sorrow that the mirror multiplies; and though time will eventually relieve him of his anguish, yet that method of relief is too tardy for youth; so that physician, surgeon, and specialist are often appealed to.

Treatment.—A simple means of relief, and sometimes cure of this affection, is the use of strongly alkaline soap, such as is often manufactured in the farmhouse. An article similar to this is a species of soap sold by the chemist under the name of German green soap. Let either of these articles be rubbed well on the affected parts at night; and on the following morning let this be washed off. A repetition of this application a few times often removes the acnaceous points. Another remedy that may be employed for the same purpose is corrosive sublimate in an emulsion of sweet almonds, viz., in the proportion of two grains of the sublimate to an ounce of the emulsion; this should be applied twice a day. A third remedy is an ointment of calomel, viz., five grains of the submuriate of mercury to an ounce of spermaceti ointment, applied twice daily. These local remedies are preferable

to the methods, sometimes adopted, of pressing out the harden sebum, or of splitting the cup-shaped cavity and expressing t contents.

The frontal integument is the site of benign and maligna growths; the latter class is so rarely seen here that our attenti will be limited to a consideration only of the benign neoplas

The verrucose or warty growth seldom appears on the front integument; yet it may do so, and is then most frequently whe the hairless skin meets the scalp; and the site there may int fere with the head-dress. The removal of such growth is b done by means of a circumscribing incision, which, to be effectu must reach quite through the derm. If the gap made be larg it should be closed by a suture.

Lipoma frequently occurs in the integument of the front region, and is usually of the fibrous species, in which fibro tissue is the predominant element of the growth. The mo ordinary site of this growth is on the frontal tuberosity, and origin there is probably due to the long-continued pressure of t hat, or some article of head-dress. It is oftener seen in the ma doubtless referable to the weight and pressure of the hat on t upper part of the forehead. If such growth attains a volun which interferes with the dress of the head, it should be remove For this purpose an incision, directed horizontally or verticall should be made through the skin to the growth, and when this reached, it is to be uplifted with a tenaculum and dissected fro the under surface of the skin, to which it is closely adherent. A this detachment is tedious, owing to the close adherence of t skin to the tumor, which in flattened form, due to pressure, intimately joined to the skin; in fact, this adherence to, and fusi with, the skin is the distinguishing characteristic of the front fibro-lipoma. The connecting bands of adhesion must be patient cut asunder with scissors or scalpel; for it cannot be rapid lifted out of its recess, as one does with the normal lipoma. T irregular wound made by such dissection does not heal rapidl as a rule, and will require much care in dressing to avoid unsightly scar. Since the site of this scar is such as to render conspicuous, the operator must study to lessen and conceal it much as possible, and to do this the line of incision should be one of the wrinkles or furrows which often exist in the front tegument; and since the vertical or horizontal furrows may p dominate in depth, the deeper one should be chosen for the inc ion; usually this can best be done horizontally.

The angioma often occurs congenitally in the frontal region; and the vascular growth presents itself in various forms; there may be only a miniature point, or it may embrace a large space; it may be definitely bounded, or, without clear limit, it may vanish insensibly in the adjacent structure. It may be venous in structure, or arterial and venous elements may be intermingled. It may be situated only in the surface of the skin, in the form of the so-called wine-mark; or it may occupy the papillary structure of the derm, or it may extend quite through the skin. Varicose dilatation seldom occurs here. Appearing as a speck in the new-born child, it may soon grow, and, in a few months, spread over a large surface. Within eight months more than half of the frontal region was occupied by the vascular growth, in a case seen by the writer. Again, having attained wide dimension, it may cease to grow, and may even recede and vanish.

For further description of the angioma and of the means employed for its extinction, the reader is referred to a previous chapter of this work, in which this subject has been fully considered.

The frontal wall of the cranium is the occasional site of exostosis; and this may spring from the outer plate, or from the diploëtic structure. Such osseous growth has been found most frequently at the site of the frontal tuberosities, or near the junction of the frontal, ethmoid and superior maxillary bones; and in this latter situation the osteal growth can encroach on the orbit. Such growth demands surgical aid, both to free its possessor of deformity, and of obstruction to the subject's head-dress.

The exostosis, here as elsewhere, must be excised from its parent bone; and to guard against re-growth, the excision must include the external plate of the cranial wall, and should reach slightly beyond the growth. If the section made be a smooth one, the wound will heal quickly, with but slight scarring.

The secondary manifestations of syphilis seem to have a preference for the frontal region as field for their development. In the dermal structures Venus displays the elements of her varying coronal chaplet in the diverse forms of rashes which, enumerated in climacteric order, are maculated, papular, squamous, vesicular and pustular. After these eruptions have taken possession of the surface, the disease, like a Messalina, in orderly disorder revels in riot, and seeks ground for further occupancy in the deeper structures, in the form of the syphiloma or gummatous tumor. The gummatous growth develops within

the derm, the pericranium, the bony wall, and then, if followe it may be found in the dura mater and brain.

The superficial syphilides, if the patient receive early an proper treatment, will vanish and leave no trace; but neglecte until the pustules have destroyed the surface and ended in ulce ation, then, though the disease be controlled by treatmen enduring vestiges of it will remain.

The gummy growth in its site can be limited to the derm oftener it arises from the periosteum, and implicates the wall the skull. In each situation it may, under proper local and co stitutional treatment, disappear by absorption, and leave onl slight marks of its previous existence: viz., such fortunate endin is often obtained by the topical use of iodine, and the interna administration of mercury and iodine. In many cases, howeve the gummy growth ends by caseous and suppurative change; an then, if the soft parts are the site, they become the site of chron ulceration, of which the healing is tedious. But in those case in which the gummata arise from the periosteum, or still deepe from the diploëtic structure of the frontal bone, then extensiv caries may be the event, in which the outer plate, or the entir thickness of the wall, may be destroyed. When the gummat occupy large districts of the bone, these growths in their regressiv change may, by depriving the osseous tissue of its nutritio cause death of separate sections; or a large mass of the vertica portion of the os frontis may become necrosed. Caries or deat of small sections of the osseous structure is oftenest seen in th supra-orbital ridges; the external portion of those ridges is frequent site of syphilitic caries. Whether the necrosis be on large or a small scale, the dead structure must be removed; als the affected bone bordering the necrosed portion must be excise This rule is specially incumbent when the caries is in the form of a fistula, in which form it often penetrates the entire wall. such fistula be merely curetted, it will not close, but caries wil soon reappear in the sides around. Where large portions of bon are necrosed, they should be removed through incisions made i the soft parts; and, at the same time, marginal portions whic are diseased should be excised. And the operator should eve bear in mind that this local excision is but plucking leaves fro the tree, which also must be attacked by collateral constitutiona treatment, plied rapidly, persistently and thoughtfully.

Frontal Sinus.—The frontal bone is the site of two hollo spaces, which are situated above the root of the nose, and each on

lies respectively over the inner portion of the orbit. Similar to a monstrous diploëtic cell, they are situated between the inner and outer plates of the cranial wall. These spaces, filled with air, communicate by means of an infundibuliform opening with the middle nasal meatus. They are absent in childhood, and only begin to appear when the subject is over ten years of age, and at eighteen years these cavities have nearly reached full development. Their appearance is, in some measure, coincident with puberty; yet in a few subjects they never develop, and when present, they vary much as to dimension, being, in some cases, very diminutive. If a section be made of a skull, in which the sinuses are of normal dimensions, the space will be found to be pyramidal, the base resting on the partition which separates the two, and the apex lying over the external orbital process. One is usually larger than the other, and the separating portion does not lie in the median line. Each sinus will contain, on an average, a half drachm of water. They are lined by a mucous membrane, which is white, smooth, thin and non-vascular, thus differing from the mucous membrane which lines the nasal passages, which is much thicker, very vascular, and studded with glands, which do not exist in the lining of the sinus. This mucous membrane has a ciliated epithelium, is provided with nervous filaments, and its deeper stratum readily ossifies.

This larger air cavity is the subject of accidental injury and disease. Fracture has here occurred; likewise, gunshot wound. In case of fracture, the outer plate alone may be broken, and forced into the sinus, either as depressed bone, with attachment of the fragment to the bone adjacent, or the fragment may be quite detached and lie loose in the hollow space. And, lastly, from some penetrating object, as a piece of broken glass pottery, or a pointed object, both walls may be broken. The error has been made of mistaking fracture of the outer wall, accompanied by depression, for fracture which implicated both outer and inner plates; for in the former, similar to what is seen in the latter, blood, tissue or pus may rise and sink in the cavity, and such motion may be wrongly referred to encephalic movement, while it is merely caused by the action of the air in the nasal passages. A French surgeon records such a mistake made in the diagnosis of an injury made in this region. If the probe failed to determine the extent of the injury, light on its nature might be gotten by letting the patient breathe through his nose, or suspend the breath for a few seconds; in either act the fluid lodged in the sinus would remain quiescent.

A simple fracture with only depression of the bone, withc opening through the skin, if not a signal deformity, should be l to the care of nature; should, however, the deformity be strikir by drilling a small opening, the bone might be restored to its natu place. If, with an open wound, the bone has been broken anc fragment lies loose in the sinus, this must be removed, throu the existing opening if this is possible, or if this be too sma enlarge it. In such injury, unusual care should be given to secu occlusion by means of aseptic dressing, lest exposure of t fractured bone should permit the broken margins to die, and th a tedious healing result.

The frontal sinus has been opened by gunshot injury, and t missile has lodged and remained for a long time in the cavi and if the missile were so impacted as to be motionless, it mig be left there; the anxiety of the patient would seldom be conte with such inert conservatism. The ball could be removed an opening made with the trephine. The missile, in a report case, escaped through the nose.

Larvæ of insects, in both man and animals, have entered tl sinuses from the nose, and have developed there. Dislodgme of such intruders has been effected by arsenical vapors; it probable that the fumes of tobacco would be an equally efficie as well as a much safer agent to be used, and to many patients would not be repulsive.

Blumenbach mentions a case of a curious intruder into tl frontal sinus, viz., a many footed insect named scolopendra ele trica, which, safely housed, tortured its bearer for over a yea Osteoma originating in the frontal sinus was the matter research by Dolbeau, in 1871. He says that the osseous growt proceeds from the mucous lining, and, hence, that it is easi removed when the front wall of the sinus is opened; in fact, th such osteoma can be lifted from the cavity of the sinus as readi as a stone can be removed from the bladder to which an openir has been incised. Richet asserts that the removal is more difi cult; he cites cases in which it was necessary to chisel the growt from the bony wall of the sinus.

The lining of the sinuses is the site of an excretion which, fro morbid change of the generating membrane, may become muc purulent. As long as the outlet into the middle nasal meat remains open, this material would have free outlet; but shoul the funnel-shaped orifice become occluded, then this conte would be retained, and induce disease in the containing wal

and, if unrelieved, the continued increase of the muco-pus, by pressure, would reopen the normal outlet, or pierce the front wall of the sinus. The pent-up material, from the author's observation, singularly and fortunately enough, spares the posterior thin wall, and causes caries of some point in the anterior wall, which finally opens and allows the content to escape.

Before the appearance of pus through the nose or the anterior wall of the sinus, it would be difficult to determine its presence there, and the only trustworthy means of doing so would be to make an opening into the cavity; and this could be done through the nose, or, more directly, by drilling a small opening through the anterior wall; the latter would be the preferable way, since afterwards through such opening a flexible probe or silver wire could be introduced and carried to the lower angle of the sinus, and the occluded outlet opened. And even a drainage tube might be carried from the sinus into the nose, and be tied and retained in place for what time would be requisite for the recovery of the cavity. To hold the tube in place, a thread should be fixed to its upper end, and at its point of attachment so enlarged by a knot as to prevent the tube from escaping unless considerable traction be made on it. This thread will lie alongside of the tube in the middle nasal meatus. Through this tube the sinus can daily be washed out with some antiseptic fluid; meantime, any fluid excreted there can readily escape. And when the escaping material denotes a return to health, the tube can be withdrawn by making traction on it and the thread at the same time. It is probable that the tube would have to be retained in place for three months at least, before the sinus would be restored to healthy condition.

When, however, the case comes into the surgeon's hands after the sinus has opened entirely, and there is a fistulous opening where muco-pus opened, then another course of treatment will be demanded. In such a patient, the anterior wall of the sinus will be found in a carious or semi-necrosed state: a condition most unfavorable to healing. Five cases of the kind have been seen and treated by the writer: the sinus had an opening piercing the anterior wall. In one of the cases, the orifice was beneath the superciliary arch, where the orbital plate ends in the vertical portion of the os frontis; in three others, the opening was slightly higher than the point here mentioned; and in a fifth one, the orifice into the sinus was near the middle point of the anterior wall of the sinus. In the patients here mentioned, who

were all adult men, the following were the causal agencies: one, the affection of the sinus was the sequel of measles, co tracted after puberty; in one it was from constitutional syphili in a third, the cause was traumatic, in which the bone had bee fractured with an open wound of the soft parts; in a fourth was traceable to scrofula, and in a fifth man it was doubtf whether it had syphilitic or scrofulous paternity.

In the four cases which originated in constitutional diseas deep-seated pain of a neuralgic character had preceded the ope ing of the sinus for a long period.

In the patient, in whom the sinus was opened by fracture du to violence, there was a persistent trial of various means to effe a cure: injections of iodine and other stimulating agents we used topically with the object of restoring the inner wall to sound condition. In this way the discharge was temporari arrested; yet this soon reappeared. Curetting the cavity w also ineffective. The man retained his diseased sinus for over year, when he died from a chronic diarrhœa, which seemed have no connection with his local trouble. A necropsy w made, from which it was apparent that the local treatment whic had been pursued, had fallen far short of restoring the diseas wall to integrity. In fact, when the anatomical conditions pre ent are considered, it is seen that they are wholly unsuited effecting a cure; the breach in the wall cannot bridge over wit osseous structure. And even if such closure were possible b dermal covering, and though the usual outlet of the sinus we reopened, it is probable that the latter would become occlude again, and the pent-up excreta would force a passage throug the point which had been closed. These facts, and the failure accomplish anything satisfactory by conservative topical trea ment, convinced the writer that the proper way to treat suc cases is excision of the anterior wall and total obliteration of tl sinus. In this way four cases have been treated with successf result by the writer. To perform this osseous exsection, the s parts covering the anterior wall should be carefully uplifted l means of a long-horizontal and a short-vertical incision; the ver cal cut should end over the inner angle of the eye. Next, l means of a pair of forceps, which is used by the dentist for alveol excision, the removal is done by inserting one blade of the force into the cavity, and excising a portion of the border of the out wall. This work of excision by piecemeal can be continued all directions, until the whole of the necrosing wall is remove

As remarked before, the inner wall of the frontal sinus is found but slightly affected in these cases; and whatever abnormal structure is discovered there, can be scraped off with a curette. The wound is now to be sprinkled with iodoform, closed by suture, with provision made for temporary drainage; this latter can be removed in the fourth day. There will be recovery in from three to four weeks. This speedy healing is in marked contrast with the long and tiresome efforts which are often made in such disease to obtain a cure by conservative means, which end in failure. In the case which had arisen from an exanthematous affection, the writer ran through the list of topical means, including curetting, with the only result to see the suppurative action soon reappear. After this radical excision (the first case in which it was tried) both patient and operator were surprised to see the part entirely healed at the end of twenty days.

The question is asked: Does this exsection not leave a formidable scar and change of form? This, in fact, is a serious objection to the procedure; a permanent cicatrix with depression of surface remains. But the patient is cured; he is freed from the pus-exuding orifice which hitherto disfigured his forehead; and he is delivered from the necessity of spending some time daily in cleansing this diseased point. Before the operation is done, however, the patient should have these points placed clearly before him, and as he elects, so should the surgeon proceed. In all operations which are done for cosmetic purposes, and which do not concern the life, but the convenience of the patient, the option of the latter, unbiased by persuasion, should guide the operator; the latter should scrupulously withhold his hand from giving that artful touch to the scales, which, too often unperceived, turns them from impartial poise. In all such cases, an excellent rule is to let "even-handed justice present the chalice" to the operator; and if he would willingly accept it, the patient will not err in commending it to his own lips.

Trephining, how done over the Frontal Sinus.—As site for entering the cranial cavity the region of the frontal sinus is never chosen; sometimes, however, it becomes necessary to trephine there, and then the operation requires some modification. If the same instrument be continued through the outer and the inner plates, when the boring crown reaches the inner plate, it will become entangled with the mucous lining of that plate, and uplift and tear this structure in an irregular manner. To avoid this, Boyer advises to use a larger crown to perforate the outer plate and a smaller one to open the inner one.

Schillbach, of Jena, in 1860, advised to trephine through t outer plate, as had previously been done by Reid, for the remov of neoplasms which arise in the sinus, or which, originating in t nose, extend into the frontal sinus; and such operation may required for the removal of a foreign body that has lodged the In such cases, Schillbach counsels to expose the bone by a ho zontal and vertical cut over the inner angle of the eye. T opening is to be made at the junction of the nasal bone with t frontal bone. If need be, some bone may be exsected. In thr cases, trephining was done in this way. After the trephining h accomplished its purpose, the communication with the no should be established, and the opened integument closed suture.

CHAPTER IX.

NOSE AND NASAL PASSAGES.

THE nose, as the portal through which objects of smell are admitted, and by which in respiration air should enter, has recently been abandoned to the specialist; still many of its affections fall within the sphere of general surgery; and prior to studying these affections, it is proper to consider some points in the anatomical structure of the nasal apparatus.

In its central and promontory-like position the nose is favorably situated to receive violence, and avert in some degree its effects from the eyes and front of the cranium. The visible prominent portion is composed anteriorly of cartilage, and posteriorly of bone; a disposition likewise protective in nature. The prominent external portion presents a root, dorsum, tip or lobule, sides, wings, septum, and openings of the nostrils. And each of these may vary in outline, figure or volume; such variety being characteristic of race. And each of these parts of the nose may, through injury or disease, deviate so much from normal type as to become the subject of surgical treatment.

The dermal integument at the root of the nose is thin, smooth and easily moved on the subjacent bone; but below, where it lies on the cartilage, it is closely adherent to the latter, and is thick: hence, the integument at the root of the nose is suited for plastic purposes, since it admits of displacement; while that covering the cartilaginous portion is ill suited for such purposes. The skin of the nose has a rich vascular endowment; this condition adds to its vitality and favors the rapid healing of wounds here: even if a portion be partially or wholly detached. This vascular quality favors hypertrophy. The skin of the nose is the site of sebaceous glands, of which the distribution is irregular: viz., few glands exist on the dorsum, while they are more numerous on the sides, and most abundant on the wings of the nose: hence, the more frequent derangement, or disease, of the glands in the latter sites. The subcutaneous tissue is thin and loose over the

nasal bones; but on the cartilages it is thick and closely adherer to the skin.

The muscles of the nose, greater in name than in materia puzzle the anatomist to clearly demonstrate them, since they ar dwarfed to inconspicuous vestiges, except the pyramidalis nos which, reaching from the root of the nose upwards, is concerne in rhinoplasty, when restoring material is taken from the fronta region. If this muscle be included in the twisted flap, the latte is lessened by contraction of the muscular element.

The osteo-cartilaginous framework maintains the nose in it prominent form; and from disease or injury of it, sunken nos can result. The osseous portion consists of the nasal bones, an a partition composed of the vomer and the perpendicular plate c the ethmoid. The nasal bones, arch-like, have great strengtl enabling them to resist external violence; but the partition, whic is less strong, is screened from injury by the protective vau above; in fact, it adds to the strength of the latter. The carti laginous portion is movable, and, according to the statement anatomists, cannot be broken, though surgeons have reporte such fracture.

The external skin passes into the nares, and as it penetrate inwards, at the entrance it contains strong, short hairs; but as reaches farther inwards, it loses its dermal character, and assume the character of mucous membrane: yet, as mucous membran a portion of it is imperfect in excretory function; but this compensated by fluid which is poured into the nasal passages o every side from the adjacent sinuses, viz., maxillary, sphenoida and frontal.

Much of the surface of the nasal fossæ is lined by a mucou membrane of a peculiar character, named the pituitary or Schne derian membrane. The Schneiderian membrane is thicker tha ordinary mucous membrane; this thickness is such that it lessen the space of the fossæ, and tends to lessen the calibre of th orifices which open into the cavity. It is thick and resistan where it lines the floor of the nares, as well as where it invests th basilar process of the occipital bone; but on the turbinated bone it is soft and pulpy. This membrane is composed of two layer a deep one that adheres to the bones and cartilages, and is fibrou in structure; and a superficial one which lies on the preceding soft and very vascular; and above, where the olfactive nerve enter this superficial stratum is clad by ciliated epithelium. Mucou glands lie in the pituitary membrane.

The nasal cavity is divided into a right and left passage by the vertical partition; and these passages are bounded by an internal, external, superior and inferior wall. The inner wall, usually regular, may be irregular from deflection or deviation of the vertical septum; the outer wall is in the highest degree irregular in surface, owing to the scroll-like form of the turbinated bones which are attached to it and constitute a part of the wall. The upper wall is narrow, and, according to Richet, it measures from one inch and three-quarters to two inches in length. The lower wall, or floor, measured from the anterior nasal spine to the posterior one, is shorter than the upper one.

Behind the nasal passage lies a space, which, as the frequent site of neoplasm, should be studied by the surgeon. Though it may be represented as having six sides, yet two of these are open, viz., the anterior, which opens into the posterior nares, and the inferior one, which is only closed when the soft palatal veil is uplifted, as occurs in swallowing. The other four sides, which are bounded by walls, are the superior, posterior and lateral. The superior wall, bounded by the occipital basilar process, forms, with the posterior wall, an angle of one hundred and thirty degrees; and if the head be turned backwards, the angle becomes greater, so that the two surfaces are nearly continuous. This disposition is utilized when it is necessary to pass a tube or sound through the nostrils into the pharynx; such instrument passes without interruption. The posterior wall corresponds to the atlas and axis; it is two-thirds of an inch high. The lateral walls are adjacent to the carotid artery, the internal jugular vein, the vagus, hypoglossal and the sympathetic nerves. On this wall opens the Eustachian tube, at a point on a level with the prolongation of the inferior turbinated bone.

The nasal fossæ are divided, on each side, into three passages by the turbinated bones; these passages are known as the superior, middle and inferior meatuses. The middle meatus, into which open the outlets from the frontal and maxillary sinuses, and the lower meatus, into which the lachrymal canal ends, are the two passages with which the surgeon is mainly concerned.

Defects.—The nose is the site of defect, which may be congenital or acquired; it may also be the site of injury and disease.

As congenital defect, a case of absence of the nose has been seen by Maisonneuve: instead of a nose there only existed a plane surface pierced by two openings. This is the only instance of such defect that the writer finds on record. An attempt was

made by Maisonneuve to improve the appearance of the part by lifting up a bridge-like fold of skin, provided with a median narrow portion, which being turned inwards, served as a septum or division of the subjacent space. As there was no cartilage to maintain the form, it is probable that, like many examples of restoration of parts by the plastic surgeon, the restored part is fairer in description than in actuality.

As the reverse of the defect mentioned, cases have been observed in which nature was too generous in her gifts to the new-born: the infant appeared with a double nose. Also, the new-born has had a nose which was much too great in volume. Duplicate form would puzzle, if not baffle, surgical effort; more, however, could be done where there was merely excess of volume; yet even here there should not be haste to intervene. For the infant's nose, which is always shapeless at birth, through the plastic molding of evolution undergoes singular changes, changes by which feature is acquired which is absent in the new-born; for at birth infantile noses are all alike: featureless, expressionless; feature, expression, and character, if an old writer,* be credited, appearing in the changes which growth brings. Hence, in view of the improvement in form which time may bring to the abnormally large nose of the infant, intervention should not be premature, lest nature be thwarted in her reparative effort. Should, however, the infantile nose have such excessive proportions that time instead of retrenching will add to them, then some of the excess may be removed by cuneiform excisions so situated and directed that when closed by sutures, the remaining part will conform to normal form.

The entrance of the nostrils of the new-born may be abnormally narrow; such narrowness, for its relief, does not demand operative interference; care is chiefly to be directed to preventing the nose from becoming still narrower, as occurs where there is ulcerative disease. To oppose closure, tamponing plugs should be introduced from time to time.

Injury.—The nose may be the site of incised, lacerated, and contused wounds, with or without fracture, and there may be fracture without lesion of the investing integument.

The incised wound occurring from accident, or intentionally made by the surgeon's knife, is not infrequent. Such wound, owing to the vascularity of the derm here, bleeds freely; and for

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*Noscitur ex naso.

the same reason, heals readily. This is true of both incised and contused wounds. And even where a portion of the nose has been cut off, the detached part can often be reunited. Béranger-Ferraud has made research in this field, and finds sixty-five cases on record in which the detached portion of the nose was successfully restored to its place. Martin and Hoffacker have collected a number of similar cases. According to Galen, even though the fragment has been separated from the remainder of the nose for from twenty to sixty hours, yet an attempt should be made to save it, since recovery has been obtained in such cases. In attempting reunion of such fragment, the clots of blood should be carefully washed from it, as well as from the surface to which the former is to be restored. The bleeding must be thoroughly staunched, even though it be necessary to tie a vessel. The raw surface being thoroughly cleansed with alcoholized or sublimated water, the fragment must be fixed securely in position by means of metallic suture, or by the twisted suture. Warm, moist dressing should be applied over the part. Cold dressings, used by some, are improper, since the cold must contract the parts and impede the cell-growth requisite for healing. The replaced fragment often remains cold and pale for some time; in fact, for hours it may have a cadaveric hue. Holmes Coote observed an alternation from paleness to redness, and from redness to paleness, and these changes of color continued for two or three days. These facts encourage the surgeon to persevere in his endeavors to save the detached part, in such wounds of the nose, and not to abandon his efforts until the fragment is surely dead.

Fracture of the Nasal Bones.—The external osseous fabric of the nose, though having great power of resistance, is not unfrequently fractured. Hippocrates deemed this injury sufficiently important to devote several chapters to it. Celsus, likewise, wrote a chapter on the same subject. These writers also describe fracture of the nasal cartilages, which is denied by modern surgeons. The classification of Celsus is fracture of parts in front, and lateral fracture. A brief classification, in which the principal attendant conditions are included, is that of lateral fracture, which may be unilateral or bilateral; subcutaneous or open; and fracture with or without displacement of the broken bone.

Fracture of the nasal bones is from violence, of which the impact may be directly in front, or on one or both sides; thus one or both nasal bones can be broken. The adjacent nasal process

of the superior maxillary bone, in severe fracture, may also be broken without a wound in the soft parts, or there may be a breach in the mucous membrane, or derm, or in both. As a rule, the external surface is not wounded; the inner or mucous lining is commonly injured, and, as a result, there is bleeding. This hæmorrhage is ordinarily small in amount; yet a case is recorded in which the patient bled to death from nasal fracture.

In fracture limited to one side of the nose, the broken nasal bone is usually depressed. Or if both bones be fractured by violence received directly in front, the dorsum is driven backwards, and the nose is flattened or sunken. Again, where the violence has been received on one side, the nose may be deflected or driven wholly to one side, and it will then be inclined towards one cheek. In any of these cases, the change of position and alteration of form would clearly indicate the nature of the injury; the surgeon's eye, rather than his touch, would make the diagnosis, for crepitus, which is present in fracture of bones elsewhere, can scarcely be detected in this injury. The injury is not always limited to the nose, for if the violence is not exhausted in the fracture of the nasal bones, it will pass to the ethmoid bone and do further violence by either fracturing this bone, as once claimed, or it will cause concussion of the brain. Hyrtl has experimented on the cadaver by striking and breaking the nasal bones, and yet in no case did he find that the ethmoid bone had been broken; the cribriform plate of that bone is so strong, he thinks, that it can resist fracture in such cases, and, hence, in most if not in all cases, the cerebral injury present is due to concussion.

Treatment.—The treatment consists of two acts: the restoration of the broken bone to natural site, and the maintenance of this position by proper dressing.

To restore to normal position the broken, deviated and depressed nasal bone, or bones, a finger, or something similar to it, must be passed into the nose beneath the displaced bone, when the latter is to be lifted and restored to its place. As the surgeon's finger is commonly too large to enter the nostril, hence some smaller instrument must be used, and for this purpose the grooved sound, which always should have a place in the pocket case, may be used. The round end of the male or female catheter can be used for the same purpose. Whatever is employed must have a smooth surface that will not wound the mucous membrane. With the instrument which is used to restore the fragments to site, the surgeon's fingers must carefully coöperate, and the work

of uplifting and molding be continued until the nose regains its natural figure. When the fracture is bilateral, which is usually the case, then the modeling must be done in each nostril; and, if the nasal bones be not displaced directly backwards, one bone is usually depressed and the other uplifted; in such state the modeling consists in pressing one side inwards, and uplifting the other. And as there is concurrent deviation of the septum, this is likewise to be restored to vertical position. If this lateral deflection be overlooked, the calibre of the nostrils would be altered: a condition which might interfere with normal respiration and olfaction; especially with the latter, since, for the accomplishment of smelling, it seems necessary that the current of inspired air should be compressed. Hence, in the endeavor to restore the broken bones to site, the septum should have as much attention as the containing walls of the nose.

After the restitution of the broken nose to form, means must be employed to prevent the part from becoming misshapen through displacement of the bones; such displacement, it is true, cannot arise from muscular action, as occurs in the case of fracture elsewhere; yet the prominent and exposed site of the nose renders it necessary to guard the parts against derangement. In antiquity we learn from Hippocrates that many forms of contentive appliances were used to retain the broken nose in proper position; says he: "Many errors are committed by physicians who without judgment admire beautiful bandages, and who especially pride themselves on such appliance for use; for this, bandages of the most varied forms are used; bandages containing compresses, and in rhomboidal form, so disposed as to present diversified intervals and islets. As has been said, those who pique themselves upon thoughtless mechanical display, are pleased to meet a fractured nose, so as to apply their bandage to it. Then for a day or two the physician struts in delight of his work, and the bandaged patient is also delighted; the latter soon gets annoyed with and is tired of his dressing; but for the physician it was enough to have shown that he knew how to apply remarkable bandages. Such a bandage defeats its purpose; for if the nose has been flattened by the fracture, such bandage will render it more sunken." Celsus counsels to maintain the broken nose in position by the aid of an adhesive band, which, fastened to the nose, is to be attached to the head behind the ears. Both he and Hippocrates advise to support the fragments by means of plugs introduced in the nostrils. But Hippocrates, after his

satirical dismissal of the complex bandages then used as retentive dressing, says that no contentive apparatus is equal to the index finger of the patient, if the latter be attentive and constant. These should be applied, one on each side, and retained until the cure; and if the patient does not do this, the soft fingers of a child or woman may be used instead. "Men, though they would be rid of deformity at any price, will not give care and attention for their relief, unless they suffer, or are in dread of death." Both Hippocrates and Celsus direct that sustaining plugs of soft material be inserted and permitted to remain in the nose, until the bones heal; such obturator was made by Hippocrates of whatever soft material was at hand; and he used a portion of a sheep's lung, yet he preferred a plug made of Carthaginian leather.

These ancient methods, as detailed by Hippocrates and Celsus, contain the fundamental elements of treatment as pursued by the modern surgeon. After the parts displaced by fracture have been restored to normal site, they must be retained so by obturating plugs or tubes, which are inserted and should remain in the nostrils.

The obturating supports may be made of almost any material which can be molded into cylindrical shape; a convenient article is a portion of a cotton roller. This should be rolled into a hard cylinder about two inches in length, and of sufficient thickness to entirely fill the nasal passage; in the bilateral fracture, two of these are needed. The plug should be saturated with an alcoholic solution, and then smeared with vaseline, and, thus prepared, it must be inserted its full length. In the young subject, and where the nose is small, a shorter plug should be used. As the outer layer of the obturator may be displaced in its introduction, it is well to first wrap a fine thread around it several times; and nothing is better for this than the thread which can be detached from the end of a common roller. The little cylinders when once placed can be retained in position by a strip of rubber adhesive plaster, carried across the nostrils and fastened to the upper part of the cheek. These plugs should be withdrawn and replaced by new ones, as often as every second or third day; if this is not done, they soon become offensive through the septic matter with which they become impregnated. Instead of this solid obturator, a hollow one may be employed. This has the advantage that the patient is able to breathe through the nose instead of through the mouth, as he is compelled to do

when the nostrils are wholly occluded. Such hollow plug might be made of a section of a quill, which, if too small, could be enlarged by wrapping about it adhesive plaster or a strip of cotton, or linen cloth. Such hollow obturator might be constructed of India rubber or metal; but as each case demands a tube of different dimensions, hence the surgeon will find it most convenient to extemporize one, adopting one of the plans before mentioned.

When the nose has been restored to form, and remains in shape by means of the internal supports, nothing more is required than to apply to the part cold water dressing. It is rare, however, that the internal support alone suffices; to prevent the tendency to deviation to one side which is often present, lateral support is required. Also, where the injuring violence has depressed one nasal bone, and elevated the other, then, a compressive support should be applied on the uplifted side, so placed as to maintain slight pressure backwards. Also, if the uplifted bone has been broken into two or more fragments, then such lateral compress is required to maintain the broken parts in level position; the neglect of this precaution has resulted in an irregular form, unsatisfactory to surgeon, and as much so to the patient.

This external dressing may consist of two small rollers, of length equal to the nose, covered with adhesive plaster, with the adhesive face turned outwards; and these adhering compressive rollers are to be placed on each side of the nose, and retained there by transverse strips of plaster. The adhesive rollers should be of equal size in case merely lateral support and protection of the injured nose is required; but in those cases in which one side is too much elevated, and must be repressed, then one roller should rest against and press on this side; while a thicker roller must be placed alongside of the bone that has been sunken, and held there by the crossing adhesive strips; thus closed, the uplifted side will be maintained at a proper level, and the side which tends to sink will be protected from pressure. Under such treatment the fractured nose will heal in a period of three weeks, in the adult, and in a less time in the child.

Fracture of the nasal bones is, in rare cases, associated with an open wound of the soft parts which cover them; and such wound, as a rule, is of lacerated and contused species. Such a complication is certain to entail an unsightly scar; and, besides, it demands a slight deviation from the treatment already described

for subcutaneous fracture; for after the fractured bones have been restored to position, and provision made for their fixation by plugs in the nostrils, attention must be given to the external wound. If there be hæmorrhage, this is to be controlled by torsion; and, that failing, the ligature should be applied. Contused and fringe-like margin should be trimmed off; thus the wound is converted into one of the incised type, and healing with slight scarring is favored. Should there be unevenness of surface of the broken bones, this should be corrected by digital molding. To correct gaping, and to fix the edges of the wound, fine metallic sutures should be used; and these should be so introduced as to effect accurate coaptation of the edges. Lint saturated with alcoholized water may be used as an external dressing. If a fragment of bone tends to rise and form an uneven surface, this must be corrected by pressure over the dressing, maintained by a bandage transversely applied. Such dressing must be examined daily, in order to see whether the bones remain in place. After three days, the metallic sutures may be removed, and fixation continued by means of strips of India rubber plaster beneath the alcoholized dressing. By such management and daily observation of the wound, a satisfactory cure of both bones and soft parts can be secured.

Growths affecting the external surface of the Nose.—The outer integument of the nose may be the site of neoplasms, benign and malignant. The benign growths oftenest seen here are simple hypertrophy and angioma; of the malignant species lupus is often seen here; a less frequent development is epithelial cancer.

Hypertrophy of the lobule or lower end of the nose occurs, in those who have passed the meridian of life, and who have been the subjects of acne rosacea. It is occasionally seen in the female, who, as is known, is sometimes affected with this acnaceous affection: yet in the majority of cases of nasal hypertrophy, the deformity is met with in the male.

This growth involves both the skin and the subcutaneous tissue; the glandular, vascular, and epithelial elements of the skin are greatly increased in volume. This structural augmentation is greatest in the lobule; yet it occurs also in the wings and septum of the nose; and, in the worst cases, the entire nose is monstrously enlarged. Hyrtl refers to instances of the kind in which the part attained such dimensions that it reached to the chin, and interfered with breathing, eating, direct vision and kissing. For suggestive reasons the osculatory functions would

seldom be interfered with. The hypertrophy then may affect partially, or totally, the nose; or it may appear in the form of an isolated growth, of which there may be one or several on the nose. Such tumor consists of an irregular aggregation of small lobulated masses; and it may be pedunculated or sessile. The growth is conspicuous for its red or purplish color; it is tuberculated or uneven in surface, and is in a high degree unsightly and deforming: in the male, to whom facial beauty is often a serious detriment, the enormous nose may be tolerated; but in the female the deformity is such as to extinguish whatever attractive lines her face may possess, and even to force her to social retirement.

The development of this hypertrophy is promoted by whatever induces congestion of the face, for example, the use and abuse of spirituous drinks. Such congestion is, at first, active in character; later, the dilated vessels remain permanently widened and constantly filled with blood. Cases, however, have been seen by the writer which were not referable to irregular regimen, and which, presenting no remarkable enlargement of the vessels, the growth was pale instead of florid or purple. The patient, however, should be advised to abstain from articles of drink and food which cause facial hyperæmia. The subject of nasal hypertrophy rarely appeals for surgical aid until the growth is so advanced that some radical treatment is necessary to relieve the deformity: some procedure which will at once remove the excessive structure, or which will promote its atrophy. As means which might arrest growth and lessen the existing volume, the tincture of iodine, fluid extract of ergot or ergotine, and Fowler's solution of arsenic, may be employed hypodermically; from two to four drops of one of these agents may be injected into the enlarged structure once in two days. If inflammatory action is awakened, the injection should not be repeated until this has wholly subsided. For if the part be much irritated, suppuration would be caused, and destruction of a portion of the structure would ensue; thus, though the hypertrophy would be reduced, an unsightly irregularity of surface would result. The fluid extract of ergot used externally will reduce the growth.

As the acnaceous disease which usually causes the hypertrophy has been plied by remedies which were chiefly remarkable for their number and ineffectiveness, the patient is probably ready to accept treatment which will at once remove the disease: and hence he will prefer, or at all events he will not decline, a resort to the knife. The hypertrophied mass should be reduced by

multiple cuneiform excision: enough being removed to reduce the nose to normal form. Inasmuch as it is difficult to know how much should be taken away, it is better to operate twice: the first time doing most of the work, and later finishing it: thus, cautiously proceeding, there would be little danger of rendering the nose too small. The long axes of the wedge-shaped sections should, as a rule, correspond with the long axis of the nose; as exception to this may, perhaps, be a section removed transversely from the tip of the nose, in cases in which the nose remains too long after the longitudinal exsections. From the enlarged septum, a longitudinal exsection should be cut, and this should reach in deep enough to provide an ample opening for the nostrils. The remaining wounds must be accurately closed by fine metallic sutures, which should remain in site for one week. The writer has learned from experience in such cases that accurate closure of the wounds is no easy matter where several broad excisions have been made, and hence, to avoid such difficulty, the portions excised should not be broad, and each gap should be closed as it is made. In thus proceeding, the amount of tension caused by closing the wounds will appear, and allowance for the same can be made. The scars which remain after healing are not conspicuous, owing to the vascularity of the structure.

Instead of total enlargement of the nose, a portion of it may be the site of hypertrophy, and this may be so isolated as to resemble a pedunculated growth. In such isolated hypertrophy, whether sessile or pedunculated, the procedure of removal would be much simpler than in the condition of total hypertrophy. The part should be extirpated by an oblong circumscribing cut, which would wholly include the affected part. The resulting wound, from its elliptical outline, would be easily closed, and the remaining scar would be linear in direction.

Angioma.—The nose is a frequent site of angioma. This growth nearly always dates from fœtal life. And every grade of it is seen, from the merest superficial speck, to a vascular growth which occupies the entire thickness of the nasal wall. When seated superficially, which may be limited or cover a large surface, the nose is of normal size. But when it extends through the greater part, or the whole of the wall, the affected part is enlarged. And if this deep-seated species occupy the tip of the nose, the part is developed much beyond the remainder of the nose, and imparts to the figure of the infant a ludicrous appearance. As the venous element is the predominant constituent,

instead of the red hue as seen in the superficial species, this deep-seated variety presents a bluish or cyanosed hue.

Treatment.—This vascular development can be removed by subcutaneous ligation, or by partial or total excision. Since subcutaneous ligation leaves but few scars, it may be tried, though it is less certain to accomplish the purpose than the knife. To do it, a needle armed with a strong thread is made to enter and emerge at short intervals, around the border of the angioma, until it emerges at the point of entrance; there the two ends of the thread lying in the first opening made can be firmly tied. Care must be used not to overdo this work of concealed circumscription, lest sloughing be caused. The writer, however, has employed this procedure in an angioma, which occupied the entire nose: and his experience would indicate that it is not an easy matter to wholly arrest the supply of blood to such structure: for the atrophic action induced was insufficient, and it was necessary to repeat the ligation. It is probable that the needle, reëntering after emerging, left portions of the periphery unincluded. After the work is thus done, the part should be dressed with carbolized vaseline. The case should be kept under close observation, and should it appear that the blood supply has been wholly cut off, as would be denoted by a continued cyanosed color, then the ligature should be divided, so that the constriction will be lessened; and, if need be, the thread is to be removed. On the contrary, should it be apparent that the constriction is insufficient to effect the purpose, then the ligature must be tied tighter. From what has been said, it is clear that the work should be kept under close observation; and the ligature is finally to be removed when it has become loose.

Should the method of concealed circumscription fail to accomplish the extinction of the angioma, a resort to the knife should be had, in which the procedure before mentioned used in removing hypertrophy should be followed; cuneiform sections of the vascular growth should be excised, and the wounds made, accurately coaptated by suture. Yet even this plan, as the writer has experienced, may not effect a cure: the remaining vascular structure may awaken to new action, and the unsightly growth reappear. In such case the last refuge of the patient is substitution of normal tissue instead of the vascular, by rhinoplastic means. The material for replacement may be obtained from the frontal or malar regions: preferably from the cheek adjacent, when the vascular structure does not occupy the entirety of the

nose. To operate thus, the angiomatous structure should be first excised, and the hæmorrhage carefully arrested: and for this, fine ligatures may be used. Next, from the cheek contiguous, lift up a flap, somewhat larger than the breach to be filled, and fix the same in place by sutures. This replacing flap should be so planned as to have its pedicle near the breach to be filled: and this may be accomplished by having the pedicle situated near the wing of the nose, and the body of the flap directed towards the malar bone. In proceeding thus, the wound on the cheek can be so closed as to somewhat support the flap, and to leave a scar on the cheek nearly coinciding with a natural furrow of the cheek.

Lupus.—Writers are nearly in harmony in making two species, or rather grades, of the disease: viz., lupus ulcerans and lupus rodens; and in whichever form it appears, the disease has a selective preference for the nose and cheek adjacent, for its development.

Bacteriological researches prosecuted by Koch, Neisser, Demmé and others have determined that there is a close kindred between lupus and tuberculosis. Koch obtained cultures from the two diseases which were identical in character and action. As the result of these investigations, the modern pathologist seems justified in naming lupus a tuberculosis of the skin.

Lupus ulcerans may commence on the dorsum, point or wing of the nose. It may be situated on the skin or the mucous membrane, or simultaneously on both these surfaces.

The disease begins on the surface as minute papules, which enlarge and fusing become larger; and in this latter form they are crowned with a thick epidermal covering. The summits of these nodular eruptions pass rapidly through a vesicular or serous stage and become pustules. If the summit of these be removed, there escapes a sero-purulent fluid, which, drying, the part is covered with a brownish crust. If this crust be removed, there remains an ulcer-like surface, which bleeds when touched, and becomes the site of fungoid granulations. This denuded surface is, at first, level with, or perhaps higher than the adjacent skin. The bounding skin, though red, is not indurated. Later, the disease penetrates inwards, and in time destroys the skin; and even the cartilage and bones may be attacked. This ulcerative process tends to move laterally, more than inwards, so that, as a rule, the supporting framework of the nose is not destroyed; and what is remarkable, the disease, like a fire on the prairie, dies out behind, while it proceeds onwards in its destructive work.

The scar covering the healed portion is thin, and, for a time, permits the subjacent red structures beneath to be seen; later, the cicatrix thickens and contracts so as to deform the part. And, though healed, there is a tendency in the disease to reappear in parts in which it has previously existed; and this recurrence is probable where there remain abnormal hardness and redness, and the cicatrix is streaked with fine vessels.

It is sometimes a question to determine whether the disease is one of lupous or syphilitic ulceration, especially so in a patient of syphilitic antecedents; yet the form of the ulcer in the two diseases is quite different: viz., the syphilitic ulcer has margins clear cut, steep, well-defined, and the adjacent skin stands higher than the denuded part; while lupus has no definite boundaries, the point where the disease ends being hardly distinguishable; and the subject of it is young, in many cases not having reached puberty; hence early youth and ill bounded ulcers would prove the case to be lupous in character.

Treatment.—Seven months prior to the time when these lines were written, the world believed itself in possession of a cure for tuburculosis whether that disease be in lung, joint, skin, or mucous membrane; and the discoverer of that cure, Robert Koch, was lifted to a position of popular eminence, by the professional and popular press, loftier than that ever attained by any writer, and, it may be added, by anyone within the ranks of medicine. For a few weeks, the radiant personality of this physician as the first star in the firmament of fame, was the subject of reverent admiration of all eyes, and his name was hourly spoken by every tongue of the civilized world. Yet this great medical scientist, who had already secured by his bacteriological discoveries an enduring place for his name on the page of future medicine, committed the error of announcing as fact that which, though probable, had not been fully demonstrated; tuberculin, the remedy announced against pulmonary tuberculosis, after a test by trial and careful use, disappointed the hopes which had been awakened: so that to-day the clamors of fame which recently deafened the ear of Koch have subsided into expiring echoes; and have almost been replaced by the remonstrating murmurs of public disappointment.

Inasmuch as ulcerating lupus is cognate to tuberculosis, the remedy of Koch was tried against it also; and the trials made seem to indicate that tuberculin may arrest or even extinguish this form of lupus. This inoculation, however, demands so many

precautionary guards, lest the reaction caused by it should injure the patient, that it is not probable that it will ever become a popular remedy for the treatment of lupus.

The treatment of simple ulcerating lupus should be both general and local. General remedies should be given to combat the scrofulous diathesis which is present; cod-liver oil, iron, bark, and the phosphate of lime should be administered. The preparations of iodine and arsenic may also be given. A nutritive diet should likewise be used.

As topical means to combat the local destructive ulceration, a number of agents may be selected from the list of escharotics. In the initial stage, ere the disease has invaded the deeper layers of the skin, the author has found much benefit from the nitrate of silver; let this, in small cylinder form ground to a point, be thrust into the affected structure, until this is thoroughly destroyed. If the disease has advanced further, and involves the deeper tissue, then a more active escharotic should be used; and yet too much destruction must be avoided, for the caustic action should not penetrate through the nasal wall. As agents which will not act severely, one may employ a paste of charcoal and sulphuric acid, of which a layer may be smeared over the affected surface, after the latter has been curetted. Or a paste made by mixing three parts of powdered Radix Sanguinariæ Canadensis with one part of potassa fusa; or one made by saturating salicylic acid with creosote, or with concentrated carbolic acid, may be applied on the curetted surface. Or, as liquid application, one may use nitric acid, carbolic acid, or the acid nitrate of mercury. Finally, the diseased part might be superficially cauterized with the ferrum candens.

From his experience with all the destructive agents mentioned, the writer would counsel the use of the mixture of Sanguinaria and potassa fusa, or of that of carbolic acid and salicylic acid; a paste from one of these, applied, destroys the diseased tissues to a slight depth, and forms a crust which, scab-like, adheres for some days and then falls, leaving a surface which heals. As dressing to the part, after the eschar is detached, one may use citrine ointment, diluted with an equal part of adeps; or an ointment containing five grains of biniodide of mercury to the ounce, will promote closure of the wound. In the selection, use and retention of the topical remedy in place on the nose, one must bear in mind the intractability of childhood, in which the disease often occurs, and take precautions accordingly.

Lupus Rodens, or Rodent Ulcer.—This disease is closely allied to epithelial cancer. It is probably a severer form of ulcerating lupus. It is cancerous in its appearance, cancerous in its march, and cancerous in its destruction of parts. Like cancer, it nearly always is seen in those who have reached or passed beyond fifty years of age. Unlike cancer, it is seen in those who are otherwise in perfect health; and it rarely implicates the lymphatic glands.

Rodent ulcer appears on the nose at some point of the skin which is not bordering on mucous membrane, and is oftener an immigrant than an aboriginal production; for it occurs more frequently on the eyelids and cheeks, and then it passes to the nose; and yet exceptionally, the disease may travel from the nose to the structures contiguous. It commonly begins as an isolated tubercle; in rare instances, other tubercles arise around the first one. The tubercle, whether single or multiple, does not undergo pustular change, but its summit opens fissure-like; this opening being often due to the action of the patient's own nails. From his observation, the writer is certain that the initial tubercle would remain for a long period a harmless growth if it were not stimulated to further development by incessant irritation. Many examples of such irritation will suggest themselves to the experienced physician; there is one, however, to which reference may be made, and this is the ill custom into which the majority of persons fall of touching, handling, rubbing and scratching any irregular point on the surface of the face. And such habit once established, is nearly incorrigible; when thought is absent, the hand without voluntary guidance seeks the forbidden part, and a nail detaches the epidermal covering. A patient, with such rodent ulcer, stated that, despite the sternest efforts of self-discipline, he found, when attention was withdrawn, that his finger would resume its forbidden task; and only after the rodent ulcer had attained a dangerous foothold on his face, and fear became a diligent ally of his efforts, did the patient break his ill habit.

Finally, the initial point of the disease begins to ulcerate; and as the ulcer advances, the new growth, in the form of dense, hard tissue, appears around and underneath the eroding breach. The neoplasm with its following ulcer attacks the skin, subcutaneous fascia, and is not arrested by the bones which occur in its pathway; they, too, are destroyed. Thus the nasal bones have vanished, and the destroying disease continued its course of ruin, until it has reached the cranial base, which, also, it perforated and attacked the brain. The patient, whose face finally becomes

indescribably hideous, often enjoys, otherwise, excellent health; and the lymphatic glands, of which the afferent absorbent vessels lie in the track of the ulceration, do not enlarge. As a rule, the patient has but little pain, were it not for his apprehensions of the future.

The picture which has been traced of rodent ulcer clearly distinguishes it from the more simple form of ulcerating lupus and syphilitic ulceration; the mild lupoid ulcer is in the young subject, and its margins are not so hard, nor so uplifted, as are those of rodent ulcer; and the syphilitic ulcer is distinguished by being contagious and, also, more rapid in its course.

The course of rodent ulcer, as here given, is that which one finds described by the English authorities; and though such a form is sometimes seen, there is evidently a much milder species which is more frequently seen. In this milder species the disease appears as an isolated tubercle; this tubercle finally becomes covered with a dry crust-like eschar. Other tubercles appear as does the first, the whole forming a confluent mass, which becomes, like the primary point, invested with a hard brown or black epidermal crust. When this crust is detached, specks of pus and bleeding points appear.

Treatment.—Inasmuch as the severer form of rodent ulcer is fatally destructive of the part on which it is situated, and, if its course is not arrested, ends in frightful deformity and final death of the patient, it is clear that the treatment which promises the speediest extinction of the disease should be resorted to; and as such means are the knife and the actual and potential cautery. With the knife the work can be done, care being taken that the line of excision be well in the sound tissue. The writer's experience has forced him to regard excision as uncertain, and less to be depended on than the cautery. And what the *knife* (ferrum) cannot cure, the Hippocratic aphorism tells us *fire* can cure. The ferrum candens, if properly used, does its work effectively, yet it has the disadvantage of leaving a contracting, shriveled and scarred surface: a species of tissue which is arid and sterile ground, ill suited for the reception of a transplanted rhinoplastic flap. For the reasons mentioned, the surgeon will do better to employ potential cauterization in preference to the actual heat, and, as agent for this, good results will be gotten by applying the paste composed of potassa fusa and Sanguinaria. This should be used immediately after being prepared; and only a thin layer of the agent should be applied; and even then, the

destructive action may extend through the nasal wall. A minute breach thus made might be neglected, yet a large one should be repaired by transplanting upon it sound tissue. For the treatment of the milder form of rodent ulcer, to which reference has been made, a less active cauterization will suffice; then one may use the paste of charcoal and sulphuric acid, or that made of creosote and salicylic acid. It is sometimes necessary to repeat the use of the escharotic, reattacking the disease when it reappears.

Carcinoma of the epithelial species may appear originally on the nose, or by transition from neighboring parts, viz., from the cheek or lip. In its initial appearance and subsequent development the disease closely resembles rodent ulcer; the cancerous disease, however, differs in this respect, that it first appears on the transitional integument which lies between the derm and mucous membrane, viz., on the border of the nostrils. Thence the disease proceeds laterally rather than centrally, and, hence, the title of cutaneous cancer is sometimes used to designate it. This cutaneous cancer sooner or later manifests itself by adjacent metastasis in the neighboring lymphatic glands.

Cancer, here as elsewhere, has a fatal destiny; yet, akin to the fire, which begins as a spark, and is then easily extinguished, yet later a brigade of firemen can hardly arrest it, so this carcinoma, in its infantile stage as an isolated fissured tubercle or wart, can easily be eradicated; but if the destruction be permitted to proceed until it has poured into the numerous adjacent lymphatic streams its fertile germinal elements, then surgery with all its arms usually suffers defeat. A treatment, similar to that indicated to be used against rodent ulcer, should be resorted to. The part must be well curetted and then cauterized with one of the escharotic compounds above named; and should, unfortunately, there have been so much delay that there is already infection of the neighboring glands, these should also be removed; such removal being done less with the hope of a cure than of staying the disease, and giving the semblance of doing something; *ut aliquid fecisse videamur*, as Hyrtl says.

NOSTRILS AND THEIR DISEASES.

Narrowness.—The entrance of the nostrils may be abnormally narrow or entirely closed; and these may be congenital conditions or they may be subsequently acquired.

The unshapen nose of the infant often presents nostrils too

narrow at their entrance for free breathing; usually, in the course of development, this imperfection is rectified. In infancy and childhood narrowness may be acquired through some inflammatory or ulcerative disease, situated in the nostrils, which, in the process of repair, constricts the nasal orifices. Examples of such disease are scrofulous inflammation and eruptive cutaneous affections, as variola, impetigo, rubeola and scarlatina. The scrofulous child often presents a nostril denuded of its mucous coating; likewise, rubeola and scarlatina may act in a similar way; the result being as the surface heals, cicatricial contraction and narrowing of the outlet of the nostrils; and this narrowness may extend some distance into the nasal passages. In these cases, during the period of repair of such denuded or ulcerated surface, the tendency to constriction should be resisted by the introduction of obturating plugs which will retain the nostrils of proper calibre. Such obturator should be tubular or hollow; yet, in the want of these, the solid form may be used. For this purpose the writer has found a section of a drainage tube to do the work satisfactorily. Such tube should be somewhat larger than the nostril, so that it must be compressed before it will enter; and when thus placed, the elastic walls of the tube exercise continuous pressure on the walls of the nostril, and not only prevent closure but even enlarge the opening. During this dilating treatment, the affected surface of the nostrils should daily be smeared with some alterative ointment; for this, one may use a dilute mercurial ointment; or an excellent application is an ointment made of iodoform and cod liver oil; also an efficient compound for this purpose consists of fifteen grains of the subiodide of bismuth to an ounce of vaseline.

If the contraction be great, the method of dilating just mentioned will be insufficient, and a resort to the knife becomes necessary. In such cases, in 1840, Schmitt announced a plan as follows: the opening is to be enlarged by removing sections from the nostrils, and then tannin is to be applied to the wound, and, later, nitrate of silver. This plan has the objection that a raw surface is left, which, in cicatrizing, contracts, and the opened nostril is again lessened in calibre. A better plan, as the writer has found, is to preserve the dermo-mucous membrane, and afterwards use this for covering the wound made. To do this, first lift up a flap and excise structure, in shape and amount sufficient to enlarge the orifice, and then fix by suture the flap that had been formed. The structure is best removed from where the nostril

joins the posterior wall, that is, from the posterior part of the outlet of the nostril; thus done, the opening will be elongated antero-posteriorly. This procedure would be unsuited for cases in which the narrowing is due to cicatricial contraction; in such, the opening should be enlarged by excising sections of the orifice, and patency maintained by dilating obturators.

In case of total atresia of the nostrils, whether congenital or acquired, the imperforate condition may only be superficial, as a membranous operculum; or the occluding structure may extend some distance into the nostril. In such condition the occluding material will require to be excised, and the passage retained open by an obturating tube, which must be used for a long period. In this operative work, if it be possible to cover a portion of the wounded surface with dermal investment, the restored nostril will be more apt to remain permanently open; especially so where, the occlusion being deep, a deep and extensive excision of the parts must be made.

In the plastic operation of restoring closed nostrils, Velpeau and Jobert utilized the outer wall by paring and folding it inwards upon itself. This method is attended with the inconvenience that the border would be abnormally thick, and the septum would prominently protrude; and were the latter removed, the nose would attract attention by its shortness.

The sub-septum or inferior portion of the partition between the nostrils is sometimes so pendent, or reaches downwards so far beyond the other portions of the nose, that it is a conspicuous deformity. According to Blumenbach's observations, the Hebrew race is distinguished by prominence of the nasal septum. Cases may occur in which the surgeon's knife may be asked to retrench the superfluous structure. Such was the case in the patient mentioned by Blandin in whom the prominence of the septum was such that it became an insuperable obstacle to getting a wife; the writer would add that a few cases have been seen by him in which subjects of such deformity were more fortunate than was the patient of Blandin, since they found escape from their enthrallment through the magic of coined metals.

Such deformity should be removed by an operation done so nearly within the nostrils that but slight marks of the cutting will afterwards be visible. To do this, the author's plan is to let the pendent dermal portion of the partition be separated from its posterior attachment, and be dissected so as to hang suspended from the tip of the nose; next a section sufficiently large must be

excised from the cartilaginous partition above so that when the pendent flap is restored to place, it will not project, but conform to normal type. The coaptation should be accurately made, and the part retained in position by fine metallic sutures, which should not be removed before one week, that is, when union is assured.

Chassaignac reports operations for the relief of prominent septum, in which he proceeded somewhat similarly, yet instead of excising a section of the septum in its entire thickness, after uplifting the mucous membrane, he pared the remaining partition laterally, and, thus attenuated, he forced it into position, and then replaced on this the flap-like mucous portion which had been uplifted from the septum. The mode of operating before described is preferable to this one, since the surplus structure is wholly renewed, and the septum is at once restored to normal type.

Deflection of the Nasal Septum.—Some deviation of the septum is, in many cases, congenital, and, as a consequence, one nasal passage is rendered larger than the other. In the adult, equality of the space of the nasal passages is rarely found; yet, in most cases, the difference is so slight that the subject of it is so little inconvenienced by it that he is not aware of his condition, since he breathes readily through each side of his nose. Not unfrequently, however, the deviation being congenital, or, having commenced in childhood as the consequence of some accident, continues to increase until it nearly or quite occludes one nasal passage. This deflection may be situated deep in the nose, and is then unseen unless the nose be turned upwards; it may then be discovered to involve the deeper portion of the cartilaginous septum, and perhaps, likewise, the bony septum Or, instead of this deep location, the deflection may be in the outer cartilaginous portion, and may project from the nostril so as to become a conspicuous deformity, in the shape of a red pouting mass. This protruding structure, more commonly occurring in the boy, is usually mistaken by his parents for a neoplasm; and a similar, though less excusable, error is sometimes committed by the medical attendant. And such error is apt to arise in cases in which the deflected part, hitherto unseen, has suddenly appeared, due to tumefaction from irritation or inflammatory cause.

The diagnosis of the deflected septum, whether the deviation be high up in the nose, or situated at the outlet, is readily made if one examines the two nostrils. The convex portion is lined by

mucous membrane which is continued upon the parts adjacent, and in the other nostril, corresponding to the deviated part, one finds the partition hollow from inflection; such inflection of the septum will always be found on the side of the larger nostril. It cannot be a nasal polyp, since this does not arise from the septum. A case resembling deflection is one in which there is isolated tumefaction on one side of the septum due to a small abscess or hæmatoma situated there, or to a swelling from localized inflammation of the mucous membrane; yet, in cases of abscess, hæmatoma, or localized inflammation on one side, incurvation of the other side of the partition would rarely be present

The consequence of such deflection is partial or complete closure of the affected nostril; in such nostril the nasal excreta would be retained unless they escaped posteriorly. Such occlusion, according to Moleschott, favors the development of the nasal polypus. And should the unaffected nostril become obstructed, the patient would be forced to breathe through the mouth. For these reasons, surgical interference in such condition is not only justifiable, but necessary.

Treatment.—The rectitude of the partition may be accomplished in several ways. An attempt has been made to do this by first crowding the deviated part into proper position, and retention there by means of a tampon introduced into the nostril. This plan, the writer has found by experience, is tedious, painful and unsatisfactory; for, though the deformity be thus rectified, it tends to recur. Another procedure similar to that of Chassaignac already mentioned, is that in which the mucous membrane covering the convexity is uplifted flap-like, and the subjacent cartilage is trimmed off so that the partition can be forced into position, and the flap returned to its place and held there by a plug in the nostril. The fault of this plan is that the continued compression may cause death and sloughing of the part pressed on, and an opening through the septum will remain. Another plan which has given the writer satisfactory result is to make a long oblique incision through the deviated part, so that the latter can be rectified; and when this is done, the two faces of the obliquely divided septum will slide on each other, and then a retaining plug being introduced, the wounded facets may unite. In this sliding, if a wounded part should be displaced upon sound tissue, then the latter must be trimmed off, so that union can occur. By another method, which was proposed by Adams, a star-shaped cut was made through the septum by means of a specially devised knife;

thus divided, the part is to be brought into position and retained so by ivory plates retained temporarily in the nostrils.

Jurasz, of Berlin, writing in 1882, on this subject, finds that such deviation is commonly situated in the posterior two-thirds of the cartilaginous portion of the septum. If situated in the anterior third, Jurasz would remove the prominent part by excision; but, to correct deviation which is more deeply seated, he uses forceps constructed after the model of obstetrical forceps, one blade of which is to be introduced into one nostril and the other into the other, and the blades are then to be locked and compression to be made by means of a screw that passes through the handles. This instrument is to remain in place for three days, and then the rectitude is to be maintained by means of the ivory plates of Adams. A more radical procedure has been practiced recently, viz., to excise the deflected portion of the septum, thus forming a permanent opening through the partition; such an opening, though, causing no functional disturbance, has the objection of leaving a lasting defect. Excision, if done, should be partial and limited to the removal of the outer prominent portion of the septum, which, sometimes, protrudes through the nostril, and occasionally is accompanied by but little deflection of the deeper portion of the septum; in such cases (which are those which oftenest ask surgical aid) the mucous membrane should be uplifted flap-like, with attachment above, the cartilage then excised, and the flap restored to place and fixed there by suture.

The septum is the occasional site of what is named purulent tumor by Beaussenat, by whom the disease was first described in 1865. Such tumor consists of a collection of purulent matter, situated on the cartilage of the septum, underneath the mucous membrane. As there is not room for the mass, it swells out the nasal wings and protrudes from the nares. Such a tumor forms on both sides of the septum, and ends by perforating the latter, after which the two intercommunicate. The purulent content is mingled with blood. This affection commences as a swelling that is red and dry; meantime, the outer wall of the nose may be slightly affected. As accompaniments of this swelling are pain in the head, lachrymation and intolerance of light. The swelling finally becomes so great that the nostrils are nearly or quite closed, and breathing through them is very difficult.

The cause of this swelling is often a traumatic one in which there has been a contusion or fracture of the nasal skeleton; it may, likewise, arise from a coryza, or from some exanthematous

affection, as rubeola, scarlatina, or variola, and, lastly, it may proceed from a scrofulous dyscrasy of the subject.

These tumors are polypoid in appearance, still they can be distinguished from the polyp in this that they are redder and always spring from the nasal septum, and are near the anterior outlet; a true polypus is situated deeper, is of whiter hue, and springs from some part of the outer wall. There commonly coëxist two purulent tumors which inter-communicate through the nasal septum.

Treatment.—Such tumor should be opened and its contents evacuated; and if this be done early in an acute case a speedy cure may be obtained; yet, if the case is neglected, or becomes chronic, there may be entailed atrophy of the cartilage or a perforation of the septum.

Besides this purulent tumor, Beaussenat describes a collection of blood (hæmatoma) beneath the mucous membrane of the septum, which is caused by a wound or blow. This swelling when large can obstruct respiration. As proper treatment of such hæmatoma, it should be opened, emptied and the wound brushed with the tincture of iodine.

Sir A. Cooper has described a fungous tumor of the nose, resembling polyp. The writer has seen a similar form, which springs from the septum, is unilateral, and nearly or quite occludes the nostril. The patients were chiefly children, though exceptionally it was seen in the adult. Such fungous swelling may be treated by scarification or astringent applications. In the adult, free scarification, in which the part is divided by a number of incisions which reach through the swollen tissue to the cartilage, is the speediest mode of cure: cicatricial contraction is thus induced, which speedily lessens the swollen part. In the child, which is less amenable to operative treatment than the adult, topical means can be used for reducing the swollen part, and as proper agents astringents may be employed; and of these one of the most effective is tannin. A mixture, compounded of glycerine saturated with tannin, may be applied to the part, once or twice daily, on a pledget of absorbent lint; and this may be used as adjuvant treatment where scarification has been done; and in any case, this astringent application, to be effective, must be continued for a number of weeks.

The nasal septum is the frequent site of ulceration; and this is nearly always confined to one side, and is situated in the lower third of the partition, just inside of the movable or der-

mal extension of the septum. As predisposing cause, there may be syphilis, scrofula or some obscure cachectic condition of the patient. In such subjects, the nasal excreta collect on the septum, as hard, dry and adherent crusts, and their removal often causes some abrasion of the mucous surface; such is the manner in which a slight lesion arises and, having commenced, enlarges and becomes permanent through continued irritation. And as an indolent ulcer elsewhere has but slight tendency to either recede or advance, so, in this location, it may remain with little change, for an indefinite period, as a denuded point of the mucous surface, covered by a thin crust; yet, exceptionally, it may penetrate deeper and perforate the septum.

This little ulcer is most unfavorably situated for healing, and hence it often remains as a tiresome annoyance to both patient and physician, for an indefinite period. For the ulcerated tissue soon becomes tolerant of the local remedy used, and ceases to respond to its action; and hence the remedy must soon be exchanged for another; and the more frequently the remedies are changed, the sooner will a cure be obtained. As means which may be tried are the compound tincture of benzoin, and ointments composed of thirty grains of iodoform or subiodide of bismuth to one ounce of vaseline. Ointments of tannin and of the salts of mercury may be tried; and, as before indicated, these several remedies may be successively used for a short time, and then again repeated. The most difficult cases to treat successfully are those in which the ulceration has made a breach through the septum, and the destructive process continues slowly enlarging the opening. Should local remedies not arrest the ulceration, the thermal cautery should be tried; and thus, the surface being destroyed in which there is probably lodged some parasite or other agency which maintains ulceration, healing may take place in the sound structure which remains. Sometimes, in spite of the most careful management, such ulcer remains stationary, and is a source of anxiety to the patient lest the destruction of the partition may proceed so far as to permit the nasal dorsum to sink. When it commences in the anterior part of the cartilaginous portion of the septum, this ulcerative disease never entails the sunken nose, unless it arises from syphilis, through which the osseous portion of the septum being also attacked dies and is finally ejected. In these cases of ulcer of the septum, with whatever constitutional disease the ulcer

may be associated, the latter should be appropriately treated, for, if a military simile be permitted, it would be folly to arrest the individual skirmishers who advance in front, while the main force of the enemy lurks in immunity behind.

Necrosis of the Osseous Septum.—The vomer and the perpendicular plate of the ethmoid, which together form the bony partition between the nares, are the subjects of disease. This disease is, in most cases, of syphilitic origin, and, in the form of gummatous deposit, this usually appears in the soft parts which line the bone. This disease, in its course in the soft parts, often deprives the bone of its vascular supply so that it dies, and this is sometimes on so large a scale that the entire bony partition becomes the site of necrosis. As a rule, this necrosis is only partial, portions of the bone from time to time dying, and are detached; and for the complete destruction of the bony septum, often a period of one or more years is required. Besides constitutional treatment, there should be directed to the part topical remedies, which will act curatively, and likewise deodorize. As curative agents solutions of iodine and mercury should be applied; an excellent mixture is one composed of equal parts of tincture of iodine and the tincture of nut-galls. To deodorize, one may use the compound tincture of benzoin, or the following:—

℞. Potassii Permanganitis. ....ʒij
Aquæ Menthæ Piperitæ..... .... .℥x
Misce.

Irrigation with a solution of chloride of sodium may be practiced. In spite of the best directed efforts of treatment, the bone usually dies, and fragments, becoming detached, must be removed. The patient should be foretold of his coming misfortune, viz., that the dorsum of the nose will probably sink and render him the subject of unsightly deformity; thus notified, his impending evil will fall less severely on the victim.

Obstruction of the Nasal Passages.—Golding Bird, who has studied the causes of nasal obstruction, finds that these may vary, and, according to symptoms, may be classified as follows: 1. Where there is no discharge from the nostrils, and no change occurs during alterations of the atmosphere, the obstruction may then arise from necrosis, sarcoma, enchondroma, deflection of the septum and thickening of the inferior turbinated bone. 2. In obstruction from a mucous polyp, there is a discharge from the nose; and the condition is worse in bad weather. 3. In long-

continued nasal discharge from the posterior nares of mucous or purulent content, the obstruction may be from an adenoid growth in the posterior part of the passage. 4. There may be a chronic nasal obstruction situated anteriorly, attended by a continuous muco-purulent discharge from an ozæna of local or constitutional origin.

Nasal Polypus.—Among these causes of obstruction of the nostrils, the most common is that produced by a growth named polypus: an ill name, since this tumor is rarely many-footed and many-branched: characteristics which the name implies.

Two forms of nasal polypus are met with, to wit, the mucous and the fibrous or fibro-cartilaginous. Hippocrates says that the polypus, when it arises in the nose, originates from phlegm, gives obliquity to the nose and disturbs breathing. The brief and erroneous pathology here given, which finds the origin of the polypus in phlegm or mucus, has reference to the easily mastered pathology of the ancients, in which four elements, viz., blood, phlegm, bile and atrabile served for the compounding and evolution of all organic structures of the animal body. Through the cribriform plate of the ethmoid bone, the old physicians thought the phlegm was decanted from the brain into the nose. But Virchow, Billroth, Paget, and the microscope have disturbed these felicitous simplicities of the olden times and given us knowledge nearer the truth. Microscopically the mucous polyp is found to consist of a mesh of delicate fibres, analogous to connective tissue; and in its meshes one finds a liquid or semi-liquid material in which are seen elements round, oval and fusiform. According to Billroth, there are contained hypertrophied mucous glands in clusters in the polypus: and from these enlarged glands vesicles or cysts may arise. The polypus will be denser or softer according as the fibrous constituents or the mucous substance predominates. Its serous content and the lack of vascularity render the nasal polyp translucent. When its form has not been altered by compression, the polypus has a singular resemblance to an oyster. Its figure may be changed by pressure of contiguous parts. There may be a single one, or several; and when multiple they lie at different distances from the anterior outlet of the nose; so that when occupying that outlet, if one be removed, another one comes into view.

The mucous polypus may arise from every part of the nasal passages except from the septum; it may arise also from the frontal sinus, or the ethmoidal cells, and pass thence into the nose. The

most usual origin is from the mucous membrane covering the superior and middle turbinated bones, as well as from the remaining mucous membrane of the meatuses bounded by these bones. The polyp may attain such dimension that there is no longer any room for it in the passages; it may then pass backwards or forwards, and appear in the pharynx, or protrude from the nose upon the upper lip. By inspiratory and expiratory effort, the polyp can be drawn inwards, or forced outwards: and this mobility is due to the polypus being pedunculated. Yet exceptionally, the polypus may be sessile, and then it is less movable. The soft plastic structure of the mucous polyp does not allow it to compress the adjacent parts to the extent of injuring them; the nose may be more rotund on the affected side, yet rarely has the mucous membrane been found ulcerated; and never have the bones been seen diseased, as occurs from the fibrous polyp, or malignant growth; and hence the mucous polypus is not regarded as a serious matter, by either physician or layman.

Symptoms.—The presence of a mucous polypus in the nasal passage, as soon as it assumes some dimensions, is announced by a heaviness and fullness in the affected side of the nose; there is sneezing and a constant mucous discharge from the part. The patient thinks he is "taking a cold;" and his medical adviser is often similarly misled; and this error may originate in the circumstance that the trouble has become worse, seemingly, from some atmospheric change. The eye of the affected side is often red and tears flow from it. One of the most notable symptoms is a change in the voice; this is nasal in tone. The voice sounds as if in some way it were muffled. The complete obstruction of one side of the nose, or of both passages, where the growth is bilateral, compels the patient to breathe through the mouth instead of through the nose. He sleeps ill, being awakened by his own snoring. When the growth is unilateral, if the unoccupied nostril be closed, the patient finds that he can not breathe through the affected side. The sense of smell, and even that of taste, are impaired. The patient imagines that his nose is swollen, or is filled by some foreign material; and he is continually endeavoring to liberate the nostril of its contents; and these efforts instead of affording relief, only aggravate his condition by increasing the congestion. The frequent irritation of the swollen part occasionally provokes bleeding. This condition has often lasted for a long period, the patient being ignorant of his true condition and referring his trouble to "catarrh," which, in modern times,

has been added to the category of ailments of the layman, and made to play an important part in his ills and expenses.

The effects of the polypus are so nearly analogous to those which may be caused by deflection, or suppurative tumor, of the septum, that error in diagnosis has arisen from careless examination, or want of knowledge on the part of the medical attendant from whom advice is sought. The polypus is readily distinguished from disease, located in the septum, by color and site; the mucous polypus is of pale hue and is located in some part of the outer wall; it never grows from the septum; disease or deflection in the septum is of reddish color, and its investing covering is continuous with the mucous lining of the septum. A not infrequent error in diagnosis is in mistaking a swollen condition of the membrane lining the inferior and middle turbinated bones, for a polypoid growth. Not unfrequently from congestion of the nasal passages the blood gathers in the pituitary membrane, and then the latter may hang pendent from the lower margin of the turbinated bone; and the pendulous structure can readily be moved laterally, if touched, with a probe. The rhinologist, whose field of work is bounded by the four walls of the nasal passage, easily recognizes the condition present through the intense vascularity of the affected structure and its blood-red color and mobility, provided it does not wholly fill the nostril.

As important aids in seeing and determining the situation of the growth are the nasal speculum and direct or reflected illumination. Light of the sun or from a lamp can easily be reflected into the nasal passage by means of the common ophthalmoscopic mirror. In the most of cases, however, when the patient applies for relief, the growth has attained such dimensions that it can readily be seen if the nose be so uplifted as to bring the passage within the range of the eye.

As symptoms and characteristics which distinguish the mucous polypus from the fibrous and other growths in the nasal passages, Durham gives the following: The pale color, the semi-transparence, the elastic softness, the slowness of its course, the absence of hæmorrhage, the continuance of good health, are symptoms which distinguish the simple mucous polypus from that of fibrous nature, of which the color is more or less red, and light cannot traverse it; and the fibrous growth has a dense and resistant structure, and one which is not affected by atmospheric changes. The fibrous polyp also grows rapidly, and is often attended by epistaxis. And if the growth be malignant, it is distinguished

by pain, opaqueness, hardness and immobility. It bleeds easily if touched, and the discharge from it is fetid. Again, from the mucous polypus, the osseous or cartilaginous tumor is distinguished by the hardness and immobility of the latter.

The mucous polypus, though wholly benign in character, is exceedingly troublesome from its endowment of rapid reproduction, and this reproduction is usually not from the site whence the polyp has been extracted, but recurrence is from the development of scions, or other polypi, which spring up alongside of preëxisting polypi. Hence, not unfrequently he who is once the subject of mucous polypus remains always a victim of this fertile growth. The writer, however, has known exceptions to this, in which thorough removal, done by extraction with forceps, was not followed by a return of the disease.

Treatment.—The nasal polypus was well known to the ancients; both Hippocrates and Celsus have chapters devoted to the treatment of this growth. In Hippocrates one finds all the elements of treatment which are used in modern surgery, or, if not wholly the same as methods now used, yet sufficiently similar to have suggested them. To remove the polypus which is soft, and which is forced out and again withdrawn in expiration and inspiration, Hippocrates directs to first cut a round section from a sponge that will fill the nostril, and then tie to this four pieces of Egyptian cord, each a cubit long, which are knotted together at the other end; next attach these cords to a metallic rod (wire), and carry them through the nose until they are seen behind in the mouth; then seize the cords, and, supporting the uvula by means of a forked bone, the cords are pulled upon until the polypus is extracted. Arrest the bleeding by means of lint carried in with the rod; and finally dress with a mixture containing copper.

When the polypus resembles flesh, and is hard to the touch, Hippocrates advises to pass a canula to the tumor, and, through this, cauterize the growth with the hot iron three or four times; treat the wound with black hellebore, and, later, with the compound of copper.

In a third manner, the polypus may be removed by means of a cord made from a tendon or nerve, which is tied into a loop at one end. Carry the other end of this cord through the nose into the throat by means of a fenestrated rod; the looped end of the cord, at the entrance of the nose, is next to be carried around the polypus by means of a forked sound, and, when the growth is

thus caught, the cord in the back of the mouth is to be seized and pulled upon until the polypus is withdrawn. During the traction support the soft palate with the forked bone, as was done in extracting the polypus by means of cord and attached sponge.

A fourth Hippocratic procedure was as follows: There are cases in which the polypus appears to be flesh, yet when it is touched it resounds like a stone; when the condition is thus, open the nostril with a knife and, having cleared out the nose, cauterize the part. Afterwards, close the wound with suture, and treat the former with an ointment, and subsequently with a mixture of copper, and, finally, complete the cure with lead. In case the nasal growth be cancerous, it is necessary to burn it, and afterwards, apply hellebore; and conclude the treatment with copper and lead.

These extracts from Hippocrates embody the essential elements of the treatment of nasal growths among the moderns.

Celsus briefly gives the knowledge of the Roman physicians on this subject as follows: The polypus, sometimes white and sometimes reddish in color, adheres to the bones of the nose, and may appear in front or behind where the breath descends from the nose to the fauces; and in the latter position it may grow so large that it becomes visible behind the uvula; and when the south or east wind blows, it causes strangulation. It may be hard or soft; the hard species obstructs the breath more than the soft, and widens the nostrils, and is of the nature of carcinoma, and should be let alone. The soft species is to be cured by the knife; meantime it may be reduced by a compound of lead, lime, and other ingredients. To remove this growth use the spatha (a spoon-shaped instrument similar to a curette); but use diligent care in the removal not to wound the cartilage, since this heals with difficulty. When the polypus is detached, remove it with a hook-shaped instrument. The subsequent management is similar to that taught by Hippocrates.

The treatment of the mucous polypus as now pursued may be placed under the heads of non-operative and operative.

As non-operative means are medicinal agents which possess astringent and, in some degree, escharotic properties. One of the best for this purpose is tannin, which may be used, when finely powered, as a snuff. Powdered Sanguinaria may be used in the same way. A solution of alum, of sulphate of zinc, or one of the chloride or subsulphate of iron may be used; yet of the agents mentioned tannin is the best, since it has none of the

objectionable qualities which may be urged against one or more of the others. These agents arrest the growth of the polypus, yet do not remove it; and to be effective they must be continued for a long period.

As operative means may be enumerated excision, extraction, or plucking out, ligature or snare, and cauterization: methods, as before seen, employed by Hippocrates and Celsus.

Before resorting to any of these methods, the location and site of origin of the mucous polyp must be accurately determined; and this may be done by means of a speculum constructed of metal or India rubber, and which may be used equally well in examining both the auditory and the nasal passages. This instrument may be bivalvular, with handles by which it is held in the hand; or, as a cylinder, it retains its place when inserted into the passage. With one of these instruments, by means of direct or reflected light (the latter is better), the polypus may be seen, and its situation and the volume of the growth estimated. As aid in this search, a probe may be used, with which the pendulous growth can be moved, and the fact determined whether the polypus is single or multiple. These circumstances being learned, one next selects a method for the removal of the polypus.

The Celsian method by excision was done by the Latin physicians by means of a species of spatula, probably spoon-shaped, with which the growth, being detached, was afterwards drawn out by the aid of a hook. A modification of excision was practiced by Dr. Gross, who used his finger-nail for detaching the polypus, when the latter was thrust into the throat. The plan of excision, or better named curetting, may be reserved for cases in which, after the body of the growth has been plucked off, there remain peduncular fragments. When the location of these can be seen, they may be scraped off by a curette.

Excision, or the modification of it mentioned, is rarely used; removal by plucking off or pulling out is more commonly practiced. Removal in this way, though fiercely decried by specialists, will remain as a usual method of getting rid of the nasal polypus. It is, doubtless, often abused, yet this should not forbid its use. The abuse consists in trying to remove what is not clearly seen, and in doing the work solely by traction; no attempt should be made at removal unless the polypus is clearly seen and located. And this may usually be done with the unaided eye, if the other nostril be closed and the patient then force air out

through the affected side; thus the growth is brought into view. It should, however, have been remarked that in few cases will this strategem be needed, since commonly, when the patient applies to the surgeon, the polypus is plainly seen when the subject's nose is uplifted.

For the extraction of the polypus, special kinds of forceps have been invented; these instruments, as a rule, have curved blades which are serrated and fenestrated. The writer prefers a forceps with straight blades, the rivet or lock of which will correspond to the outlet of the nostrils, when the instrument is introduced into the nose. The blades should be flat, well fenestrated, and broader than that of the instrument commonly used for extraction. With such forceps, standing where he can work with facility and not obstruct the light, the operator closes the sound nostril by pressure, and directs the patient to force the air out through the affected side; as this expiration is being done, the surgeon having already introduced the forceps to the growth with opened blades, and the polypus being carried into the grasp of the blades, they are closed. Done in this way, the polyp is caught without random groping for it, as is done by the inexpert operator; and being caught, the surgeon extracts by first twisting and then making traction. The twisting, to be effective, must be continued until the torsion has reached the pedicle; then if traction be made, the detachment will probably be at the peduncular insertion of the polypus; and occurring there, there will be but little or no bleeding, since the vessels of the pedicle have been subjected to torsion. Should the growth not be entirely removed, an effort should be made to extract the fragment remaining, provided there be not much hæmorrhage; if there be bleeding so as to conceal the interior of the passage, then further work should be deferred until the morrow or a later day. With straight-bladed forceps, there is but little danger of injuring the contiguous vascular wall; often but a few drops of blood appear; and if the operator be experienced and adroit in manipulation, and the patient be docile, no blood at all may follow the extraction. The hæmorrhage, on account of which the method of extraction is so violently decried, is usually due to an awkward hand, impatience to complete the work at one sitting, and forceps which instead of being straight are so curved that in torsion they necessarily wound the contiguous membrane. The writer has seen this traction done so dexterously by the adroit hand of Verneuil that no bleeding occurred.

A third method of removal is that done by means of metallic ligature in the form of a snare. This method, advocated by Duplay, and now practiced by the specialist of nasal disease, is done by means of an instrument modeled after the polypotome, invented by Wilde for removal of the aural polypus. This consists of a wire folded into the form of a loop, which is passed along the handle through canulated openings which partially conceal the wire. By light reflected from a frontal mirror, the growth is located and the noose having been thrown around the polypus, and carried, if possible, to its attachment, the wire snare is tightened, and the growth thus severed. By this means those mucous polyps which are deep-seated, and inaccessible to the forceps, may be removed with little or no hæmorrhage. Though some traction can be made with this instrument, the work of removal is rather done by section of the tumor; and done thus, there must remain a portion of the pedicle, when an early recurrence of the original polypus is inevitable. But when done by extraction, the pedicle is commonly eradicated, often with a fragment of the turbinated bone; conditions which insure against re-growth of the original polyp, and, perhaps, of scions that are near it. Hence removal with the snare, which was advised by Hippocrates in a reversed manner from before backwards, will not wholly supersede that by traction and torsion done by means of properly shaped forceps.

Another method of treatment is that of cauterization, potential or actual. Potential escharotics have been employed, but their use is nearly abandoned. Thudicum, known for his writings on the treatment of nasal affections, employs the thermal cautery to excise the polypus. He passes the loop of the thermal cautery around the growth, and effects the division by heat. The advantage claimed for this method is that it is free from pain and causes no bleeding. The statement by Thudicum that one polypus was removed by fifty-five sections, and in another the thermal loop was introduced thirty-three times, shows that the excision thus is tedious, and that the operator, to be proficient, must have long training of the hand.

There was recommended in 1862 by Fredericq, a treatment of the mucous polyp, by which he claimed to cure without an operation. For this purpose he employed the acid chromate of potash, applied to the growth. In this way twenty cases were cured. The remedy was used in the form of a concentrated solution applied on lint to the polypus. In case the remedy caused too much irritation, its use was temporarily suspended.

After the removal of the mucous polypus, treatment may be pursued that will retard the return of the growth. For this the author has used with advantage Radix Sanguinariæ canadensis, and tannin. These agents, singly or combined in equal parts, should be used as snuff. This must be used for months, and the snuffing done several times a day. As the powder accumulates in the nasal passages, these should be cleansed daily by irrigating them with a current of warm water. This irrigation is done by utilizing the physiological fact discovered by Weber, that when a stream of water is carried by douche, or injected into one nasal passage, and the patient, meantime, breathes through the mouth, the current of water, after reaching the choanæ returns through the other passage, escaping in front. The contact of the fluid with the upper surface of the pendulous palate, awakens reflex action, probably through the filaments of the glosso-pharyngeal nerve, and causes muscular contraction, similar to what occurs in normal deglutition. By utilizing this action, the nasal passages may be effectually cleansed, and also medicated fluids can be brought into contact with the entire inner surface, for disinfection or other purposes.

Fibrous Polypus.—The fibrous polypus or neoplasm is much more formidable than the mucous polypus just treated of. These tumors, according to their site, are named nasal, naso-frontal, naso-maxillary and naso-pharyngeal. The usual form is the naso-pharyngeal, which, though occupying a naso-pharyngeal location, may exceptionally originate outside of this region, and yet, by growth, appear there. Nélaton and others claim that these tumors always spring from the basilar process and body of the sphenoid bone. Exceptions to this have been observed, viz., that the tumor may arise from the sphenoidal pterygoid processes, and front face of the superior cervical vertebræ. This discrepancy in respect to the point of origin has originated, as Bryant has shown, from the fact that the tumor may have more than one site of attachment, the secondary ones having arisen from the circumstance that the growth, as it develops, may come in contact with other adjacent points, and contract adhesions to them; and thus the growth will appear to have more than one point of origin. The fibrous polypus primarily arises from the periosteum, starting beneath the mucous membrane, and, as it develops, it carries the mucous membrane before it, which often becomes thickened and resistant. In structure this tumor is firm, hard, and sometimes has a hardness approaching that of cartilage.

Unlike the mucous polyp, this one is inelastic and opaque. It is usually red in color, dark or lustrous in appearance; yet when it is removed, its color is gray or whitish. In three cases seen by the writer, the growths had this whitish or cartilaginous appearance before detachment; and the structure was not very vascular, as seems to be the rule in most cases. One surgeon found an artery, as large as the ulnar, on the base of the tumor.

Histologically, the chief constituent is fibrous tissue; and the tumor, or section, presents to the naked eye a fasciculated aspect. The fascicles are arranged, at points, concentrically; and if examined carefully, they will be seen to converge towards the pedicle or point of attachment. The microscope usually reveals only the elements of fibrous tissue; sometimes, however, the fibrous constituents have a fusiform appearance, in which there is an approach, in form, to that of the doubly conical nucleated cell of sarcoma; and this form is closely allied to the malignant connective tissue growths; and, similar to these, such tumors commonly return after removal. Some claim, as Boyer, that the naso-pharyngeal growth can lose its benign character and become transformed into a malignant tumor; a more rational conclusion, however, is that such growths are primarily malignant, and, in their development, violate none of the canons of pathology.

The fibrous tumor has been seen incrusted with calcareous matter which may penetrate some distance into the growth. Such chalky formation might be precipitated from the normal nasal secretions.

The growth of basilar origin is free to expand in any direction; but soon, from contact of the lateral walls, its development is directed antero-posteriorly, since the tumor meets no obstruction in these directions. Perhaps one nostril alone is occupied, and then the septum, inasmuch as it can offer but slight resistance, yields, and is forced into the other passage. The tumor coming in contact with adjacent parts becomes adherent to them. If the growth is not interfered with, the outstretching processes of it may extend forwards and appear at the anterior nares, and forcing the lateral walls asunder, enlarge and deform the nose. Or, the tumor may enter the maxillary sinus, and thence proceeding outwards, uplift and change the form of the cheek. Again, it may develop towards the eye, and, uplifting the floor of the orbit, encroach on the eye, and force the globe from its socket, and, producing exophthalmic deformity, finally

impair, if not destroy, vision. And in this situation a process having penetrated the frontal sinus may seem to have originated there. The tumor in its development may pass in a direction entailing yet more fatal consequences, viz., it may penetrate, through erosion of the base of the skull, into the intra-cranial cavity, and fatally compress the brain. In all these directions, whatever osseous structures the tumor may encounter in its march, the bone is gradually absorbed.

As results caused by the tumor from obstruction of the nasal passages, and from encroachment on parts which are contiguous, the following may be enumerated: obstruction of respiration, which may be limited at first to one nostril, and later, to both nasal passages; encroachment upon, and occupancy of, one or both frontal sinuses, and then if the volume become enormous, there is upheaval of one or both cheeks; closure of the lachrymal canal, and, as result, unilateral or bilateral epiphora; encroachment on the orbital cavity, with displacement of the globe of the eye, forwards, or laterally; penetration into the cranial cavity through the base of the skull, and as nerves are met, there will arise impairment of their individual functions; thus the trifacial, ocular motor, optic or olfactive nerves may have their functions impaired or annulled. And, finally, should the growth enter the cranial cavity, though there may be tolerance of the pressure for a long period, finally, signs of encephalic compression will appear. When the tumor develops in the choanæ and entrance of the pharynx, difficulty of deglutition arises, and is a source of much discomfort. In the pharyngeal isthmus in which the paths of air and food cross each other, there must be no impediment to either; and the presence of a naso-pharyngeal growth introduces confusion in the nicely balanced acts of reflex automatism seated there.

In the early period of development of this growth, the symptoms present are often mistaken by both patient and physician for a cold or a catarrh (as the popular phrase now has it); yet, at this initial stage, the frequently recurring epistaxis should awaken suspicion of a growth in the nasal passages; and one which is of fibrous and not of mucous structure.

The naso-pharyngeal fibroma almost always occurs in the male subject; in only a few cases has it been observed in the female. Probably, some structural or anatomical reason exists for this immunity of the female; yet none has been offered. Perhaps nature, who has been so unfair in the allotment of tasks and

burdens between the two sexes, has not erred in this instance, in placing the load on the stronger shoulders.

This growth is seen oftenest in the young, viz., between the ages of twelve and twenty years. Of one hundred and sixty-four cases collected by Durham, one hundred and twenty-two had not passed the twentieth year of life. And in this period of exuberant growth, fibroma or enchondroma may develop in contiguous regions; of this the author has seen the following example: A purely fibromatous tumor, as large as a pigeon's egg, developed in the zygomatic fossa near to the pharynx. Through an incision within the buccol cavity, this tumor was reached and extracted, without leaving any external mark of the work done. A few months afterwards, there was discovered a naso-pharyngeal fibroma, which doubtless had coëxisted with the tumor that had been removed.

In the diagnosis of the nature of the growth, a matter of the utmost importance to the patient is to decide whether the tumor is or is not malignant; and as signs that it is cancerous, are the following: The growth is in a subject who has passed the middle period of life, and it develops rapidly, and is accompanied by keen shooting pains; and the glands adjacent swell. The cancerous tumor is soft, friable and ulcerates at an early period, and the subject soon presents the ashy hue, and the poor health characteristic of the cancerous cachexy. In contrast with this, the nasal fibroma occurs in the young, is hard in structure, does not ulcerate and grows slowly. A fragment placed under the microscope would assist in determining the true character.

Yet the nasal fibroma is not a harmless invader; when it reaches large dimensions, it causes frequent epistaxis which slowly weakens the patient; and through pressure, it causes pain. Such tumor protruding into the pharynx can cause suffocation; so much so that Gosselin proposes for the tumor the name of suffocating polypus. Sudden death has arisen from asphyxia thus arising.

Cases, however, have been seen in which the naso-pharyngeal fibroma has become gangrenous, and thus the patient has been liberated from his disease without medical or surgical treatment. And analogous to growths whose appearance and development are limited to a certain period of life, it is not improbable that this nasal growth, having attained certain limits, may, possibly, cease to grow. Yet these fortunate events are so seldom seen that one can scarcely hope for their realization; absolute extinc-

tion is rarely seen; and recurrence is the rule unless the site of origin is also radically destroyed; and this leads to a consideration of the means of treatment.

Treatment.—The tumor must be attacked operatively; and the operation done may be simple or palliative; or it may be radical or curative; and, as the latter embraces subsidiary work by which the tumor may be reached, it is named complex or compound.

The simpler operation, in which the work is limited to the mere removal of the growth, without any attempt to destroy the site of origin, may be one of the subjoined methods: excision, extraction, ligation, detachment by scraping or curetting, and division or destruction of the part by cauterization.

Excision may be done by means of scissors or knife; it is clear, however, that the almost inaccessible situation of the growth will interfere with the use of these instruments, with any great degree of accurate effect; in the majority of cases, the work, at best, can only be blindly done. Another objection to excision is the danger from hæmorrhage; for, as before stated, these tumors are very vascular, and to divide such structure, where the vessel could not be reached, must cause severe, if not dangerous, hæmorrhage. If this method be pursued, the operator should be prepared to introduce, at once, a styptic tampon, and such a one is best made of sponge saturated with a strong solution of tannin, alum or a salt of iron. So many risks, however, surround this procedure, that it is rarely put into practice.

Extraction is much to be preferred to excision, for relief from this tumor. For this purpose, strong forceps, such as are used in extracting vesical calculus, should be used. The extraction is done from the pharynx; in the exceptional cases in which the tumor can be reached anteriorly, the removal might be done from in front through the nostrils. If done from behind, the forceps should have a curve similar to that of one form of forceps used in lithotomy; for, thus shaped, the instrument can be introduced through the pharynx into the choanæ, and the growth there seized. The detachment should be accomplished by traction combined with twisting. The work of torsion will be done with difficulty, if the tumor be impacted in the posterior nares, or have processes reaching into the adjacent sinuses. The torsion will act on the footstalk, and close the vessels contained in it. The difficulty of reaching the growth, of getting a firm hold of it, and of severing by pulling and twisting the strong structure of the tumor, are serious defects to this method of removal; yet, if the growth is

pedunculated, or has a small attachment, then this method, as a palliative procedure, is one of the best which can be used. It is best adapted to those cases in which the tumor having sprung from the overhanging basilar process, hangs in the pharynx; in such condition the tumor might possibly be so completely extracted that it would not recur.

A third method of removal is by ligature, which has been done in two ways, viz., one in which the ligature acts slowly, and the other in which the section done is immediate.

The ligature of slow action may consist of silken thread or wire. The work of throwing the ligature around the base of the tumor is difficult, since the operator works in a space into which he cannot see, and hence the casting of the strangulating loop around the growth is done at random; work in which "millions miss for one that hits." And when the noose has been adjusted, if the cord is silken, the formidable difficulty arises of securely tightening it by a knot. For this reason a strangulating loop of wire is better, since this can be closed by twisting, and can afterwards be made tighter by twisting it one or two turns more, if additional constriction be needed. The objections to this method are the difficulties that attend its use; and after the tying, the slow detachment is attended by the passage of foul materials into the pharynx, which, being swallowed, or entering the lungs, become a source of disease. These objections have caused this method to be nearly abandoned.

Immediate or instant ligation, by which the tumor is detached at once, is preferable to the slow mode described. The detachment may be done by the linear écraseur, or the loop of the galvano-cautery. The same obstacles are met here in adjusting the loop as in the slow method, and the division will more probably be made through the body of the tumor, than through its base; and, hence, it often becomes necessary to repeat the operation on the remaining peduncular portion. It is probable that division with the linear écraseur would be more effective than if made by means of the galvano-cautery. The thermal method, however, seems to be preferred by the nasal specialist.

A fourth method is that in which the tumor is removed by piecemeal detachment: a procedure which may be accomplished by scooping, scraping, curetting, or plucking off fragments. The uterine curette, or a chisel-edged instrument, may be used in this work. The work of such fragmentary disintegration is necessarily slow and attended by considerable loss of blood. The difficulty

or impossibility of wholly removing the growth, is an objection which can be urged against this one as against all the other methods which have been enumerated.

All the procedures mentioned, inasmuch as they leave the site of the tumor uninjured, are imperfect, incomplete and unsatisfactory to both patient and operator; for in the trilogistic rule of *safely, speedily* and *happily*, the operator has chief pride in the middle term *cito;* and as to the patient, his chief purpose with his physician is to be speedily and thoroughly cured; and hence a treatment which promises but transient relief, or a series of recurrent operations, will surely be rejected by him if anything better can be offered. And this introduces a consideration of those methods which, though radical, severe and deforming in character, yet insure a cure to the patient.

The obstacle to a cure in the methods before mentioned is the impossibility of reaching and destroying the peduncular ground whence the tumor springs; and to do this, some pioneer work is needed to open a road to the tumor and its site. For this purpose a subsidiary operation, sometimes of considerable extent, is needed. Such preliminary work may be done in three directions, and according to the route taken in this particular work, so the method may be named the *nasal*, the *facial* and the *palatine;* and of these, different operators have offered modifications. So numerous are the latter, that a monograph devoted to this subject and published in French about 1870, contained some score of diagrams, each representing some surgeon's preliminary section to reach the tumor.

As varieties of the nasal method, the following merit notice: In 1866, Collis made a vertical cut alongside of the nose until he reached the nasal bone and nasal process of the superior maxillary bone; these bones were next sawn through, when the base and side of the nose were uplifted and the whole external nose was deflected to one side, so that the interior cavity of the nose was exposed to view, and a growth there could be removed. Verneuil advises to open the cartilaginous portion of the nose in the median line, and, if need be, continue this through the nasal bone, and if further opening be necessary, to resect these bones. Verneuil lays down the rule, that the opening suffices, if the finger can enter through the orifice made. Ollier proposes a horse-shoe cut, the branches of which lie on the sides of the nose, and are united over the root of the nose. The nasal bones are next cut through, and also the septum is divided, when the nose

is lifted from its site and turned downwards, so that a free opening is made to the naso-pharyngeal cavity. Langenbeck performed a similar operation, but the horse-shoe was reversed; he severed the soft parts and divided the nose, so that the nose, with upward attachment remaining, could be turned upwards. After the removal, by either the method of Ollier or of Langenbeck, the nose is restored to its normal site and retained there by sutures.

These methods are especially suited to the cases in which the tumor lies in the nasal passages, and is not impacted in the cavity, viz., in those in which the nasal bones and adjacent portion of the superior maxillary bone are forced forwards. The way towards the basilar site of implantation is both opened and shortened; and one is enabled to directly attack the greater portion of the growth. And in case processes of it cannot be removed, it has been found that such portions may atrophy, and cease to be troublesome, if the central mass of the tumor has been removed. Besides, if it be necessary to enter the maxillary sinus, this nasal route offers a free passage. And the pterygo-maxillary fossa is penetrable by the same route.

As before stated, after extraction of the tumor, which will be considered later, it is usual to repair the breaches made by the preliminary operation: and in case a portion of the nasal wall has been destroyed, this is to be repaired by some of the procedures which will be detailed under the head of rhinoplasty. The breach, however, is not always closed; in cases in which the removal is imperfect, or an early recurrence is anticipated, the plan has been pursued of leaving the breach unclosed, through which the cavity could be inspected from time to time, and an attack on the tumor be renewed, in case of its regrowth. Such opening must be closed by strips of over-bridging adhesive plaster; and at a later period, when the growth is found to be extinct, then permanent closure by some plastic procedure may be resorted to

The facial method of operating will next be considered. In this method the preliminary work of pioneering consists in preparing a route through the superior maxillary bone: and various modes of doing this have been proposed, or carried into effect.

The entire removal of the maxilla superior, which was first done by Syme, though it offers ample facility for removing the tumor, yet the patient remains deformed beyond rescue: the eye sinks downwards, and may be lost; the tears escape continuously. Such total ablation interferes with mastication, deglutition and voice. Hence, to avoid these defects in form and function, a

partial exsection of the upper jaw has been done: a procedure in which the orbital and palatal portions of the bone are preserved. But it has been found that this method deforms the face severely, and, withal, the way thus opened to the tumor is too narrow to permit its removal.

The next modification of the facial method is that of temporary resection, in which a portion of the maxilla superior is excised, yet so retained in connection with the soft parts that it can afterwards be restored to site, and reunited. This has been done in several ways. Dezanneau thus temporarily resected and afterwards replaced the lower half of the jaw, with successful results. Other attempts seem to have been less fortunate: the teeth and fragments of the resected portion were lost. The resection was next done on the anterior face of the bone by Langenbeck, Esmarch, Trélat and others. Langenbeck resected the front face of the bone, and reflected the osteo-cutaneous flap inwards, while Boeckel reversed the work by reflecting the flap outwards. The removal of the tumor seems to have been easily done by these ways; and the uplifted flap, afterwards being replaced, reädhered to its former site.

The writer proposes as a way of doing this work, to combine the nasal and facial methods; for this, make a longitudinal cut along the affected side of the nose, its entire length; saw through the nasal bone thus exposed, and let this be a portion of the cutaneo-osseous flap, which by suitable sawings is to be uplifted from the front of the maxilla superior. The next incisions must traverse the upper jaw transversely: one just above the alveolar process, and the other must lie below the infra-orbital border: thus done, the nasal and maxillary incisions form three sides of a rectangle, which is open towards the ear; operating thus, the orbit and the buccal cavity will not be infringed on, and a satisfactory route will be opened to the growth.

These facial operations, however well and conservatively they are done, must deform the face by large scars. To avoid this, the palatal method may be resorted to. The attempt to reach the growth through the palatal way was first done, by Manne of Avignon, in 1747, who divided the soft palate. Dieffenbach operated in a similar manner, yet his incision did not divide the soft palate wholly; the posterior margin was left intact. This opening being found too small by Maisonneuve and Nélaton, the latter enlarged it by extending the incision into the osseous palatal vault. Yet even the large opening which is thus made

is sometimes insufficient to permit of the easy removal of a large tumor: in such case, the removal is done by fragmentary disintegration, and may be attended by severe hæmorrhage. The chief defect of this method is that the palatal vault is so injured by the perforation made that it cannot be repaired, or but imperfectly. This breach in the roof of the mouth is a source of much inconvenience to the patient, since in eating, the food can pass into, and remain in, the nasal passages. The attempts to close such breach, when the latter is large, have usually failed.

The three methods which have been considered have had strong partisans in those who originated them: it remains to consider which one should be chosen. The ruin made of the palatine vault, usually irreparable, the deformity and functional impairment entailed by the facial method, are serious objections to these two plans of operating: the nasal method is less objectionable, and is the one commonly selected. Tillaux, guided by his accurate anatomical knowledge, says that the nasal route is the most rational and direct way to reach the point of implantation of the naso-pharyngeal tumor. But should the removal of the tumor, through fixation of its processes, be impracticable in this way, his second preference would be for the palatal route.

The route being opened to the tumor, there are several ways by which the removal can be accomplished: and of these, the most simple is that by traction combined with torsion, in case the volume of the tumor is small enough to permit the work being thus done. The hæmorrhage which follows the removal of these tumors, and which, in several recorded cases, has ended fatally, demands the most serious attention of the operator; and as operative means which give greater security in this direction, are the procedures of linear écrasement, the galvano-cautery and the simple thermal cautery. And of these methods the division by heat has proven safer than that of linear crushing. The pedunculated portion of the tumor being included in the looped wire of the galvano-cautery, the detachment can thus be done with but slight loss of blood. In most cases the section could be made conveniently with the knife point of the thermal cautery.

The removal has likewise been done by means of the potential cautery; for this arrow-shaped points prepared from a mixture of chloride of zinc and wheaten flour, should be thrust into the tumor. This plan is less practicable than that of the actual cautery, and there is the danger inseparable from it that some of the caustic material will escape into the throat, and pass to the

stomach or lungs. A patient treated thus died, and the operator reported that the caustic agent was not "foreign" to the death.

In many cases, after the removal of the tumor, the road that has been opened to reach it has been left open for some time, in order that the operation should be repeated if there be recurrence.

The nasal fossæ are the site of malignant growths, of which the type most often seen is epithelioma: the sarcoma has been observed. These tumors appear at all periods of life. They are found so adherent to the bones that it becomes difficult to decide whether the growth originated from the bone, or the structures covering the bone.

The malignant neoplasm may spring from any portion of the inner surface of the nasal cavity; it develops rapidly, soon reaching the ulcerative stage, and bleeds when the surface is scratched or broken. Durham finds that the veil of the palate is red, thickened, and distended. The special origin of the naso-pharyngeal fibroma, its advent in the youthful subject, and its slow development, distinguish this growth from the malignant growth. It is true that each type is recurrent, yet recurrence of the malignant tumor is soon concurrent with that form of vitiated health named the cancerous cachexy.

The concealed site of the malignant tumor in the nasal fossæ lets it develop for a time unperceived: this circumstance, and the difficulty of radically removing the tumor in its labyrinthian retreat, render the prognosis of such growth eminently unfavorable.

The treatment described for the removal of the naso-pharyngeal growth is proper for any form of malignant disease located here. The site of origin must be destroyed; otherwise the removal would be a temporizing culture of the growth. The osseous ground must be removed; hence, after an opening has been made to the tumor by the excising chisel, and the growth completely removed, extinction is best insured by attacking the osseous site by thermal cauterization.

Hypertrophy of the Nasal Mucous Membrane.—The mucous membrane of the nose may become thickened to an extent which may interfere with respiration. And as the growth depends on development and widening of the vessels of the membrane, the condition may properly be named vascular hypertrophy. This thickening of the membrane occurs especially on the inferior and middle turbinated bones; yet when prominently present on these bones, the remaining mucous membrane is likewise affected,

viz., that of the septum and floor of the passages. The hypertrophied membrane hangs pendulous from the turbinated bones, and has been mistaken for a polypoid growth. Such pendulous structure, however, differs from the mucous polypi in being sessile or directly attached to the margin of the bone, instead of being pedunculated, and it is of a dark red color, this color indicating that the venules are mainly concerned in the formation, and not the muciparous glands, as is the case in the mucous polypus.

Besides interference with respiration, this hypertrophied formation seems often to be the causal agent of asthma, through reflex excitation. For these reasons the surgeon's aid is sometimes appealed to, for the removal or repression of such hypertrophy. This may be accomplished in two ways, viz., scarification and cauterization. The procedure of scarification is adapted to cases in which the subject is plethoric, and to whom the loss of blood will not be detrimental. To do this use a sharp-edged scalpel, and make rapid, shallow incisions at various points in the swollen membrane. The result will be, for a few minutes, a free bleeding. This escape of blood will lessen the volume of the structure, and the bleeding will cease spontaneously in a few minutes. The loss of blood will be lessened if cold water be applied to the bleeding surface. There will result from the wounds made a gradual contraction and lessening of volume, due to the contraction of the cicatrizing structure. This contraction can also be accomplished by the thermal cautery, with which the surface may be burnt at numerous points. The division of the surface by means of the scalpel can be done more readily and easily, and the lesion made can be measured better with the hand when holding a knife than the long handle of the thermal cautery. As topical means which will favor the completion of the cure, tannin, or a solution of a mineral astringent, may afterwards be applied for some weeks.

Bleeding from the Nose.—Nasal bleeding was observed by Hippocrates, who makes frequent mention of it; he named it hæmorrhage, a term which has acquired a much broader signification, viz., to indicate bleeding from any source. Several names have since been applied to it, all of which have fallen into disuse except the term epistaxis, invented by Vogel and Pinel. Traced to its Hellenic origin, this word means "falling drop by drop." This name, formal and pedantic as it is, has crowded out better ones, and obtained an enduring place in nomenclature.

Bleeding from the nose was given high diagnostic meaning

by Hippocrates, Celsus, and other ancient writers, an importance which the moderns have failed to verify.

Blood to the interior of the nose comes through the common carotid artery, and is finally received through branches of the external and internal carotid arteries: the final branches of supply being the ethmoidal and the spheno-palatine arterioles.

The greater part of the blood comes through the spheno-palatine, a branch of the internal maxillary. The recurrent blood traverses venules, which accompany the arteries, and a part of it returns directly to the heart, while a portion returns indirectly through an intra-cranial route. As a result of such anatomical arrangement, when there is congestion in the district supplied by the internal maxillary artery, the mucous membrane of the nose will participate in the same, and the same is true when there is hyperæmia of the district supplied by the internal carotid artery.

Hæmorrhage from the nose would seem to herald its coming by certain local signs; as such have been noticed unusual redness of the mucous membrane, a feeling of tension, heat and itching in the nose, fullness and redness of face, and suffusion of the eyes. As further concomitants there may be ringing of the ears and vertigo. The pulse is hard and full, and the extremities may be cold. Also, signs in remote portions of the body have been observed; a remarkable instance is glandular swellings.

The advent of the bleeding is peculiar, for, in most cases, the stream of blood breaks forth from the nostril as if it had been pent up and merely awaited an outlet for escape. It escapes through the anterior or posterior nares, according as the head is inclined. It may escape from one nostril alone or from both, more usually from one alone. After the blood has started, it may flow slowly or rapidly, according to the character of the source. If the point of origin be well behind in the fossæ, or, even if it be situated forwards, and the patient be reclining as in sleep, then the blood will not be seen, but it will pass backwards into the throat. During sleep such blood has slowly passed from the throat and been swallowed; and afterwards, the blood being vomited, the source of it has been thought to be the stomach. This imperceptible passage of the blood to the stomach is due to the fact that, in the dorsal recumbent position, if fluid be dropped into the nostrils, it will enter the pharynx and descend to the stomach without any effort being made to swallow. And as Hyrtl observes, nutritive material may thus be given in cases of

trismus, tetanus, or in which the patient cannot or will not open the mouth; the precaution to be taken is that the fluid be introduced drop by drop. Or the blood may collect in the throat, and some of it passing into the windpipe may cause coughing and ejection of blood, which has been mistaken for pulmonary hæmorrhage.

The amount of blood which may thus be lost may vary from a few drops to amounts which fall within the incredible and fabulous: thus in the Actes de Leipzig, a case is recorded in which a man lost seventy-five pounds of blood in two days. Such a statement is more suited for a page of Munchausen than for a work on medicine. The large quantities sometimes seen are generally augmented by the addition of other excreta.

Usually, after the hæmorrhage has continued for some time, it is arrested by a clot of blood closing the nostrils; but as soon as the patient clears his nostrils, which the interference of breathing leads him to do, the bleeding returns. The bleeding may recur several times during the same day, or once daily for a period; and this daily return may be at the same hour, or at a different one; and when appearing periodically, it has been cured by quinine.

The amount lost may be so great as to become dangerous to life; death has thus arisen from syncope; as a rule, however, the patient nearly faints, and rallies again if the head be lowered. As before remarked, the blood may escape down the throat, and enough blood be swallowed to endanger life; such bleeding can be discovered if the pharynx be examined; and besides, when a considerable quantity has entered the stomach, the fact is revealed by vomiting, since the blood coagulating acts as an emetic.

Adopting the classification of the varieties of epistaxis as given by Jaccoud, we have the following: 1. Traumatic, or from ulceration. 2. Bleeding from a morbid condition of the vessels. 3. From a mechanical cause, which may be active or passive. 4. From an adynamic condition of the patient.

1. Bleeding from a wound of the nose is often seen in the child from falls on the nose, in which the nasal bones may be broken, or merely the mucous membrane. Bleeding may be from violence, in which the patient in falling strikes on his head or other portion of the body, and is the subject of severe concussion. Fracture through contre-coup implicating the ethmoid or sphenoid bone, has been revealed by hæmorrhage in the pharynx and posterior nares, the blood then escaping from the nose. An

ulceration of the mucous membrane from any cause may open a vessel and cause bleeding. A growth in the nasal fossæ is often indicated by bleeding.

2. Bleeding from the nose is seen in the subjects of hæmophilia; viz., in those who have a constitutional tendency to bleed; in such subjects, hæmorrhage occurs from the most trivial wound of surface, so trivial often as to be indeterminable. This hæmorrhagic tendency is referred by Virchow to vascular narrowing due to fatty change of the walls of the vessels. It is probable that defective coagulability of the blood has a causal agency. Such unfortunate subjects oftenest bleed from the mucous membrane, and especially from that of the nose.

3. Bleeding may arise in what may be designated a mechanical way, through active or passive congestion. As examples of active congestion are those caused by violent expiratory efforts, exposure to great heat or to great cold, and breathing a highly rarified atmosphere. Thus during the march of the French army in Russia, when exposed to cold, as well as during an African campaign when exposed to heat, nasal hæmorrhage was a common occurrence among the soldiers. And the blood often bursts from the nasal mucous membrane at great elevations where the atmospheric pressure is much lessened; often witnessed in passengers who pass over one of the Peruvian railroads, built over a summit of the Andes.

This active congestive epistaxis is seen in the hæmorrhage which sometimes replaces the menstrual flow of the female; also in that supplementing the flux from hæmorrhoids. As is known, hæmorrhage vicarious of menstruation may occur from the rectum, lungs or nose; in a large list of such cases, Puech found that in eighteen cases the hæmorrhage was from the nose. Such vicarious hæmorrhage announces itself at its approach in the female by a sensation dull, heavy and sometimes lancinating in the nasal region; there is present the general lassitude which heralds the advent of the menses. But when the epistaxis commences, these local and general symptoms vanish. The amount of blood which is lost equals that which escapes in normal menstruation; yet, in a few exceptional cases, the quantity has been excessive and imperiled the woman's life.

Nasal hæmorrhage may result from cerebral congestion, also from closure of the superior longitudinal sinus. It has occurred in cases of leucæmia; one was observed by the writer in which, despite all efforts to control the bleeding, the young subject died.

In leucæmic hæmorrhage, Jaccoud finds the cause in obstruction of the capillaries by leucocytes.

Nasal bleeding accompanies hepatic disease. It is a common accompaniment of icterus, of which it may be the initial herald, as well as the subsequent attendant. The loss of blood adds to the gravity and fatality of the disease. Nasal bleeding, according to Monneret, is present in cirrhosis; also in hepatic congestion. The bleeding in these cases has been referred to a vitiated change of the blood.

Nasal hæmorrhage occurs in disease of the spleen, in which the blood has been morbidly altered.

Cardiac disease in which the circulation is accomplished with difficulty, is attended by epistaxis, especially in the latter stages. The same has been observed in renal disease by Bright, Graves, Rayer, Virchow and Braun. It is often present in acute Bright's disease. Uræmic poisoning may be accompanied by nasal hæmorrhage.

Disease obstructing the pulmonary circulation may cause bleeding from the nose.

4. In the fourth class of nasal hæmorrhage, Jaccoud finds the cause in an alteration of the blood, and from the accompanying debility he names the cases adynamic epistaxis. There is present, as chief causal agency, diminution of the fibrin, and a dissolution of the blood-cells. In many cases which he calls pseudo-hæmorrhage, it is not blood but colored serum which exudes from the mucous surfaces. Yet there may escape blood in such cases, and its escape may be referred to an alteration in the walls of the vessels, or to impaired vaso-motor innervation leading to vascular rupture.

Hæmorrhage of this character may be a prodromal attendant of fevers and of exanthematous affections. As is well known, epistaxis, as pointed out by J. K. Mitchell, is one of the most trustworthy indications of an approaching typhoid fever. Also, a nasal bleeding is a common precursor of scarlatina and rubeola; and where these diseases appear in their malignant form, in which the eruption presents itself as a dark purple redness, there is a frequent or continuous hæmorrhage from the nose. And the same is the case in variola, when it appears in a malignant purpural type. Malarial fever, when long continued, may induce a cachexy in which there is frequent bleeding from the nose; and such bleeding is characterized as pernicious hæmorrhage.

In the cancerous cachexy there is often nasal hæmorrhage.

Also in the ill conditions of the blood present in scurvy, chlorosis, purpura hæmorrhagica, and kindred cachexies, nasal hæmorrhage is a frequent accompaniment.

Nasal hæmorrhage of the class here mentioned, becomes of diagnostic importance in indicating the approach of disease; and in many of the instances cited, it is of prognostic value as indicative of grave and obstinate disease, which sometimes is incurable, inasmuch as the affection depends on disintegration or morbid changes in the blood-cells.

Treatment.—The diversity of causation which has been presented, frequently connected with conditions the opposite of each other, indicates that the treatment must vary, and that thought and discretion must be used in the selection of curative means.

In cases in which the cause is traumatic, for example, as is often seen in the child from a blow or fall, the bleeding soon ceases spontaneously; and its cessation may be promoted by cold water applied to the part. And in the robust and plethoric youth, who is reaching the adult period, when the structural development and sanguification should be in mutual equipoise, it sometimes occurs that the production of blood exceeds the demands of the economy; in such case the surplus blood may be rejected through the nose; and such bleeding, as a physiological aid, should, as a rule, not be interfered with. Exceptions, however, are sometimes met with, when the nasal bleeding is so profuse as to demand treatment; for though such hæmorrhage does not directly menace life, yet it may impair the health for a long time. In such subjects, an essential point in the treatment is that the patient should rest and avoid effort which causes afflux of blood to the head. When the bleeding appears, cold water may be snuffed up, or injected into the nostrils. Should this not suffice, a mineral astringent may be added to the water that is injected: and for this purpose, alum, in the proportion of fifteen grains to the ounce of water, may be employed.

As in the youth who has excessive sanguine endowment, so in the adult of middle life, the nasal hæmorrhage may be salutary: the turgid vessels of plethora find through the nose a convenient outlet: and interference in such cases has met with a severe rebuke to the physician, and brought disaster to the patient: for the sudden arrest of the blood has, in more than one recorded case, caused a rupture of a cerebral vessel, with death from apoplexy or half death from hemiplegia. An attention to the resistance and tension of the pulse present in such cases should serve as a

monition to depletion, if nature does not take the work in her own hand; and such conditions of tension should certainly guard against arresting the nasal bleeding.

It would be unwise to arrest epistaxis which is the initial symptom of a fever, or exanthematous affection. Yet in a scrofulous, scorbutic, cancerous, purpural, or leucæmic cachexy, the bleeding must be arrested.

When the nasal hæmorrhage is vicarious or supplementary of the menstrual flux, it should not be disturbed, unless the loss of blood be excessive; then it must be controlled.

Should the bleeding recur periodically, then it should be treated with quinine, provided there be no existent plethora contra-indicating the arrest.

In renal disease of chronic albuminuric or glycosuric species, nasal hæmorrhage should be repressed. But in acute uræmic intoxication a nasal hæmorrhage would be salutary, and should not be checked: indeed, if it be scanty, it should be supplemented by a free depletion from the arm; thus, as the writer has verified, eclamptic convulsions may be arrested, and, without doubt, the life of the patient saved.

The methods of arresting nasal hæmorrhage are the following: The topical application of cold water, styptics in solution or in substance, cauterization of the bleeding point, when that can be found, tamponing the nostrils before and behind, or throughout their entire length, compression of the carotid artery, lifting the arm upwards, and, finally, the erect position of the entire body.

The slow irrigation of the bleeding nostril with cold water often suffices to arrest the hæmorrhage: this may be done by means of an irrigating apparatus suspended above the head from which the water is conducted through a tube into the affected passage. Or the water can readily be pumped into the nose with an elastic tubular syringe. The cold fluid should be carried into the affected nostril; or into one, and then into the other, in case of bleeding from both sides. The discovery of Weber, already referred to in this work, that a fluid thrown into one nostril will pass to the choanæ and return by the other nostril, is utilized in this irrigation.

Beside simple cold water, the irrigating fluid may be made more effective if there be added to it alum or subsulphate of iron, in the proportion of fifteen grains to the ounce of water. Or the astringent and styptic material may be used in the form of a powder, which is to be snuffed into the nostrils. For this purpose

alum or the iron salt mentioned, or sulphate of zinc, or acetate of lead, or tannin in pulverized form, may be snuffed into the nostril, and, coming in contact with the bleeding point, there will be formed a clot of blood which will temporarily, or permanently, arrest the hæmorrhage. As a styptic for this purpose, tannin is the best, since it exerts no corrosive action on the mucous membrane, as do alum and the salts of iron.

From observations on epistaxis made by Chiari in 1883, he found that the bleeding originates, in most cases, from the septum, and that an inspection will reveal a bleeding point there: or if not found there, it will be in the floor of the passages. Dr. Simrock, a specialist in New York, has also found that the bleeding point is usually on the septum, and in most cases this is near the outlet. These specialists advise to arrest the bleeding by cauterization of this point: Simrock touches it with a pencil of nitrate of silver.

Should the methods mentioned fail to arrest the hæmorrhage, or should this be so profuse as to admit of no delay, then the tampon may be employed. This may be done by completely plugging the nostrils throughout their entire length: or the closure may be done at the posterior and anterior outlets. As material for the tampon, sponge of fine texture can be used: also surgeons' lint.

The closure through the entire length is best done by means of a narrow strip of lint, several inches long, which has been saturated with some astringent solution, as of alum or tannin. With a probe or attenuated sound, one end of this strip is carried into the posterior portion of the passage, and enough is thrust in to close the posterior outlet. The plugging is continued with the remainder of the strip, until the nostril is entirely closed. And if there be bleeding from both sides, the other passage must be treated in the same manner. In this tamponing occlusion, the work must be done gently: for if done too forcibly, the mucous lining of the passages will be lacerated and subsequent bleeding promoted. To completely close the rear of the nostril, the dimensions of the posterior opening must be known. This outlet in the dried skull of the adult has the form of a parallelogram, with short diameter from side to side: but in the living subject, this outlet is lined by mucous membrane, and is an ellipse, of which the long diameter is nearly an inch in length, while the short one is nearly a half inch long. Hence the occluding tampon must have these dimensions. For this use, sponge of fine

texture answers well. To introduce this tamponing plug one may use the canula of Bellocq, which is exhibited in the accompanying figure. This is an ingeniously contrived instrument,

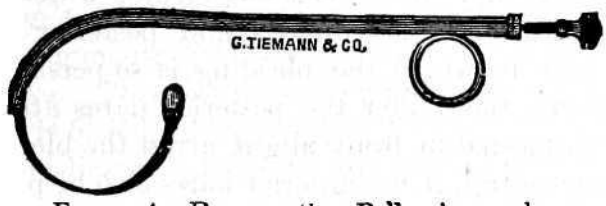

FIGURE 4. Representing Bellocq's canula.

consisting of a canula in which there is concealed an elastic coil resembling a section of a watch-spring. When the canula is carried through the nostril into the pharynx, the spring is thrust out and projects forwards in the oral cavity, so that the tamponing plug can be drawn into the posterior opening and left there.

The surgeon may not have at hand Bellocq's canula; in fact, other means may be devised to replace it. For this purpose, a wire folded on itself may be passed along the floor of the nostrils and the end caught, and a piece of occluding sponge attached to it; and thus the wire pulled on will draw the sponge into the passage. The tampon must be drawn quite into the passage The other nostril may be plugged in a similar manner; and to prevent the sponge escaping into the throat, a thread attached to each one may be tied in front across the septum. Instead of a wire, a convenient means of carrying a thread backwards along the floor of the nostrils is a small soft catheter, or a piece of flexible whalebone. When the posterior passage is occluded, the anterior one is to be filled with occluding material. The blood thus having no egress, clots at the bleeding point, and the hæmorrhage is thus controlled.

If a comparison be drawn between the mode of continuous plugging and that of only closing the anterior and posterior nares, the former is preferable, for the following reasons: When the entire passage is plugged, the tamponing material will probably come in contact with the bleeding point and directly close it; but if merely the anterior and posterior nares be occluded, then the blood accumulates in the included passage, and, clotting, arrests the bleeding. But before coagulation occurs, a large amount of blood is poured out, which seeks vent, and may penetrate the sinuses connected with the nose. It has been seen to pass through the lachrymal canal and appear in the corner of the eye: and in a case thus treated by Créquy, after some hours

the blood escaped from the ear; and later the cheeks and eyelids became swollen; and the condition became so perilous that the tampon was removed, and a solution of a salt of iron was injected into the nostrils, and thus a clot was created which arrested the hæmorrhage. Should the anterior and posterior plugging be done in a case in which the bleeding is so persistent as in the case of Créquy, then, after the posterior nares are occluded, a styptic fluid injected in front might arrest the bleeding, or certainly insure control, if the anterior nares also be plugged.

The author, in a case of terrible nasal hæmorrhage in a leucæmic child, controlled the bleeding by carotid compression. And this compression, which is best done digitally, need not be continuous. Pressure made for ten or fifteen minutes usually suffices to arrest the bleeding; and when the hæmorrhage reappears, the pressure must be repeated. Such compression must be made on the vessel where it lies alongside of the larynx, just prior to its bifurcation: and to be effective, the work must be done by an instructed hand. The error often fallen into is, in pressing, to force the artery inwards beneath the side of the larynx. When the bleeding is arrested by the compression, the pressure may gradually be lessened, and finally discontinued. Here, as in compression to cure aneurism, the flow of the blood through the vessel should not be entirely checked; enough should be permitted to pass to form an occluding clot.

A simple method to arrest nasal bleeding is to lift and maintain the arm erect on the affected side. The manner in which this acts may be explained as follows: The heart, to propel the blood through the vascular circuit, exerts a fixed amount of force: now if one arm, and still more if both arms, be uplifted, no small amount of this energy will be used in moving and sustaining the high column of blood in the erect limbs: and this expenditure will lessen the pressure in the nasal vessels, and tend to lessen or arrest hæmorrhage from the nose.

Thus a French surgeon narrates that during a campaign in the north of Africa, a number of soldiers who were seized with nasal hæmorrhage from exposure to the tropical sun, were ordered to lift up an arm, with the result that the bleeding was arrested.

A method akin to this is that of Bresger of Vienna, who in 1883 advised as a means to check nasal bleeding that the patient stand erect; such position would lessen pressure.

Foreign Bodies in the Nasal Passages.—Children to amuse themselves, or to gratify a curiosity to explore the cavity of the

nose, thrust bodies into the nostrils, which remain and partially obstruct the passage. Examples of such bodies often thus toyed with are the seeds of apples and cherries, peas, beans, beads, pebbles and other small bodies used as playthings by the child. In swallowing, fragments of food sometimes enter and lodge in the posterior nares. This occurs in the adult; and, as a rule, intruding material is dislodged by coughing.

Foreign bodies may lodge in any portion of the cavities, yet the most usual site is the inferior meatus. At first, it may produce but slight irritation; yet later the body becomes a nucleus about which the nasal excreta collect, harden and enlarge the body. If it be a seed which can germinate, it swells, and, as in the case of the bean seen by Boyer, it can sprout. In his case, the bean, having sent forth a dozen roots, was imbedded in a mass of hardened matter, and had been mistaken for a polypus. Also an inorganic body may become coated with hardened saline material, until it reaches such dimensions as to crowd on and irritate the adjacent walls. Such body is sponge-like and easily broken, and sometimes presents irregularities of surface similar to a mulberry calculus of the bladder. In other cases it has been found of stone-like hardness.

Again, concretions of mineral matter in which no preëxistent nucleus can be discovered, occur in the nasal passages. This body, named rhinolith, is a calcareous compound, and is composed of carbonate and phosphate of lime. Its origin has been referred to an inflamed condition of the pituitary membrane; others refer it to an affection of the lachrymal gland. A gouty diathesis has been assigned as a cause. Such petrifaction is an occasional accompaniment of ozæna, in which disintegrated nasal material forms crust-like concretions, which collect and adhere to the irregular recesses of the nasal fossæ. The rhinolith may appear single or multiple. When divided by a saw, they present concentric layers, or there may be a central cavity containing fetid matter.

When the rhinolith attains considerable size, it becomes a constant irritant and causes swelling, and sometimes a sanious or sanguinolent discharge. The condition is similar to that caused by a foreign body which has lodged a long time in the nasal fossæ. The body can become embedded in the swollen mucous membrane, so that the latter nearly covers the concretion. About the site of it one finds masses of ill-smelling, cheese-like matter.

It is evident that both a rhinolith, as well as a foreign body lodged in the nose, can occasion great inconvenience in causing foul breath and an intolerably offensive discharge. The irritation may extend to the eyes, and, besides conjunctival redness, there may be flowing of tears.

Yet, despite these and other indications pointing to the presence of a foreign body in the nasal passages, from the neglect of careful examination of the cavity, the condition has been mistaken for some more grave affection. More than once a severe operation has been arrested midway, which would not have been commenced had there previously been made a careful examination with speculum and probe. The writer was the intervener once in a case in which the patient was saved from a painful operation that was on the eve of being performed; a probe introduced found a movable foreign body, which, being removed, proved to be a cherry-seed incrusted with calcareous matter. Several cases are recorded in which the rhinolith was mistaken for necrosed bone.

Such bodies are commonly easily removed by means of properly constructed forceps. Durham uses a pair of forceps of which the blades can be separated and introduced singly, and then locked. A forceps with small blades which are toothed answers the purpose well. The precaution must be taken not to force the body backwards into the pharynx, since it might drop into the windpipe and cause strangulation. After the removal, the passage should be irrigated for a time with some antiseptic fluid.

Parasites in the Nasal Passages.—Frequently in the tropics, and sometimes in the temperate zone, parasites have been known to enter the nasal passages, and deposit larvæ, which develop there. This parasite is a species of insect, and from its habit is named Lucilia hominivora. It probably lays its eggs in the entrance of the nares; and the eggs are afterwards drawn inwards by inspiratory efforts, and lodged in the deeper recesses of the nose. As the insect develops, it causes a stinging or boring pain, also epistaxis. If undisturbed, the insects continue their ravages, in which the soft parts ulcerate, and the bones are perforated. Later, the face is opened, and the disintegrated structures teem with moving worms. This hominivorous parasite has been known to perforate the base of the skull, and, having entered the cavity, caused death by meningitis.

As soon as such trouble is suspected, the enemy should be vigorously attacked by local remedies. Among the most effi-

cient means at our control is turpentine, which is swiftly fatal to insect life. In solution, or in its pure state, this agent should be injected into the affected cavity. Other germicidal solutions may be used; for example: chlorinated or sublimated solutions. The fumes of tobacco, arsenic, or chloroform may also be used. The frontal sinus has been trephined, and the germicidal solution thrown through the opening into and through the nasal passages.

Ozæna, or Nasal Catarrh.—The essential idea implied by the term ozæna is a foul odor; and since fetor of the breath is the prominent characteristic of nasal catarrh, the terms ozæna and nasal catarrh are equivalent terms. The European writers more often use the name ozæna, while the American writers oftener employ the name nasal catarrh. The name ozæna will be used by the writer, inasmuch as it more definitely specifies the most offensive feature of the disease; catarrh, or descending discharge, only occasionally offends the sight of others, while the foul breath of the patient is an unending annoyance to those within its reach.

Ozæna, then, may be defined to be a disease of the nose in which there is a diseased condition of the inner surface of the nasal passages, whence ill smelling matter is excreted; and this material may be profuse in amount, or so small in quantity as scarcely to be discoverable. And this difference in the amount of the excretion led Hedenus, writing on the subject in 1861, to make two species: one in which there is a discharge, and another with no discharge; and the former may be of scrofulous, herpetic, syphilitic or mercurial origin.

In 1863 Trousseau, writing on ozæna, finds that ill breath may arise from causes outside of the nasal disease: it may arise from the mouth, teeth, throat, disease in the œsophagus, and he might have added, disease of the lungs. Some persons, again, have ill smelling excretions, of which it is difficult to determine the cause; and such cases are sometimes incurable.

To determine whether the fetor proceeds from the nose or the mouth, Trousseau directs to alternately close the one and the other; by thus doing the true source of the odor will be discovered. An error might, however, be made in cases in which fetid matter has fallen into the choanæ, or space which is common to the mouth and nose.

Fortunate for the patient of ozæna, his fetid breath only disturbs others; and only by others is he reminded of his unfortunate condition. A fetid odor may be generated by a healthy

secretion when this remains too long in contact with its generating surface. But if the surface is unhealthy, then the matter excreted is offensive as soon as it is found.

Ozæna is commonly associated with some constitutional cachexy; such cachexy may be scrofula, scorbutus, tuberculosis and syphilis; a scrofulous or syphilitic origin is oftenest met with. It may be associated with some cutaneous disease, as lupus, herpes; or an exanthema, as scarlatina, may be referred to as the origin.

In the general constitutional disease, or the cutaneous causal affection, the mucous membrane, as well as the subjacent osseous and cartilaginous structures, become affected. Primarily, the mucous membrane is swollen; and the localization of the dyscrasy here is favored by the numerous acinous glands seated in the membrane. This swollen stage is nearly odorless, and succeeded by an atrophic one in which the fetor is present. In the atrophic condition the thick tenaceous secretion is retained and decomposes. Also, if the profuse discharge from the hypertrophic form remains, dries and adheres, crust-like, to the surface, a fetor may arise from this desiccated matter.

According to Max Schaefer, of Bremen, scrofulous ozæna occurs between the ninth and twelfth years of age, and begins with a snuffling and nasal discharge. The membrane here is swollen; but the atrophic form occurs in older persons.

At a medical congress in London, in 1881, ozæna was the subject of discussion. Frankel claimed that it is associated with a chronic catarrh; and there is atrophy of the mucous membrane to a greater or less degree. The ill odor is from the stagnant excreta.

Fournier, referring the origin of ozæna to syphilitic, diphtheritic, catarrhal or scrofulous disease, finds that it may be moist or dry in character.

Watson finds ozæna associated with lupus and chronic eczema.

Martin, of Paris, finds an ulcerative and a non-ulcerative form; in the latter the periosteum and bones do not become affected; and he and Zaufal refer this species of ozæna to a preternatural width of the nostrils. They claim that this width of nostrils depends on a cessation of growth of the inferior turbinated bones, in which the middle turbinated bone is also implicated. In this malformed condition of the nose, atrophy with catarrhal discharge ensues.

Hedenus saw cases of ozæna in which the fetid breath ap-

peared and continued only during the time of the menstrual flux.

Hence, as appears from the preceding, authors agree in opinion that ozæna is dependent on some general or constitutional disease, and that the nasal affection is only a local manifestation of the same. This local trouble may be limited to a simple swelling of the lining membrane, and, as a result of this hyperæmic condition, the mucous glands become abnormally active; or the disease may not thus be limited, but may reach to and attack the subjacent bones. The osseous invasion may be caused by gummatous or other neoplastic development, which interferes with the proper vascular supply of the parts; or the nutrient supply can be obstructed by embolic or thrombic closure of the minute vessels. The dry atrophy of the membrane, before mentioned, may be thus caused. Inveterate duration of the disease, and rebellious obstinacy to resist treatment, characterize those cases in which the turbinated bones and the septum have become affected. And when this stage is reached, the sense of smell is greatly impaired. The delicate structure of the terminal filaments of the olfactory nerve are the subjects of lesion, which sometimes proceeds to the partial loss or total extinction of the sense of smell; and as this impairs the gustative sense, it results that the subject of ozæna becomes maimed, as to two of his important special senses. Also, the bones when once lost are never restored; hence ozæna, with necrosis of the interior bones, entails permanent mutilation of the interior architecture of the nose; and, in some cases, the collateral constitutional disease destroys the external skeleton of the organ, and ends in the sinking of the nasal arch, and leaving one of the most offensive of disfiguring deformities, viz., the saddle-seat nose. With these possible eventualities, especially if the affection arise from constitutional disease, ozæna demands earnest care on the part of the surgeon.

Treatment.—This will vary according to the stage to which the disease has proceeded, as well as according to the character of the causal constitutional disease: conditions demanding varied local and general treatment. Where the ozæna has arisen from syphilis, the patient should receive such varied care, viz., mercury and iodine, with a predominance of the latter; and, locally, the parts should be treated with astringent and alterative compounds, of which mention will presently be made. In all cases scrupulous care must be used to remove the nasal excretions; and this may be done by resorting to Weber's procedure, in which the fluid, siphon-like, is caused to make the circuit of the nasal passages.

And the fluid thus used should be warm water, to which is added the agent designed to act topically.

If the ozæna occur in a tubercular or scrofulous subject, anti-scrofulous remedies must be administered, viz., iodine and cod liver oil. If the affection of the nasal surface is confined to the mucous membrane, and consists of a swollen state of the same, linear thermal cauterization should be resorted to. This may be done with the wire loop of the galvano-cautery, which, for a moment, is caused to touch in lines the affected surface; or, in absence of the thermal appliance, a simple one may be extemporized of a steel pin fixed on a cork for a handle, of which one end, heated in a lamp, may do the work of linear cauterization. Thus fine linear sloughs are produced, and the heat, coagulating the blood in the subjacent vessels, lessens the nutritive supply, and thus reduction of structure is accomplished. In place of fire, a potential caustic may be used, viz., with a pencil of nitrate of silver, or of fused potassa; one may touch and destroy small sections of surface, and thus effect structural retrenchment.

As local treatment advised by different authorities, the following may be cited: Hedenus used creosote both internally and externally. Pulverized charcoal, to which some aromatic is added, as the oil of anise, bergamot, etc., may be used as a snuff. Tincture of myrrh with infusion of bark may be used locally. Where the local application caused too much discharge, Hedenus added alum to it. As errhine remedies, Trousseau advises the use of subnitrate of bismuth, chlorate of potash, and especially the red precipitate of mercury. The nasal passage should be prepared for the use of these remedies by previous irrigation. As nasal injection, Trousseau uses a solution of nitrate of silver, corrosive sublimate or sulphate of copper. As internal medication he uses iodine, cod liver oil and the preparations of arsenic. Schæfer cleanses the passages with a syringe, and cauterizes thickened surfaces; and, for use by insufflation, he employs the following powder:—

℞. Argenti Nitratis.. .... .gr. i ad x
Talci. ... ...ʒijss
Misce.

Or,

℞. Sodii Benzoatis.....gr. x
Talci. ....gr. 50
Misce.

Insufflation can also be done with boric acid, alum, or iodoform. Frankel cauterizes with the hot iron. Fournier, as local means, uses the decoction of althæa and that of poppies. The crusts of concrete matter must be removed, and the surface touched with nitrate of silver, carbolic acid or tincture of iodine. In the dry form with constitutional cachexy, Fournier advises arsenical baths, and he gives internally arsenic and the bicarbonate of soda. In the moist constitutional form he uses sulphur baths and internally iodine, iron and cod liver oil. He removes the crusts and injects a two per cent solution of salicylate of sodium. Fournier cauterizes the ulcerated surface with nitrate of silver. The treatment must often be continued for a period of two years. Relapses are frequent, so that treatment must often be resumed again. Watson uses iodoform bougies, and lets the patient snuff bismuth in powder. Internally he administers iron, arsenic, cod liver oil, iodine, copaiba and mineral acids. Göttstein, after removing the crusts that form in chronic cases, introduces tampons of cotton into the nostrils, and he limits his treatment chiefly to this simple work.

As ozæna may, according to Zauful and Hartmann, arise from too great width of the nostrils, it is probable that in such cases relief might be obtained by lessening the entrance of the nares. To do this, a wedge-shaped portion might be excised from the posterior part of the nostril, viz., where the wall is continuous with the upper lip. The wound thus made is to be closed by a deep metallic suture. Such an operation, besides lessening the orifice, would improve the form of the nose; it would overcome in some degree the unsightly flaring of the part.

In the forms of ozæna mentioned the disease was limited to the pituitary membrane; it may advance further, and attack the bones of the nasal labyrinth, and this is not unfrequent in the subject of tertiary syphilis. Also in patients of scrofula in whom there is an element of congenital syphilis, there is often an affection of the nasal passages, which finally attacks the turbinated bones and the septum. The concealed site of these bones permits the affection to lurk in them for a long time before the full extent of the disease is realized by the patient or suspected by the physician. The fetor from the necrosing structures finally announces the nature and advanced stage of the disease. The course of such a case, if its stages be enumerated in their consecutive appearance, is primarily a congestion of the mucous membrane which lines the nasal cavity; this congestion arises from the

return of the blood being impeded by minute gummy or connective tissue growths, developed by constitutional disease. The bone, deprived of a regular supply of aerated blood, dies, and the investing membrane dies also at points, and this constitutes the secondary or destructive stage. There is now concurrent necrosis and ulceration. The tenuity of the bones is such that death of surface involves death in totality. For the ulceration attacks both sides of the paper-like bone, when the arrested or disturbed circulation becomes inadequate to maintain vitality. This process continuing, a large portion of a turbinated bone, or a section of the long partition, necroses, becomes loosened and detached from the remaining parts, and, like a foreign body in the passage, moves during the act of clearing the nostrils. The necrosed bone when loosened appears at the anterior or posterior outlet, most frequently, at one nostril in front; and this period of elimination, though it is the concluding stage of the worst form of ozæna, is often prolonged for an indefinite period: first, a portion of the vomer, and, later, its entirety, are separated and thrown out. Meantime the turbinated bones, one or all of them, and the perpendicular plate of the ethmoid, die and are eliminated; in brief, the architectural structure of the nose falls piece by piece until there remains little else than the superior arch formed by the nasal bones; and even these occasionally share in the ruin, and, sinking, the patient's face is marred with the revolting deformity of a sunken nose: a saddle-seat on which the fiend of impure venery mounts and announces himself to every observer.

The treatment of this destructive form of ozæna, if wary, foreseeing and comprehensive, will, at an early period, apply the ax at the root of the causal tree, in the form of remedies which will arrest, if not extinguish, the constitutional cachexy. If, however, the surgeon only sees the case at the second stage, when necrosis has commenced, an effort must be made to stay or limit the destruction of the bones. Nasal irrigation to remove the septic excreta must be industriously done; and for this purpose alkaline solutions should be used, viz., a solution of carbonate of potassium, in the proportion of five grains to the ounce; or Aqua calcis may be used. A solution of chloride of sodium, or of borax, may be used, yet the purely alkaline solutions, which as chemical agents are solvents of albuminous or fibrinous matters, will be more effective in dissolving and removing excreta which are cognate to such material in composition. To check osseous decay, irrigation may be done with iodized solutions; for example, iodide of

potassium in the proportion of half a drachm to an ounce of water. Or a drachm of tincture of iodine to an ounce of water might be injected into the nasal passage. In case the necrosis has involved but a limited portion of bone, for instance, a section of the vomer, the query arises: Should the dead portion be removed at once, or should one delay until the sequestrum is wholly detached?—a question not promptly to be answered, according to the writer's experience. The observation of cases in which the dead bone was removed early, and of others in which removal was delayed, inclines the writer to advise late removal as the better practice; for in the work of extracting the dead bone before its detachment, the adjacent bone, which is but slightly affected, may be disturbed and its death favored. Hence the more conservative method is to wait until the sequestrum is freely movable, and then remove it with a pair of forceps. If the osseous fragment is too large to emerge from the nostril, as sometimes is the case, then it should be divided with cutting forceps.

When the osseous septum and the turbinated bones are lost, there is no reparative power in the tissues which invest them to repair the breach; the partial or complete destruction of the lining periosteum and the ulcerated and diseased state of the pituitary membrane forbid any hope of such repair; the work of devastation has permanently ruined the interior of the nose, and with such ruin the sense of olfaction partially or completely vanishes.

If the necrosis should invade a nasal bone on its inferior surface, the osseous destruction may proceed until the bone is perforated or is so weakened that it cannot maintain its position longer; it sinks, and lets the overlying soft parts sink inwards. This sinking may be on one side; or, both sides falling, the lobule of the nose is tilted upwards, and the complete saddle-seat nose is present. The deviation, both of side and point of nose, may be greater towards one side.

If the patient be treated properly, constitutionally and locally, the event here described may be averted; the weapons are mercury internally and iodine internally and externally, with nasal irrigation. Iodine, used locally, is the most efficient remedy. To use this apply the tincture of iodine on the inside and iodine ointment on the outside. Thus the minute gummatous and scrofulous neoplasms which may exist in the mucous membrane, or the inner or outer periosteal lining, will be caused to recede, and the vitality of the bone maintained. This absorbent, or better styled

conservative, action of iodine has been verified by the writer in a few cases. If, however, through neglect of treatment, the necrosis be allowed to proceed, the dead bone is eliminated piecemeal, rather than in entirety; so that portions of the nasal bones remain, especially the articulating borders. Occasionally the skin is perforated, and the sequestrum thus escapes, and a scar results. In the majority of cases, however, the elimination of the dead bone is on the inside through a breach in the ulcerated mucous membrane; and the avoidance of a scar, which then results, renders this mode of ending preferable to the other.

In operations on the face and mouth, in which blood may pass into the nares and thence into the pharynx, Verneuil advises as a preliminary to tampon the posterior nares by the aid of Bellocq's canula; after such preliminary plugging, the patient can be anæsthetized, and the operation more safely done.

CHAPTER X.

MAXILLARY SINUS, OR ANTRUM OF HIGHMORE.

Of the three accessory cavities, which communicate with the nasal fossæ, the largest is the maxillary sinus, or antrum of Highmore. This exists at birth, while the frontal sinus develops post-natally. In the adult this large air-cell is prismoidal in figure, and has four bounding walls. It may be compared to an irregular triangular pyramid, the base of which lies upwards, and is formed by the floor of the orbit. This wall is traversed from behind forwards by the continuation of the superior maxillary nerve. Of the three vertical walls, the internal one separates the antrum from the nasal fossæ; a second or front wall lies behind the cheek, and looks forwards and outwards; the remaining wall looks backwards and outwards. These three upright walls converge from above downwards, so that the inferior floor is very small when compared with the upper one.

There are, as a rule, two openings from the middle meatus of the nasal fossæ into the maxillary sinus. Near the middle point of this meatus exists, usually, an opening which leads directly into the antrum; but more careful observation has found that this orifice may be absent, or, at least, so occluded by mucous membrane as to prevent the passage of fluids. But near the anterior end of the middle meatus there lies the infundibuliform opening of the frontal sinus into the nasal passage, and if the outer wall of this funnel-shaped passage be examined, there will be found an opening into the antrum; so that if a fluid be injected from the frontal sinus, some of it will pass into the antrum. This normally duplicated communication between the nasal fossæ and the antrum gives additional security against the accumulation of fluid material in the antrum.

As seen, there are three sides in which openings can be made, and a communication established with the cavity of the antrum; viz., through the inner wall, through the anterior one, and thirdly through the underlying alveolar process. The opening through

the inner wall would be difficult to make, and, when formed, would be too indirect for use by the surgeon. An opening through the alveolar process may be made through the site of a molar tooth; yet this requires the extraction and sacrifice of an important tooth, viz., the second molar. As most patients would, like Don Quixote, part with such a tooth as sadly as they would with a near friend, hence there are earnest objections to this site for an opening into the antrum, and, besides, such opening is apt to remain open. A third route by which the antrum can be entered is through the anterior wall, which is thin, and, if opened, it can be closed without difficulty.

We will next proceed to consider the surgical affections of the antrum, and will commence with fracture.

Fracture of the anterior wall is not an unfrequent occurrence, and this may be subcutaneous or complicated with an open wound. The thinness of the anterior wall, and its exposed position in the face, render it liable to fracture. And within the writer's observation a number of such cases have been observed, in which the causal agency was a kick of a horse, or a blow with a strong fist. If the violence be not great, then the soft parts are not opened, but the wall of the maxillary sinus is broken and driven inwards, and thus a depression is made in the face, below the eye, and outside of the nose. And the depressed bone will remain in its new position unless restored to place by surgical assistance. The rule has been, if an attempt was made to reduce to normal form, to attempt this by an incision in the cheek, and through this to elevate. As this must leave a prominent scar, the patient has commonly preferred to retain the sunken place in his cheek rather than to exchange it for an unsightly cicatrix. In place of this method, the author proposes a less deforming one, as follows: In the cul-de-sac between the alveolar process and the lip, make an opening close to the bone until the canine fossa on the upper jaw is reached, and, having exposed this, perforate the wall with a small trephine, or a carved chisel, and through this opening introduce an elevator and restore to normal position the sunken wall; and, thus outlifted, the wall would remain in normal position. The opening which the surgeon has made would soon permanently close.

A more severe injury is that in which there is an open wound to the fracture, and in such case, there may be a number of fragments, some of which may lie in the antrum, and others may hang to shreds of the torn soft parts; in fact, there are present

all the elements of a severe compound fracture. The treatment here will commence with the removal of fragments which are wholly separated from the soft parts, and the restoration to place of fragments which are adherent to the lacerated soft parts. Fragments, which are wholly loose and have no vascular connection remaining, should be removed, for if left, they would act as foreign bodies, which would prevent healing of the wound. But fragments of bone that are adherent to flaps of the torn cheek, which will maintain the bone alive, must be preserved, since their preservation will materially lessen the scarring consequent on such open fracture. The irregular edges of these usually need not be trimmed, but if they have a fringe-like border, which floats in the fluid used for cleansing the wound, this edge should be trimmed off, and the fragments or flaps should be restored to site, and fixed by sutures, which should first connect opposite angles or opposite free borders; and after this, suturing should proceed towards the base of the flaps or beginning of the borders. If thus united, the torn parts will lie in their natural position. The wound should be dressed with lint moistened with an alcoholic sublimated solution. The healing occurs rapidly, and often with less scarring than was expected.

An occasional accompaniment of fractures of the walls of the antrum is the passage of air into the adjacent soft parts of the face. This may arise during an expiratory effort, in which, the mouth and nose being closed, the air is forced into the wounded soft parts. Such emphysema will be the cause of more mental than physical trouble to the patient; without treatment it will vanish in a few days; probably much of it returns to the nasal passages, through contraction of the containing soft parts. If absorbed, as sometimes stated, would not its presence in the vessels occasion serious trouble?

Gunshot missiles, as balls of medium calibre, have entered and found permanent lodgment in the maxillary sinus; such intruding body has been tolerated in this recess for an indefinite period, causing but little or no inconvenience. As such missile, if even slightly movable, must irritate the containing cavity, its removal is indicated. This extraction can be done by detaching the soft parts from the canine fossa, and trephining at that point.

Abscess of the Maxillary Sinus.—The lining mucous membrane of the antrum may become inflamed and pus or an ichorous fluid be generated in the cavity. As exciting cause of the inflamma-

tion may be an eruptive disease, as scarlatina or other disease accompanied by embolic processes. A frequent cause is dental caries, in which the root of a tooth near the antrum becomes affected. As is known, the roots of the first and second molar teeth often penetrate into the antrum, and from such roots, if carious, inflammation can pass to the mucous lining of the sinus. Also, when such diseased molar is extracted, the floor of the cavity may be opened, and through such opening, as Duplay has pointed out, particles of food may pass and, lodging in the antrum, cause inflammation and eventually pus in the cavity. Also, the continuity of the nasal mucous membrane with the lining of the antrum, forms a way by which disease in the nasal fossæ travels to the sinus; thus chronic catarrh and nasal polypi have led to suppurative inflammation in the antrum.

Such pus being long retained in the antrum becomes thick, caseous, and of foul odor, or it may be thin like serum. The contact of this material with the containing wall causes disintegration and necrosis, and the final result, in most cases, is the perforation of the wall; yet in some instances the wall, instead of being attenuated, is thickened.

The primary symptoms of such inflammation is a dull, continuous or pulsating pain in the region of the cheek. The tears flow, and finally there is a fullness and swelling of the corresponding cheek. As the pus accumulates, the antrum is enlarged through the yielding of the front or inner walls. Or the palatine floor of the cavity may be forced downwards, or the floor of the orbit uplifted. From such eccentric swelling, therefore, the cheek, palatine vault, nasal passage, or eye may be encroached upon, and functional disturbance be produced. Frequently, instead of thus enlarging when the antrum becomes filled with pus, the pressure reopens the passage into the middle meatus, whereupon the material escapes into the nose, and presents itself in front or in the throat. If such escape through the natural way does not appear, then the pus may perforate the attenuated wall and form a fistula. Such fistula has formed through the cheek below the eye, or through the canine fossa into the mouth, or through the floor of the antrum. The fistula has passed directly into the oral cavity. It is especially troublesome and conspicuous when situated in the cheek, and is most fortunately situated when it passes through the alveolar process, or through the canine fossa, emerging between the lip and the alveolar process. In many cases the opening is so situated that the pus cannot

wholly escape, and a part remaining becomes extremely fetid; and where the opening is through the inner wall, the case might be mistaken for an affection of the nasal fossa.

Suppurative inflammation of the antrum is difficult to diagnose in the beginning, for the reasons that the symptoms are similar to those which attend disease in the roots of the teeth, an abscess in the gingival tissue, or a facial neuralgia. The purulent collection in the antrum will soon reveal itself by excentric protrusion of one or more of the containing walls; and this wall, when pressed on, yields with the crackling sound of parchment. But to banish all doubt, a small trocar can be thrust through the wall, and the pus brought to view.

Treatment.—It may happen that the pus may escape through a perforation so situated that the entire content can escape, and the sinus gradually return to its normal condition, and the outlet of escape finally close. This occurs when the outlet is at the most dependent portion of the cavity. Nature, unaided, seldom opens at a point most favorable for recovery, viz., the perforation is oftenest somewhere above the floor of the antrum, and consequently surgical aid is required.

When the choice of site for the opening is left to the option of the surgeon, he may choose to open through the alveolar process, or above this, through the lower part of the anterior wall in the canine fossa. Most surgeons prefer to open through the alveolar process; and they do this by sacrificing a tooth, if this has not already been lost. The opening may be bored with a drill through the alveolar depression of the first or second molar tooth; the second molar is preferred. Should one of the molars be carious, that one should be extracted. The writer greatly prefers to open through the canine fossa, since when the work is done there the opening can afterwards be closed. To operate here incise upwards close to the canine fossa of the upper jaw; then, having separated and elevated the detached soft parts, an opening is to be made with a small trephine or a curved chisel. Through the opening thus formed the cavity is to be thoroughly cleansed with water slightly acidulated with nitric or hydrochloric acid. The opening is to be maintained open by means of a drainage tube, through which the cleansing irrigation can be repeated daily. And, as fluid for this purpose, one may use a solution of sulphate of zinc, five grains to the ounce; or one of chloride of zinc, two grains to the ounce; or of alum, five grains to the ounce. Should there be much fetor in the dis-

charge, an antiseptic fluid should be used for the irrigation, and then dilute chlorinated water, or a solution of chloride of lime, or of permanganate of potash, of which one can use Condy's solution diluted, as follows:—

℞. Potassii Permanganatis ....ʒi
Aquæ..... ....℥x
Misce.

Since some of these solutions are toxic in action if swallowed, care must be taken in their use that the fluid does not escape from the buccal cavity into the throat and be swallowed. Such irrigating fluid can flow through the orifice in the inner wall of the sinus, and thence pass into the pharynx; to prevent this let the patient's head be inclined forwards during the irrigation; and then, if the fluid enters the nose, it will escape through the anterior nares. To do this irrigation, an elastic tubular syringe may be employed. This work, for a time, should be done by the surgeon; later, the patient can do it himself, with the occasional supervision of his medical attendant. After the sinus has thus been restored to a healthy state, the outlet may be allowed to close, provided there exists an outlet into the nose, and if one does not exist, one could be made from the middle meatus into the sinus, by means of some sharp, perforating instrument, for example, a blunt dissector or a small curved chisel. The inner wall is fragile and can readily be fractured. Should the opening made through the front wall for irrigating not close spontaneously, it can be done by trimming the borders of the opening and uniting them by sutures. In case the sinus proves not to be restored to health, as shown by the escape of fetid excreta from the nose, then the opening in the canine fossa should be resorted to, and the irrigation continued for a longer period.

Fistula of the Antrum.—From the purulent collection in the sinus bursting through the anterior, superior or inferior wall, a fistulous opening may form, which may remain an indefinite time unless surgically relieved. According to its situation, this fistula might heal spontaneously, or remain open; if it were in the roof of the mouth, or were above the alveolar process within the buccal cavity, the fistula might close after the sinus had ceased to excrete diseased matter; but if the opening were through the cheek, or the floor of the orbit, then the fistula, without some surgical aid, would be permanent.

The diagnosis of this fistula can readily be made when the

previous history of the disease has been considered, and all obscurity vanishes if a probe be passed through the opening into the cavity. Such diagnostic exploration being once made by an English lady, the feather she used passed so deep into her face that she became alarmed and feared she had entered her brain. She consulted her physician, Nathaniel Highmore, who relieved her fears by his explanation, and, publishing the case, he gained for his name an undying place in Anatomy as the discoverer of this sinus, though it had previously been known to Galen.

Treatment.—If the fistula be situated so as to constantly drain the antrum, the treatment need only consist of simply irrigating the sinus with an antiseptic fluid, which would accelerate the healing. But if the fistula perforate the cheek or pass out beneath the eye, then the task of closing and permanently healing it becomes more difficult. The work will then commence by making an opening through the canine fossa within the mouth; afterwards enlarge the fistula, and, through the opening, remove any dead structure which may exist in the bone, and then trim the walls of the sinus and close accurately, with sutures. Cleansing irrigation of the sinus must then be continued, until the walls are restored to integrity; and then the provisional opening may be permanently closed, provided the normal opening through the inner wall is patent. The patency can be determined by filling the sinus with fluid, when the latter will flow into the nose, if there exist an outlet; and if no outlet exists, an artificial one can be established. To do this, pass an instrument through the opening made in the front wall, and bore through the inner one near its middle point, and retain this open by means of a drainage tube, passed from the outer to the inner wall. As soon as the outlet into the nasal passages is permanently established, then the intra-buccal wound of the soft parts on the canine fossa can be closed by trimming its margins, and closing by sutures.

Where there is a collection of retained pus or ichor in the sinus, instead of escaping by a small opening, a large portion of a wall may become necrosed, and be detached and eliminated. Such a case the author observed in a child eight years of age; a portion of the anterior wall was thrown off through an ulcerative breach in the cheek. The detachment of the bone was confided, in this case, to nature, and the result was a sunken, permanent scar.

Cysts in the Antrum.—The mucous glands of the lining wall of the antrum have been studied by Giraldès, who finds that their

excretory ducts or outlets tend to closure and obliteration, and thus the retained content forms a cyst through retention. Such cysts of moderate volume, which had not been suspected, are often found in the antrum. The cyst may be so located as to occlude the normal outlet of the antrum, and thus the cavity may be filled with muco-serous content; or the fusion and growth of several of these cysts can form a large one, filling the antrum. Thus Giraldès explains the origin of what is sometimes erroneously named dropsy of the antrum. The small cysts, seldom exceeding the size of a pea, cause no inconvenience; a large one may encroach on, and force outwards, the containing walls. Such swelling can be discovered by everting the upper lip and pressing on the front wall, when a crepitating, parchment-like sound will be felt, as the attenuated wall yields under the finger. The encroachment on the inferior wall may have worse consequences; the palate may be depressed and the alveolar arch widened, and the teeth caused to fall from their sockets; or from upward crowding, exophthalmos may be produced. The lachrymal canal is, fortunately, rarely interfered with. To sum up, then, as functional troubles from such cyst, there may be disturbed mastication, respiration and vision; and exceptionally the walls become thicker, and then they will not yield under pressure.

Treatment.—This consists in opening through the canine fossa, and emptying the content; and to prevent re-formation of the cyst, an iodized solution should be injected, from time to time, into the cavity, through the artificial opening. Should the normal opening into the nasal passage be occluded, this must be restored in the manner already described when treating of abscess in the antrum.

Tumor of the Maxillary Sinus.—As neoplastic growths appearing in the antrum are the mucous polypus, the enchondroma, sarcoma, carcinoma and osteoma.

The mucous polyp, similar to that occurring in the nose, has been seen in the antrum. Cartilaginous growths as well as the more malignant forms of tumor have originated within this cavity, and continued to grow until they crowded upon and displaced the containing walls; and such displaced wall presses on parts contiguous, and disturbs their function. This anterior protrusion will disturb the contour of the cheek, and change facial expression; if directed towards the roof of the sinus, the orbital floor may be uplifted, the eye displaced, and double vision be produced. Growth and pressure downwards will encroach on the

bony palate and alveolar arch, and thence result destruction of the teeth. Growth inwards towards the nasal passage will crowd on the latter and impede breathing. The tumor does not end its baleful march at mere functional disturbance; it presses on the structures which it meets until it opens a way through them by ulcerative action; and thus the tumor presents itself to view, in many cases. The pressure on branches of the trifacial nerve, during this devastating march, causes severe and agonizing pain.

The treatment must be directed to a radical and complete extirpation of the growth as soon as its presence has been indicated by some phase of the functional disturbance which has been mentioned. And when suspected and not clearly indicated, an intra-oral incision may be made through the canine fossa. When discovered, the tumor, whether polypoid, enchondromatous or cancerous, may be removed through the following incision: Cut and separate the upper lip from the superior maxilla, and then retract the separated soft parts from the jaw by a large retractor; remove or uplift the front wall of the antrum, so that its contents can be inspected, and extract the neoplasm which is discovered. Should the incision mentioned not suffice for the complete extraction, then it may be enlarged by another cut extending vertically from the inner angle of the eye to and through the upper lip. And should it be possible, this flap should contain a portion of the front bony wall of the antrum, which has been sawn through with an exsection saw. The triangular flap, thus formed, can then be drawn outwards and upwards, and thus a much larger field will be opened for exsecting the contents of the antrum. In case the tumor be found to be malignant, then the entire upper jaw must be removed. But if the growth has previously been diagnosticated to be of benign nature, then the front wall having been uplifted along with the soft parts, after the growth has been removed, the osteo-cutaneous flap can be replaced, and thus the form of the cheek preserved.

Osteoma may originate within the maxillary sinus and attain dimensions which may encroach on the parts contiguous, and cause functional disturbance. An instance of the kind came under the writer's observation. In the patient, a woman of twenty years of age, a deformity of the right cheek and roof of the mouth gradually appeared; also the right eye was shifting its position upwards, and double vision was present. It was appar-

ent that the upper jaw was enlarging; and a growth within the antrum was inspected, and an operation for its removal counseled. To do this it was decided to do the work without external incision, viz., by separating the upper lip and cheek from the maxilla. The loosened parts being retracted, a portion of the front wall corresponding to the canine fossa was removed with the mallet and chisel. It was found that the bone removed was very hard, and that no vestige of an antrum existed. The excision of the bone was continued by means of chisel and mallet, until a large portion of the upper jaw was excised, and a cavity left of larger dimensions than the normal antrum. The osseous exsection revealed the fact that the antrum was entirely obliterated, and the enlarged maxilla consisted of bone of unusually dense nature; the bone was of ivory-like hardness, and its removal was a task of the most tedious and tiresome manual labor. The walls of the jaw were left except a part of the anterior one. Not much bleeding occurred. One tooth was loosened in the work and was removed. Some anæsthesia which existed prior to the operation was not relieved by the exsection. The cavity made was filled with alcoholized lint; and this treatment was continued for many months, during which time fragments of bone detached themselves from the surface which had been chiseled off. The granulative tissue which appeared on the inner surface, later became a tissue which resembled the normal lining of the alveolar processes. The extruded orbital, malar and palatal walls gradually resumed normal position, until from the eye, cheek, and roof of the mouth there vanished all aberration of form; the right side of the face was not distinguishable from the left side; a condition different from what would have been the case had the work been done through an external cut; and certainly far different from the aspect which the patient would have presented had the entire upper jaw been removed as had been counseled to the patient by less conservative surgery. The lapse of five years now gives immunity from recurrence in this case; yet to observe the condition of the interior of the cavity, the labio-alveolar incision was allowed to remain open.

In this osteomatous growth it was not determined whether the tumor originated in the antrum, and grew eccentrically, or whether it was a general hypertrophy of the maxilla superior, in which the bone grew both centrally and eccentrically.

Perforation of the Nasal Septum.—The cartilaginous septum of the nose is often the site of ulcerative action, which sometimes

perforates the part and forms an opening of greater or less extent between the nares. This ulceration is oftenest seen in the scrofulous and syphilitic subject, yet it also occurs in subjects of otherwise normal health. The point where the ulcer oftenest commences is at the junction of the cartilage with the lower part of the partition. Where this muco-dermal border joins the cartilage above, the partition is thinner than elsewhere; and, from the mobility of the parts here, this thin part might with some anatomical license be named a joint of the nose. The mobile nature of this structure predisposes it to lesion, and explains the frequent commencement of ulcerative action at this point; and the breach commencing here, its enlargement is promoted by the same cause, and by the habit of the patient of industriously promoting the extension of the ulceration by often touching and examining it, and especially by the mischievous habit of often detaching the encrusted scab which adheres to it. Under these influences an insignificant initial lesion is enlarged and deepened until it perforates the attenuated wall. This ulcer extends upwards into the adjacent cartilaginous septum; the cutaneous margin underneath does not ulcerate, or only in exceptional cases; and hence the patient is spared the exposure of his ill, as would be the case if the lower margin of the septum were opened by ulceration. The extension upwards, and immunity of the sub-septum, depend on the lower vitality of the cartilage.

From an extensive observation of such ulceration, the writer has remarked that this otherwise trivial ailment is often the source of much annoyance to its subject: his apprehensive fancy descries in the future some mutilation of figure. This mutilation is rarely realized, as the ulceration seldom reaches great limits; it is infrequent that an opening greater than that which would admit the end of a finger, arises. Yet this small breach cannot be closed, and to stay its enlargement is no easy task. The treatment is, in the main, of topical character, though any concurrent cachexy must be met with appropriate remedies. As a local means, is the compound tincture of benzoin, applied daily with a camel hair brush. Or an ointment of ammoniated mercury, viz:—

℞. Hydrargyri Ammoniati. ... .partes 10
Adipis... .... .partes 90
Misce.

Apply once daily after the removal of the crust. Also, an ointment of quinine, in the proportion of ten grains to the ounce of

vaseline. An ointment of calomel, in the proportion of six grains to the ounce, acts well. The site of the ulcer, so located as to receive and retain the excreta in their escape from the nasal fossa, is so unfavorable to healing that often, despite attentive treatment, the ulcer persists. As ultimate resort, the ferrum candens or the thermal cautery may be used, and the ulcerated surface slightly cauterized.

In cases which have come under treatment after the septum is perforated, the best that can be hoped is a cure with an opening between the nares; though such condition is unsatisfactory to the patient, yet he can be confidently assured that no functional impairment can result from it as regards breathing, smelling or speaking; these functions will be as perfect as before the perforation; and as the defect is completely hidden from sight, it is relieved from most of the odium which attaches to a corporeal deformity.

Nasal Deformity and Means employed for its Relief.—There may be a deformity of the nose from excessive volume; likewise, from abnormal shape of natural volume; and, lastly, deformity may arise from defect in which a portion or the entirety of the external nose is absent.

Deformity from excess of volume is rarely congenital; it is oftener acquired. There is rarely excessive volume of the entire nose; the hypertrophy usually affects the lobule, or lower half of the nose. Reference, however, has already been made to this, as well as to the means of relief by the excision of cuneiform sections and closure by suture. By such method, excess of structure of any part of the external nose may be successfully corrected. In this retrenching excision, care must be used not to remove too much; for a nose rendered too small offends the eye of both observer and observed, quite as much as one of excessive proportions. Also, if the proportions be asymmetrical, the effect will be unsatisfactory. To avoid, therefore, error on the side of excessive removal, the cuneiform excision should only be done on a minimal scale; and, if need be, more structure could afterwards be removed; but if the excision have been too freely done, no subsequent work can efface or correct it.

It sometimes occurs that a nose which is normal in the amount of its component structure, is still so irregular in one or more of its outlines that it is disagreeably conspicuous, and is a source of no small vexation to its unlucky owner. As examples of such ill form, the following may be enumerated: dorsal depression or

dorsal elevation of the nose; deviation of the lobule to one side; deviation of the entire nose to one side; unusual prominence of the sub-septum, or recession of the same. If any nose be carefully examined, a trace of one or more of the defects mentioned may be found; and often this trace of ill shape, which, without an effort on the part of the searcher to detect, would remain unobserved, becomes so magnified in the eye of the subject that a surgeon is consulted. The duty of the surgeon in such case is to endeavor to convince his patient that his ill is unimportant, and that the offending feature is seen by no one except himself. The task of the consultant is not an easy one; for nothing is more difficult than to expel from the human head a tormenting fancy which has once been admitted there. Such fancy often eludes the best directed weapons of reason.

In the cases of this class, the slighter the deformity, the greater is the difficulty of relieving it by operative means, for the operation usually only substitutes one ill feature for a new one; hence, in such cases, the discreet surgeon will counsel non-interference, and pursue this policy even though the patient does not. But where the deformity is such that it continually attracts observation, an attempt to correct it is justifiable; yet here as in all surgical work which is done solely from cosmetic motive and purpose, the patient must be forewarned that the best planned schemes here often go awry; and also, that success often fails to bring content, even as those who, dissatisfied with their lots, are allowed to change them in accord with their praying; for many are still unhappy; so that, as the Horatian Muse tells us, the grantor, Jupiter, inflates his cheeks with rage, and declares that in future he will not give so facile an ear to human prayers. The surgeon, like Jupiter, who is persuaded to engage in cosmetic work contrary to his judgment, sometimes regrets that he has yielded to the suppliant.

A deforming condition, in which intervention may be permitted, is that in which, from accident or other cause, the nose has been deflected to one side, and the nasal passages are lessened by being encroached upon. Restoration to form here has been attempted by the writer by endeavoring to fracture the deviated walls of the nose. The fracture of the nasal bones, though so easily occurring through accident, is no easy task for the surgeon. Should it be attempted, the work may be done by blows of a mallet upon a plate of metal laid on the side of the nose, a piece of lint meantime being interposed between the plate and the nose.

To accomplish anything, violent blows must be struck: force enough, in fact, to endanger the encephalic structures through concussion. And though fracture may be thus caused, it will be found of little aid, since the broken bones are so little movable that form cannot be satisfactorily repaired. An effort to fracture excentrically, that is, from the inside of the nose, might prove more successful; to do this, first plug the nostrils posteriorly, and then introduce a lever into each nostril, and, resting on a fulcrum, pry against each side until the bony wall is loosened and movable. The work of reposition is completed by modeling the loosened sides, and supporting them from beneath by tubular supports. Even this method, as the author has verified, is attended by difficulties, and the result obtained is far from satisfactory. It is probable that the work might be done more satisfactorily by a preliminary division of the nasal bones. To do this, after posterior occlusion of the nasal passages, from the inner face, saw through each nasal bone near its lateral border. The deflected nose being thus loosened at its sides, the deviated part might be restored to approximately normal position, without any external wound.

Tubular supports in the nose, aided by lateral compresses on the outside, may be used to retain in site the restored part. And should the osseous division mentioned be insufficient, additional sawing might be done from the inside, also division of the tethering bands could be done subcutaneously by means of a tenotome. The principles here given may serve as guiding rules for improvement of form, in cases of displacement or deviation of one of the nasal bones. And in every case, the operator should bear in mind that the calibre of the nasal passages must not be so encroached upon as to interfere with respiration, and to avoid this, patency must be maintained by large tubular supports during treatment; the objective side must not overshadow, or cause to be forgotten, the subjective one; for the patient will, erelong, prize the faculty of free nasal breathing more than the form of the nose.

Another minor defect of form which may solicit correction, is unusual prominence of the sub-septum; for when this depends beyond the alæ, the aspect is unsightly. The remedy for this consists in excision of a portion of the contiguous cartilaginous septum; and then, having lifted the prominent part upwards, fasten it by suture in the space formed. The excision of the cartilage can be done without severing the sub-septum, either from

the lip or the nasal lobule. Scrupulous care must be taken not to remove too much of the septum, for by so doing, the lower border of the sub-septum would be rendered concave, and an unsightly feature created; the excision, then, should be done piecemeal, until it is found that a sufficient amount has been removed to repair the defect.

Again, the septum may, as a congenital or acquired defect, not reach to the outlet, the alæ and the lobule reaching beyond it. This defect, when a congenital one, would rarely demand the surgeon's aid; yet when the sub-septum has been destroyed by disease, a reparative operation should be done. For this purpose material from the upper lip can be used; and this may be taken from the philtrum or middle of the lip; or a flap with pedicle towards the septum, may be cut obliquely from the upper lip, as done by Desprès. If the upper lip were unusually high, it were better to utilize material from the median part of the lip. For this purpose, make an incision on each side of the median line through the lip, so as to form a flap with upward pedicle, and somewhat broader than the normal septum. Beneath the lobule make a raw surface to which the replacing flap can be attached; also, trim off the edge of the remaining septum. The flap being twisted so that the epidermal face will look outwards it is fixed by sutures to its destined site. Thus done, if the twisted pedicle be too large, after a month it can be given a better form by slight incision; or to avoid this, the flap not twisted may be lifted directly upwards; but to do this, the outer surface must be pared off, in order to get a face which can unite with the trimmed edge of the remaining septum. Besides, the hair roots, if not removed, would occupy a very inconvenient position in the male's lip. Should the lip be thick, the deeper portion might be used for repairing material. To do this, first make a median vertical cut through one-third of the thickness of the lip; from the bottom of this cut incise laterally, so that space is gotten through which a flap can be formed from the deeper portion of the lip. This flap is next to be lifted directly upwards and fixed by suture. The mucous membrane which is thus exposed in the new-formed sub-septum, at first conspicuous, will finally acquire the appearance of ordinary derm. As the new material lessens by contraction, due allowance for this must be made in the work. By this latter mode of repair, there will be less sacrifice of the labial structure. As before remarked, Desprès constructed the best sub-septum by means of an oblique flap, the

loose end of which lies towards the left angle of the mouth. This must be twisted so that the dermal side will look outwards. And, in all these methods, the wounds created must be closed by catgut suture.

Rhinoplasty.—By Rhinoplasty is meant an operation in which there is repaired or restored a portion or the entirety of the nose; and such operation may be required in cases in which the following conditions are present:—

1. Partial or complete loss of the nose through some violence, as a gunshot wound or other injury. Along with the nasal injury, there may be loss or lesion of parts adjacent or subjacent, and this accessory injury may be so great as to render any rhinoplastic restoration difficult, or perhaps impossible.

2. Constitutional disease, as syphilis, may destroy the nose, and especially some malignant growth, as carcinoma or epithelioma, frequently destroys a large portion of the nose.

3. A burn yet unhealed, or the cicatrix caused by a burn, or by the destructive action of an acid or alkali, may demand repair by a plastic procedure.

4. The devastation of parts by the surgeon's knife in the removal of malignant growths involving the nose, often demands some reparative operation, and this may be done contemporaneously with the operation, or at a later period.

Before describing the procedure for repair required in the cases enumerated, some general consideration of the subject of rhinoplasty is proper.

The Sanscrit race, which early inhabited the valley of the Ganges, along with the primal germs of language, gave to the nations of the West some of the principles of medicine; in the Ayur-Veda, a book on medicine, written by Susruta, there is mention made of nose building. In the fifteenth century the Latin race surpassing the rest of the world in enterprise, doubled the Cape of Good Hope; and it is probable that, as the art of nose-repairing appeared at the same era in Italy, this knowledge was transplanted there from the Orient. In the fifteenth century Branca, a Sicilian surgeon, formed the nose from the skin of the face. Branca's son went further: he formed the nose from structure taken from the arm. In the sixteenth century, Peter and Paul, sons of a family named Bojani, residing in Calabria, also constructed the nose from the skin taken from the arm. And near this period Tagliacozza, professor of Anatomy at Bologna, in Italy, wrote on this subject, and obtained so much

repute in re-formation of the lost nose that he was honored with the title of Nasifex, or nose-maker; and in Latin and English verse his handiwork was celebrated. In his "Hudibras," Butler mentions the Talicotian art in blunt metre. Talicotius, as his name is latinized, is thought to have really invented nothing, and the charge against him remains unanswered, that he intentionally and disingenuously appropriated to himself the work of others. The Talicotian operation consisted in constructing the nose from the skin of the arm, as had already been done by the junior Branca; it is known as the Italian method. It consists of, and might properly be named, nasal repair by transplantation. And the transplanted material, in some of the earlier essays, seems to have been taken from the body of another person; and as the theology of that time essayed to dictate to science, and had interpolated much material in the structure of science, it is no wonder that they, whose minds had the crude mold of that time, feared that the nose constructed of another man's flesh would die when the original owner died. We are not, however, told whether there was fear of the converse, to wit, that the nose might outlive him on whom it was engrafted.

In the annals of surgery one finds examples of immediate transplantation of material from one human body to that of another, for the repair of the defective nose. Unfortunately, these accounts have often been derived from sources in which the mythical and the authentic are too closely commingled for credence; since writers then did not always confine themselves to historical accuracy. An instance of this kind is the following: Dutrochet reports the statement of his brother, who had been in the East Indies, that a criminal who had been punished by cutting off his nose, had his loss repaired with material taken from the buttock of a slave. The thick integument had been prepared for transplantation by having been whipped severely. In this way, the skin became surcharged with blood, and the irritation thus caused seemed to add to the vitality of the transplanted part. The site to receive the excised skin was trimmed, so as to render it raw, and fixation was effected by means of sutures. It was so cut as to furnish material also for a septum. It is stated that a good result was obtained.

Another example decidedly apocryphal is that told of an Italian brigand, whose nose, in a nocturnal affray, had been cut off. Whilst a surgeon was deliberating what he would do, the brigand's confederates attacked a passer-by and cut off his nose,

and placed the same on the face of their companion. This nasificial exploit, if credible, would exceed the most famous deeds of Talicotius himself. A case cognate to this was that of a wealthy Frenchman whose nose having been destroyed by lupus, the proposal was made to his servant to give his nose to his master; though a promised reward of many ducats accompanied the request, yet the attempt was not made, as the servant valued his nose more than a pocketful of ducats.

An authentic case of direct transplantation from one part of the body to another, is that reported by Bünger, of Marburg. The movable portion of the nose had been lost in a woman, aged thirty-three, and fruitless endeavors had been made to repair the loss from adjacent material of the face. Bünger decided to make the experiment of transplantation of repairing material from a remote part of the body. To do this, assisted by his colleague, Ullmann, he whipped the anterior surface of the thigh of his patient, and excised from this an oval flap four inches long and three inches wide, and applied this on the remaining portion of the nose, which had been trimmed for the purpose; and the flap was fixed by sutures. The upper portion of this engrafted flap lived; the part which lived seemed to do so, not from the attached edges, but from the subjacent surface, which was raw and rested on a similar surface. There lived a sufficiency of the flap to restore the greater part of the nose; the parts lacking were supplied by the adjacent cheek and lip.

Aside from these adventurous essays, in which direct transplantation of tissue from a distant part may be done, the rhinoplastic procedure as commonly practiced consists of two methods, one named the Indian, in which the repairing material is taken from the forehead or face; the other named the Italian, in which the material of replacement is derived from the upper arm forearm, or hand.

The Indian method consists in the appropriation of the dermal surface of parts contiguous for the repair of partial or entire loss of the nose; and the replacing material may be twisted semicircularly or carried to its destined site by lateral sliding. This plan of replacement is sometimes named the French method, and, again, it is named the Celsian method; the latter name is much more appropriate, since it is described by Celsus. In the lines in which Celsus has described this work,—lines in which intense brevity merges into obscurity,—the student has the first written description, spared by time, of surgical work done to

remove or conceal defects (curta) in the face. It is inferable that the Roman race, which fearlessly conquered and held the world in its martial grasp, had the weakness of quailing before facial defect, and that, besides for glory, the Roman would suffer pain for cosmetic purposes. Celsus has a chapter entitled "Defects in the ears, lips, and nose; in what manner these may be closed and cured;" the chapter opening with these words: "Defects occur in these three parts, and if they be small in some part, they can be cured; but if they are larger, they either do not admit of remedy, or the result is such that the part is rendered less comely than it was before." Since these lines were written, the truth which they contain has often been verified by ill-devised and ill-done work within the sphere of plastic surgery.

The manner of repairing a defect in the ear, nose or lip is stated by Celsus in the following words: "Reduce to a quadrate figure that which is defective (curt); from the interior angles of this figure incise transverse lines which may separate the nearer structure from that which is beyond; then unite the parts together which we have so loosened. But if the parts are not sufficiently united, besides the incisions which we have made, we must add two other incisions of crescentic shape, which are directed towards the wound (already made), and in which the summit only of the skin is separated; thus proceeding, it follows that what is drawn upon easily yields; and this must not be done with violence; the traction must so be made that the parts easily follow, and when they are abandoned to themselves, they recede but little. Likewise, if the skin at one part is not entirely closed, it renders the part ill-shapen. In the manner described, then, one portion of such defect is to be incised, while the other portion must be left intact. We shall not make traction on the following parts, viz., the lower part of the ears, the middle of the nose, the lower part of the nostrils, nor the angles of the mouth. But we will seek, for replacing materials, on each side of the defect, in the summit of the ears, in the middle of the nasal passages, or in the middle of the lips. Defects are wont to be in two places: but here the method of cure is the same as that mentioned.
Then the lips of the wound must be united by sutures, the skin being pressed together from each side. In the inner incisions as well as in the crescentic ones, lint must be inserted, in order that the growing flesh may fill the wound."

The latter portion of this extract from Celsus is obscure. To describe mechanical work in one's vernacular tongue is a difficult

task, and unless illustrated by diagrams, the best description is vague, and scarcely comprehensible; and the obscurity of meaning is still greater when the description is in a foreign tongue, or a dead language. Yet the meaning of the first portion of the Celsian citation is clear: he advises to convert the defect into a four-sided figure, and then to elongate the incisions, and if the sides cannot then be approximated, to make subsidiary incisions at the side of the quadrangular space, so as to facilitate lateral sliding. In fact, the Celsian method is the equivalent of the Indian, with the addition of accessory cuts. A diagram of this work is shown in Figure 5. The crescentic cuts, instead of hav-

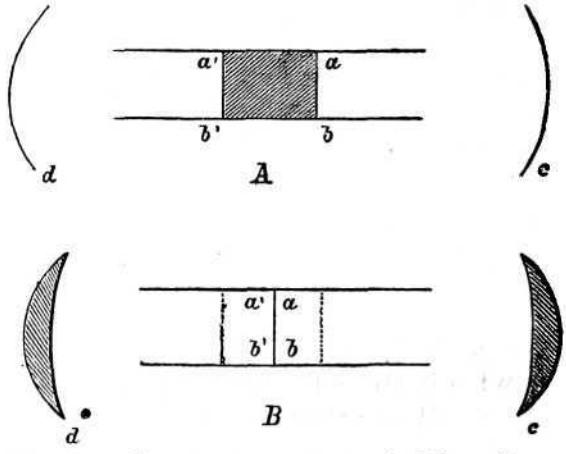

FIGURE 5. Showing the plastic method of Celsus (from Otto Weber); *a′ a b′ b* shows the defect to be closed.

ing the points towards, may have them directed from the figure. And the writer would suggest that instead of prolonging the horizontal lines, as shown, it would be better to do this after the sides were approximated, as much as possible, and then prolong them above and below.

As indications or reasons for nasal restoration or repair, the following may be offered: A face without the external nose is eminently repulsive to the layman, and is even repugnant to the medical man, though educational molding has so altered his taste that he often finds interest in contemplating examples of monstrosity. And in such degraded countenance, instead of the "human face divine," one is horrified with the sight of a figure akin to that of a Medusa, a sight which inspires the beholder with feelings of pity and disgust. Schiller realized this when he depicted his villain Roller with a deformed nose. If the subject of calamity be one who is compelled to earn a livelihood by labor,

he will find most doors closed against him; so that life becomes a burden to him. And such unfortunate has been known to tire of his lot, and to yield to the impulse to drop the burdens of life by suicide. Besides this the absence of the external nose, with perhaps disease in the remaining fragments, and the accumulation of sordes or septic excreta in the choanæ, infect the patient's breath with foul odor, so that both nose and eye of those about the victim are constantly offended. The absence of the external nose allows air laden with dust to pass unimpeded to the lungs, and to cause disease there. The warming function of the normal nose is wanting, and hence the cold air directly enters the lungs. The voice of the noseless face acquires a disagreeable tone. The sense of smell is weakened, and perhaps lost; and as the nose is an intimate ally of the tongue, it happens that when smell is lost, taste is much impaired. For perfect olfaction a complete nasal vestibule is required. The current of air must transport the odorant particles into the upper nasal chamber: a fact proven by Béclard, who found that when the air is conducted into the lower part of the nasal passages, any fragrant matters which it may contain are not perceived. And in subjects in whom the nose was wanting, the power of olfaction was entirely lost. Hence, as seen, the restoration of the lost nose is demanded, not only to overcome a great deformity, but to aid in phonation, respiration, taste and smell.

The restoration of the lost nose, as before mentioned, may be from structure obtained from some other part of the dermal surface of the body, which is directly transplanted; or this may be from the arm or forehead, with temporary retention of the pedicle, or the repairing material may be from the cheek on each side, with permanent retention of the pedicle. The structure is oftenest taken from the forehead.

In the selection of the repairing material, certain conditions in the latter are demanded, viz., that it have an ample supply of blood furnished through the pedicle, and that the material used be sound in structure. As a rule, tissue which is partly or wholly cicatricial, should not be used; for such material will nearly always perish, and render the work a failure. The writer has more than once heard the plaintive lament of some operator who has met with a signal failure through using cicatricial tissue; the whole had sloughed, and the previous deformity, instead of being relieved, had been added to; and the writer confesses to like chagrin from having violated the rule which he is here enjoining.

The only license for such violation would be in cases in which none other than cicatricial tissue existed, and the scar did not reach through the structure to be transplanted, or had existed so long that the part had nearly regained its normal character. Only in such conditions should one venture to transplant cicatricial structure. It should have been stated that the sloughing of the transposed cicatricial flap is but a part of the ill result; there remains whence the flap was lifted an open ulcerating wound, often destined to baffle all efforts at closure, for an interminable period. Indeed, a disregard of this rule is similar in result to that of violating a kindred injunction familiar to most readers, viz., the rent is greater than before.

The part utilized must have an ample supply of blood, and hence the pedicle should contain a nutrient artery or arterioles, and the flow of blood should not be impeded through this by tension or pressure. The material on the forehead is favorably situated in reference to blood supply through the frontal artery, which, emerging from the orbit above the inner angle of the eye, ascends vertically near the median line. An exact knowledge of the site of this vessel where it escapes from the orbit is highly important; as given by Hyrtl, who is ever exact and trustworthy in his statements, each frontal artery lies from three to four lines outside of the median line. Hence a pedicle of which one side corresponds to the median line, of one-half inch breadth, will include at least one of the arteries; and a breadth of over two-thirds of an inch, including the median line, will contain both vessels. The inclusion of both vessels might furnish too much blood; for, according to Dieffenbach, the death of the flap may be caused by excessive congestion of the part; in fact, he, perhaps the greatest of plastic operators, quite neglected the vascular supply and made the pedicle so narrow that it could be readily twisted. Rhinoplastic repair is oftenest done by material taken from the forehead, and the modes of doing this will next be considered.

The work will commence with the construction of a model, to which the new nose is to conform in size and outline; such a model might be taken from a nose on another face; yet it is oftener made from wax, India rubber, or plaster of Paris. On such model, adhesive plaster is spread, and the outline thus obtained. Or it might be made of leather, and afterwards this must be coated with diachylon, or other adhesive material. In the normal face the length of the nose is about equal to the

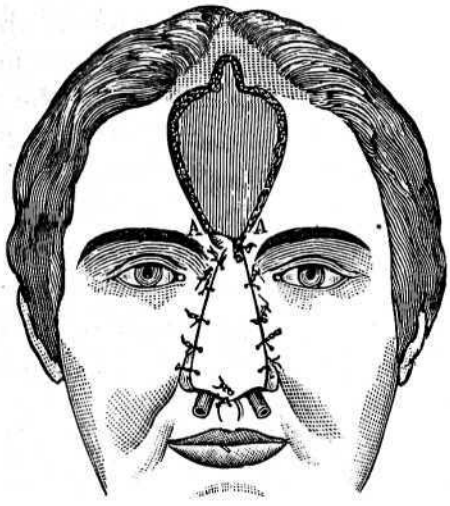

FIGURE 6. Exhibiting rhinoplastic procedure by means of a vertical flap taken from the forehead (from "Dictionaire Encyclopèdique des Sciences Médicales: Dechambre et Lereboullet).

height of the forehead; hence the guiding superficial model should have that length. But as material for forming the septum will be required, hence the model must extend into the hairy scalp for one inch, which should be shaven at that point. In this work the contractile property of the skin when divided must be remembered, and due allowance for the same be calculated. The experiments and observations of Farabeuf have shown that this contractility in the case of amputation is equal

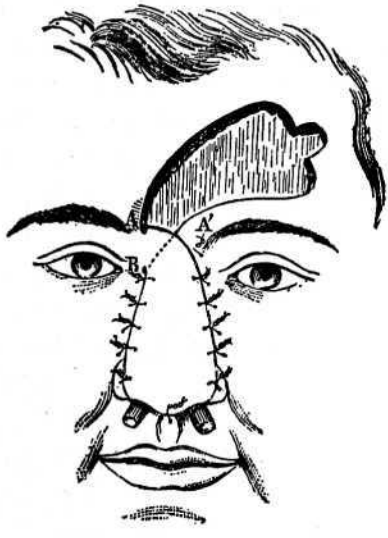

FIGURE 7. Showing Alquié's rhinoplastic method, in which an oblique flap is taken from left side of the forehead. (Dictionaire Encyclopèdique des Sciences Medicales).

to one about one-third of the diameter of the limb which is divided. Hence the frontal flap should be made at least one-third longer and one-third broader than the nose which it is designed to form. In the directly vertical flap, as shown in Figure 6, unless the forehead were high, it would not be possible to extend farther upwards without entering the hairy scalp; and hence, as a free field in which ample range would be permitted to the operator, the plan of Alquié may be followed, viz., to construct an oblique flap over one eye, with its free end directed towards one of the temples, as is shown in Figure 7. To assist in twisting the flap, one of the terminal incisions below should extend further downwards than the other; the mode of doing this will be understood by reference to Figure 7.

The retention of the periosteum along with the flap was done by Langenbeck, with the hope that bone might thus be formed beneath the transplanted flap, and that thus there may be obtained an osseous framework for the newly constructed nose. From the reports of those who have thus operated, it does not appear that this expectation has been realized. Others, laboring under as great a fallacy, have not removed the periosteum, in order to spare encephalic trouble which might result from the exposure of the cranium.

The margins of the flap should not be cut perpendicularly, but in such a way as to enlarge the surface of sutural attachment; thus coaptation is facilitated, and subsequent vitality favored.

The nasal site is next to be prepared for reception of the flap. All osseous and cartilaginous structures are to be carefully saved; for upon the presence or absence of a supporting framework will wholly depend the excellence of result in the work done: for if the bone and cartilages are absent, the newly constructed nose will be but a flattened bridge across the nasal breach; but if there is a sustaining skeleton on which to build, the newly formed part will certainly resemble, if it does not represent, a nose. The margins of the part to be restored are to be trimmed in an oblique direction, so as to present a surface which will correspond to the broadened edges of the flap. The summits of the remaining cartilage and bones must be paired so as to present a raw surface, which may cohere to the under surface of the flap.

The work having advanced to this stage before adjusting the flap to its site, the operator will wait until he has controlled all bleeding; this done, he will next give the pedicle such a form

that its torsion will be facilitated; for, without such preparation, the application of sutures on the side towards which the flap has been twisted will be difficult, and the sutured margins will be uneven, and become still more so when swelling occurs. To aid in torsion, Lisfranc proposed to elongate downwards one of the incisions. In the Indian method the incisions ended below at points on a level with the eyebrows. Lisfranc advised to carry the cut one-half inch farther downwards on the side towards which the torsion is made. Labat and Langenbeck amended this incision by carrying the cut downwards and towards the other side. For example, if the torsion is to be towards the left side, the left incision must reach downwards a half inch further than the right one; and the left cut, besides being made longer, is to be carried towards the right, until it reaches or has slightly passed the median line. In this preliminary preparation for easily twisting the flap, the vitality of the latter must be borne in mind; and one of the frontal arteries must be retained intact in the pedicle. The method of Alquié, in which the flap is taken from over one of the eyes, though the torsion might be reduced from 180° to perhaps 120°, yet in its preparation the two frontal arteries would be severed, and the upper third of the flap would be cut off from any direct arterial supply, and hence its vitality would be endangered. As seen, the problem of torsion of the pedicle has been but imperfectly solved; and this has led to the attempt to use the flap without torsion, as will be seen hereafter.

In the methods of operating described, after the reversed (overturned) transposed flap had formed adhesions to its new site, it was customary to divide the pedicle; and the result was that the reformed nose contracted into a very unsatisfactory shape. To avoid such shrinking, the endeavor has been made to dispense with the section, and to so dispose of the pedicle at the primary operation that it would be less prominent. To accomplish this, Dieffenbach made a vertical incision at the root of the nose, and placed the pedicle in this sulcus, and applied compression on the parts so as to cause adherence. Blandin, to accomplish the same, excised the surface of the skin, on which the pedicle is to lie. But Velpeau excised the pedicle, converted it into a triangular form and placed this in a sulcus which he had made, and retained it there by sutures. The plan of Blandin or Dieffenbach is preferable.

Instead of forming the sub-septum from frontal integument, this may be constructed from the upper lip, as has been heretofore described.

In case the septum is wanting, the transposed frontal flap would rest as a flattened bridge across the nasal breach, and, at best, be nothing more than a caricature of a nose. To improve the condition in such a case, Verneuil has conceived the thought of doing the work by means of a frontal flap, and two flaps taken, one on each side of the nose. A frontal flap is to be modeled and brought directly down on the breach without torsion; that is, the bleeding surface is outside, and the epiderm directed inwards. Then from each side a flap is to be uplifted, and the two are to be drawn across the raw surface of the frontal flap, and fixed there by sutures. In this way the wanting nose can be built up and given a greater solidity than it would have from a single thickness of transposed structure. The pedicle of the frontal portion may be made narrower than where it is twisted.

In this work of nasal repair, which is done to render a face less repulsive to other eyes, it must be ever remembered that the subject has another interest in the matter, viz., that it may be provided with nostrils through which he can breathe; and openings for this must be maintained. For this purpose tubular obturators must be placed in the new-formed nostrils, and retained there for many months. Such tubular obturators may be formed of silver, lead, aluminum or of India rubber.

Some facts should be mentioned in respect to the newly transplanted material. For a time, its temperature is lower than that of the surrounding parts; for a short period it is pale, cold and cadaver-like. In the transplanted structure, in regard to the alternate ebbing and inflowing of blood, and the ascent and descent of temperature, which are said to have continued for many hours, the statements of Inmisch, Coote, and others are examples of careless assertion rather than of accurate observation; for, as the writer has often witnessed, the circulation is soon established in the part, and though it may be briefly cyanosed, yet the natural color returns early, and occasionally the part becomes temporarily red and congested. Excessive congestion is assigned by Dieffenbach as the usual cause of death of the transplanted structure. And to avert sloughing, where the part becomes passively surcharged with blood, Dieffenbach scarifies the swollen part and thus relieves the turgid condition. As to the dressing of the part, authorities differ, some using warm, others cold applications. The condition of the part should guide in the matter; in the early stages, before the circulation has been restored, this ought to be favored by warm dressings; but later,

when the congestive period appears, then the constrictive action of cold dressings, or scarification, may be resorted to as means of reduction.

The sensation of the transported structure will be lessened and perverted in character; for nerves have been severed, and those left intact are altered in their position in reference to the surface of the body, and the result is that, when the new nose is touched or irritated, the sensation awakened is referred to the forehead. And this error of place continues for a long period, and whether it is finally dissipated by education and experience, the writer has not been able to verify by observation. From the fact that after amputation of limbs, a similar error of sensation exists, which finally vanishes, it is inferable that a correction finally obtains in case of the new formed nose.

The condition may exist in which the septum and nasal bones are absent; such a state constitutes the highest grade of nasal deformity; and what is quite as unfortunate, plastic surgery has been able to offer the unhappy subject only slight relief; a revolting deformity has, by the hand of rhinoplastic art, been exchanged for an unsightly, repulsive substitute. The transported structure, lacking median and lateral support, lies flat over the breach. The best that can be said of such a state is that it is better than no nose. Perhaps, through combining the untwisted frontal flap with lateral flaps from the cheek adjacent, the flattened structure could be made more prominent; but the new structure would not be relieved of repulsive clumsiness. In such a case in which there was a total lack of the parts which sustain the nose, resulting from the misfortunes of misguided passion, the writer, in 1864, operated as follows: A plate of gold was prepared, in the form of a parallelogram, of dimensions sufficient to replace the absent nasal bones. The plate was so thin that it could easily be molded into an arched form. The site was prepared by trimming the uneven margins and then lifting up the integument so as to form lateral flaps, of which the anterior margins were equal to the length of the nose which was to be formed. Such a flap was dissected up from the subjacent parts on each side. Next, a frontal flap was traced out and lifted from the bone. The plate of gold was next put into its destined position, with its marginal sides underneath the lateral flaps. The flap from the forehead was placed without torsion on the plate and beneath the marginal flaps, which covered with their raw surface a portion of the frontal flap. No septum was formed, as it was deemed better to defer

this until the remaining work had been tested. When cicatrization had ended, the band of scar along the dorsum of the nose did not present as ill an aspect as had been feared. But the patient, whose morale was below par, finally became impatient of the pain caused by the contraction of the cicatrizing structure, and after three months begged to have the metallic support removed, which being done, the unsupported parts sank almost to a level with the parts around.

The experience of this case showed that in a patient more tolerant and docile to surgical management, with some modification of the work, the plan here described might be employed to advantage in those cases in which the osseous and cartilaginous framework of the nose is absent. The frontal flap should have been provided with material for forming a sub-septum; the margins should have been obliquely beveled on the dermal side, and the flap turned by torsion; the beveled edges should then be placed beneath the loosened margins on each side of the nose. The frontal flap should be so large that it will require no addition to it from the contiguous structures of the cheeks. A procedure thus carried out would, in a great degree, avoid the pain from contracting cicatrization. If nasal reconstruction were thus done, the part would be provided with an enduring framework, which would defy change from time or disease; and, according to the Twelve Tables of the old Roman law, which forbade the cremation of gold which had been used to fasten the teeth, so the gold used in nasal repair might at death be rescued and made to do duty again by some conservative nasifex.

It is in order to next consider the method of nasal construction in which the restoration is done with material taken from the arm, known as the Italian or Talicotian procedure. This method appears to have been used particularly in those cases in which the supporting framework of the nose had been lost. This operation, as done by the Italian surgeon Tagliacozzi, consisted of a series of acts, which required from six to eight weeks for their completion.

Taliacotius, as he latinizes his name, seems to have dreaded that his material might die, and to avoid this he subjected the part to be used to a preliminary preparation; during a considerable period he treated the skin over the biceps muscle with rough friction and flagellation until the structure was hardened and resembled that of the elbow. The integument being thus altered until it no longer resembled the skin of the arm, the

operator seized and lifted up a fold of it with forceps, and cut this so that there was formed a flap with free end directed upwards, and pedicle attached some two inches above the cubital flexure. This flap in its dimensions is double the size of the future nose. The wound made behind the flap is closed by sutures, and the bleeding surface of the flap in extended position is covered with ointments, or material which will promote suppuration. Prior to the operation, during a few days, the arm is to be trained to a position in which, the limb being uplifted and the elbow fixed, the front surface of the upper arm is brought near the nose and retained there. To maintain this tiresome posture the patient must wear a hood-like head-dress, which is a continuation of the outer coat of the chest. With such a dress the arm, with the aid of attached straps and buckles, can be con-

FIGURE 8. Illustrating the Talicotian method of rhinoplasty.

fined in the position mentioned. Such a position should be maintained for not less than two days prior to the preparation of the flap. The position, as well as the means of fixing the arm, is seen in the annexed figure. The work of fixing the limb has been done by means of adhesive plaster; this plan, however, is less trustworthy. After the flap had suppurated, Tagliacozzi, having trimmed the nasal breach, to which the former is to be applied, next proceeded to apply a prepared model of the intended nose to the flap, and trimmed from the latter the surplus material, and fixed the flap to the nasal breach by marginal sutures. The arm must still be maintained applied to the head, and retained there by the contentive means described, for at least twenty days. The flap thus adheres by its summit and borders to the nasal site; the pedicle remains adherent to the arm.

After twenty days, Tagliacozzi divided with scissors the pedicle, which reached well down towards the mouth; from the lower border of the flap-like structure, the operator next proceeds to construct openings for the nares, and also the sub-septum. To form the nares, the skin is infolded, and the orifices are maintained open by tubes placed in them.

Græfe performed the Talicotian operation with some modifications; but instead of a flap from the humeral region, he took the reparative material from the front of the forearm. Instead of letting the uplifted flap pass through the suppurative stage, he used it at once. A pasteboard model of the nose having been prepared, this was laid on the forearm, and the flap incised, elevated, and at once united to the recently trimmed surface of the nasal site. The arm was maintained bound to the head for three weeks, when the pedicle was severed, and a sub-septum and nares constructed. Græfe thus operated six times, with successful result in five patients. It has been done by a few other surgeons; the result, as recorded, is satisfactory for a few weeks, but some months later the part becomes less by atrophy, so that, by its smallness, it contrasts with the remainder of the face. To compensate the future diminution, the part should, at first, have proportions abnormally large; and, as the brachial field of supply is abundant, ample provision for shrinkage might readily be made.

Talicotian rhinoplasty, or that done by the use of transplantation of material from the arm, is in less favor than is the procedure in which pediculated flaps from parts contiguous are used; yet the former may be used in cases in which the latter annot be pursued. For example, where the frontal derm is so scarred that its vitality is lowered, or its surface is greatly disfigured, then brachial transplantation is preferable. Again, the patient may object to having an indelible mark set in his forehead, which, as a telltale, would reveal his misfortunes; here, again, material from the arm might be employed for the repair.

Partial Nasal Repair.—Partial restoration of the nose may be demanded in case of loss of the alar margin of the nostril, or of the side of the nose including the alar margin, or of the tip or lobule; and finally a sunken condition of saddle-seat shape may solicit surgical aid. And the work of restoration may be required on both sides or on one side only.

In each of these cases the material for closure is taken from a surface that is contiguous, viz., from the forehead, nose itself,

cheek, or upper lip. In fact, in the selection of the material for replacement, the rule should be to take it where it is most readily accessible, and where its employment will cause the least marring of the patient's face. And these conditions are generally best fulfilled by choosing material from intact derm, which may be on the upper part of the nose, or from the adjacent cheek.

Alar Marginal Defect.—To repair this breach, after trimming the margins of the defect, map out and uplift a pedicled flap from the adjacent derm of the cheek; and as this replacing material must be swung, or revolved, into its destined site, it should be so situated that it can be moved into place through the shortest circuit. If the flap be so placed that its free or distal border is directed towards the outer angle of the eye, it can be shifted to its intended site by passing through an arc of ninety degrees. But if this border be directed towards the inner angle of the eye, the movement of transposition will be done through an arc of not more than forty-five degrees. And the same would be true if the material be taken from the upper lip. It is better to take the material from the inner portion of the cheek: that is, from the derm alongside of the nose. This flap must exceed, in length and breadth, the breach which it is to fill; and allowance should be made of not less than two lines in each direction, for subsequent contraction. Should ample allowance for diminution not be made, and the border rise above the normal level, the patient will deem himself but imperfectly paid for his pains. The flap with derm outside is placed in position and retained there by metallic sutures, which should remain in place for a week at least. It is seldom that an obturating tube is required. The wound remaining in the cheek must also be carefully closed by metallic sutures. In the closure of this wound the movable part of the nose is usually deflected to that side by the traction made on it. Such lateral deflection gradually vanishes through the structures of the cheek stretching or sliding towards the nose.

Defects from Loss of the Side of the Nose including the Alar Margin.—For the repair of this extensive breach, material in the form of a pedicled flap, might be found in the contiguous cheek; and in such case the technical steps, or acts, would be similar to those above described for the repair of defective alar margin. If the defect were not extensive, the repairing material might be obtained from the upper part of the nose.

Denonvilliers repaired the breach by means of a triangular flap which was attached at the root of the nose, and had its

movable border lying on the cheek. Nélaton used for the purpose a four-sided flap, of which the pedicle was also attached at the root of the nose. In the work reported thus done, there was subsequent retraction of the alar border.

In case the defect should be but a small opening through the side of the nares, closure might be done by sliding or twisting a small flap into the breach. Or the method which Celsus recommends for the closure of openings in the ear might be adopted. Celsus writes: "If the opening be large, as is wont to be the case in those whose ears have borne weights greater than they could bear, then one should make a long incision superiorly; and having made the borders (of the opening) raw with a scalpel, then close by suture; and over the wound a medicament must be placed, which would cause union. The plan here indicated is plainly to trim the borders of the defect and elongate this by incising, so that the sides could be brought together. By such a procedure, openings through the sides of the nose might be closed. If closure could thus be done, less scarring would result than would occur from repair through borrowed material.

In slight defect of the alar margin, Dieffenbach resorted to the novel procedure of trimming off the wing on the opposite side, so that the two sides would be of corresponding length. Though the sides would thus be made symmetrical, yet the comical appearance which would be given the nose by such retrenchment, would be a great remove from cosmetic improvement; some one compares such a nose to that of a cat.

Repair of nasal structure is sometimes demanded through depression of the middle portion of the dorsal ridge in which the part presents a saddle-seat incurvation. This may have, as origin, a lesion in which a portion of the nose has been destroyed by injury; the causal agency is far more frequently traceable to a constitutional disease, such as scrofula or syphilis, in which the nasal bones necrosing, the supporting skeleton of the nose is lost, and the nose sinks at its middle. The lobular part, or lower third, of the nose maintains its position in some cases, since its cartilaginous supports remain intact; yet not unfrequently the ulcerative disease reaches and attacks the cartilage, so that the lobule sinks, and recedes into the upper portion: that is, the lobular portion is received in the upper portion similar to telescopic ensheathing. This invaginated deformity is much more difficult to rectify than that in which the lobule is in its natural site, and the means to be pursued in repair differ in the two cases.

Where the deformity has arisen from a wound in which a section of the nasal dorsum was destroyed, and the remainder of the nose is intact, then repairs might be done by means of material obtained on the forehead, root of the nose, adjacent cheek, or from the palm of the hand. When done by means of a pedicled flap obtained from a contiguous surface, the work is similar to that which has been described for restoration of the entirety, or side of the nose. Should the contiguous material not be suitable for the repair, then a procedure cognate to the Taliacotian might be done, in which a flap is to be dissected from the palm of the hand, and this being sutured to the trimmed edges of the defect, the hand is to be fixed on the nose, and immovably held there by contentive appliance, in which the hand is immobilized; and then the arm must be bound against a support placed between the limb and the side of the chest.

A small breach in the dorsum of the nose from traumatic cause was rectified by Reid by means of flaps uplifted on each side of the nose. Each flap was formed by means of two lateral incisions, which were four-fifths of an inch apart at the base, and two-fifths of an inch apart above. Next, through the nostril the septum was cut from the structures above, so that the parts could be lifted into proper position, in which they were retained by means of pins. These pins are made to traverse plates of lead laid on each side, so disposed as to maintain the nose in normal form and position. Place tampons in the nostrils.

Dieffenbach, and after him Malgaigne, in cases in which the osseous framework had been destroyed by scrofula or syphilis, so loosened the nose from the face by incisions made at the sides and underneath, that the movable parts can be molded into something like natural form. The work as done by Malgaigne is described by him as follows: "The wings of the nose were separated from the cheeks and upper lip; the loosened lower part was still further detached by dissecting the soft parts from the nasal bones at the root of the nose, as far as the frontal bones; also the upper lip was detached from the upper jaw. After this work, the nose could be raised and modeled into form, and retained so by long pins which were passed transversely through the parts; the heads and points of the pins were sheathed with corks. To still further hold and retain the nose in place, adhesive strips and collodion were used; and silver tubes were afterwards worn in the nostrils."

To restore form to a sunken nose, König in 1886 operated as follows: A transverse cut was made across the lower part of the

nose; through this cut the nasal wings were dissected up and so loosened that the nose could be reduced to something like the normal form. Next a long flap of rectangular shape was formed on the forehead, and was detached from the frontal bone along with the periosteum and the outer layer of the bone. Thus there was formed a cutaneous periosteo-osseous flap, which was turned downwards with the dermal side inwards and the wounded surface outwards. This flap is then slightly sutured to the adjacent raw edges of the transverse wound previously made on the nose. The next step was to form a similar flap of smaller size on the right side of the forehead, which is to be turned downwards by means of torsion, so that the raw surface will be directed inwards. This flap is superposed on the other so that the raw surface may cohere. Thus a long framework was obtained which afterwards remained as solid material. König reconstructed four noses according to the plan here described; they had, however, the fault of being too thick at the root; they were "too Grecian," that is, the forehead passed into the nose with too little incurvation at the root of the nose. Yet this defect was capable of some improvement afterwards.

We will next treat of those cases in which the surgeon is compelled to remove a portion or the whole of the nose, on account of some malignant disease. Should the extirpation be followed by immediate repair, or should this be delayed to determine whether recurrence of the disease will ensue? Authority differs here. Should the work of restoration be done at once, and the disease return, it has been repeatedly observed that the disease attacked the transplanted material. The proper rule of guidance in such cases seems to be that if the growth can be thoroughly removed, plastic repair should immediately be attempted. Proof that the diseased structure has been wholly removed would exist where the lines of excision had passed at least four lines beyond all infiltrated or affected tissue. And, further, should the disease return and invade the tissue used for repair, the patient would have had some advantage through temporary suspension of both his disease and the deformity consequent on its removal. Hence, in a patient whose nose is attacked by sarcoma, epithelioma, and forms of cancer other than encephaloid and melanotic, the disease should be extirpated, and plastic restoration at once be done, from the lateral structures if possible; and in absence of material there, seek it on the forehead or on the arm.

There are cases in which it is impossible to repair the wanting nose by any of the procedures practiced in rhinoplastic surgery; or the performance of any such operation may not be advisable, owing to the existence of some disease of the part which cannot be eradicated, without too extensive destruction of the parts. Examples of the former are those cases in which the face has been nearly destroyed by violence; or the face of a patient in which the field whence reparative material is obtained is occupied by a cicatrix. An example of uncured or progressing disease, forbidding rhinoplastic closure, is where lupus, rodent ulcer, epithelioma or tertiary syphilis is laying waste or has destroyed the deeper structures of the nose; a field where such invader having intrenched himself tolerates no coöperative occupancy.

Prothetic appliance employed to conceal partial or complete loss of the nose is first mentioned by Paré. Various materials have been used for the construction of the artificial nose: namely, it has been made of light wood, of gutta percha, vulcanized rubber, of lead, tin, silver and aluminum. The art of the manufacturer has been mainly occupied in devising that which will deceive the eye of the beholder; that the false nose will be so cunningly contrived that the falsity will not be revealed; a counterfeit which will impose for the genuine. To accomplish this, attention must be directed to the form, color and retention of the device in its destined site.

The form of the artificial nose is readily attained; and since it would be difficult to select a type which would content all eyes, hence some deviation in outline is tolerable. The hue or tint of the skin is easily imitated, especially in a case in which non-metallic material is employed; but if the material be silver or aluminum, the metallic appearance cannot be disguised by simply painting it; the object, however, can be attained, as Charriere has done, by first covering the metal with India rubber; or the nose might be wholly constructed of this latter material. The lightness of aluminum gives it an advantage over lead or silver. An important need of such appliance is that it be held in position, and, if possible, that this be done by means which escape observation. If the entire nose be replaced, the substituted device may be kept in place by the framework or bow of spectacles, or the same can be attained by means of wire springs which may pass laterally around the head; or the spring may ascend the forehead, pass over the head, and rest claspingly on the back of the head. This vertical attachment has the objection of being

constantly visible. It is, however, an effective mode of retentive fixation; yet, for manifest reasons, the mode of retention by the aid of spectacles is the more satisfactory one.

To procure a mould of the site to which the artificial part is to be attached, first plug the nostrils and cover the eyes; lay over the site some thin linen or cotton cloth, and again on this place and mould to the adjacent parts a thickness of pasteboard of nasal form; now slightly lift the pasteboard, and while the patient is leaning forward, pour beneath the pasteboard liquid gypsum, which hardening forms an exact cast of the parts behind.

The fabricated nose has been held in position by being attached to sponge which is pushed into the nostrils; the odor that soon proceeds from the sponge will finally disgust he patient with such appliance. A more successful means of fixation is by means of some adhesive composition or cement; for this gum-shellac may be employed.

Along with the loss of the nose there may coëxist defect of the lips and alveolar process of the upper jaw. In such cases, along with the replacing nose there might be associated an obturator to close the defect in the jaw. And the ingenuity of the artisan might connect the nasal portion with the labial, alveolar or palatal supplement. The connecting means may be wire so placed as to be concealed; namely, from the inner or hidden surface of the nasal portion, the wire might pass through the maxillary breach and be joined to the part situated within the mouth.

Cases again may occur in which a replacement of a portion of the defect may be effected by some plastic procedure, in which structure adjacent is utilized for the work of closure.

CHAPTER XI.

THE ELEMENTS OF PLASTIC SURGERY.

Success in operative work within the domain of plastic surgery is only to be reached by him who is familiar with certain mechanical principles, and who is guided by these in planning as well as in the execution of his work. To trust to the eye, and to the inspiration of the moment, may answer for him who has had much practical experience in such matter, yet for one who has not had such discipline, trusting to the moment for lucky guidance will usually end in an unsatisfactory result. As the navigator who is compassless might reach a hundred ports rather than the intended one, so the plastic surgeon relying on fortunate chance and a mechanical eye must often stray far from correct lines. A little geometry will add to the accuracy of the scalpel in its tasks of plastic repair. Lines must be drawn in accordance with premeditated study and plan, in order that any degree of excellence shall mark the completed work; and in this, due consideration must be given to the site, inclination and outline of the part to be repaired. And, also, most attentive study must be given to the selection of material for repair, viz., where such material is most accessible, can best be spared, and, above all, that its situation is such that it can readily be shifted, or moved to its intended site.

In the consideration of rhinoplasty glimpses have been given of the points here referred to; a more systematic elucidation of them will now be presented.

A plastic operation may be defined to be a procedure by which a breach of surface may be closed or repaired; or an upheaved or irregular surface is replaced by a smooth one; or, finally, plastic surgery has, as one of its most important offices, the restoration of parts which are absent; for example, congenital defects, or which have been lost through some traumatic agency.

The work of repairing a defect may be done by one of the following methods: (1) By adduction or sliding and partial or complete approximation of surfaces which lie near each other; (2) by adduction of parts which lie near each other, after detachment of the surface from structures beneath, with which it is connected; other aids in such approximative sliding are subsidiary lateral incisions; (3) by means of a replacing pedicled flap which is shifted to its intended site by revolving it through a semicircle, or an arc of the same; (4) by transplanting pedunculated replacing material from the arm or hand of the patient, or from the body of another individual. And as a modification of this, the restoring material may be cut off, and without sustaining pedicle be transplanted to its intended location. The most of plastic surgery is done by one of the first three methods. Where the defect is small, closure can usually be effected by the first method; but where it is larger, there is often needed some preliminary preparation of the surfaces which are to be approximated. And finally, where the first and second methods are unsuited to do the closure, a pedicled flap taken from a surface which lies more distant may be prepared, uplifted and turned around into the defect.

In the first and second methods, as subsidiary work to aid in closure, the defect must be converted into a figure, the outline of which will favor adductive closure. By the third method, it matters not what outline the defect may have, the flap of replacement must have a similar one. Hence the third method has special advantages; and, besides, the fact that the pedunculated flap may have any conceivable outline, it may be taken from a surface in which closure can easily be made, and the resultant scar will not be conspicuous.

As stated, in the first and second methods the border of the defect must be converted into a figure of a shape that will favor adductive approximation; and these figures are, in the main, similar to those employed by the geometrician in the solution of his theorems. Classified in the order in which they will be presented to the reader, these figures are the circle, semicircle, and other fractional portion of a circle, the ellipse and oval, the triangle, the rectangle or parallelogram, the rhomboid and the lozenge. These figures, diagramatically, are shown in the subjoined Figures 9, 10, 11, 12, 13, 14, 15, 16, 17, 18, 19, 20 and 21.

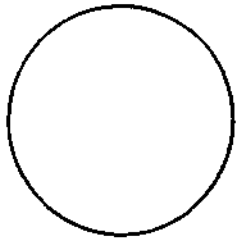

FIGURE 9. Showing the circle.

FIGURE 10. Showing the semicircle.

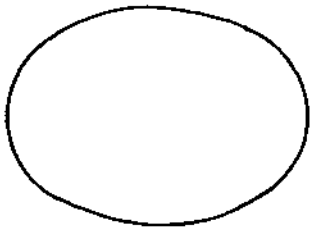

FIGURE 11. Exhibiting the ellipse.

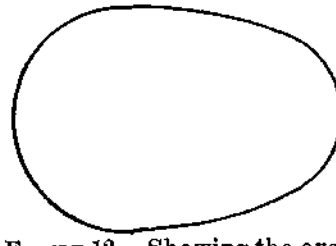

FIGURE 12. Showing the oval.

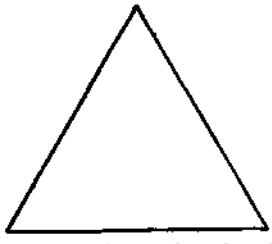

FIGURE 13. Showing triangle of equal sides.

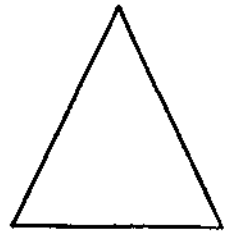

FIGURE 14. Showing triangle with two equal sides.

FIGURE 15. Showing the rectangle.

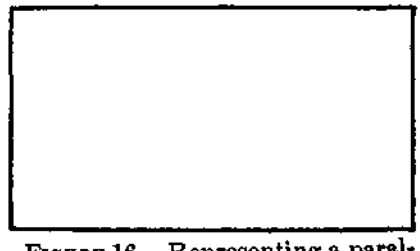

FIGURE 16. Representing a parallelogram.

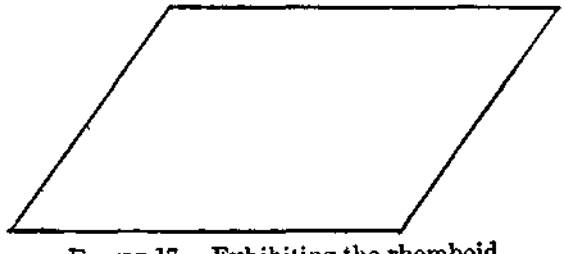

FIGURE 17. Exhibiting the rhomboid.

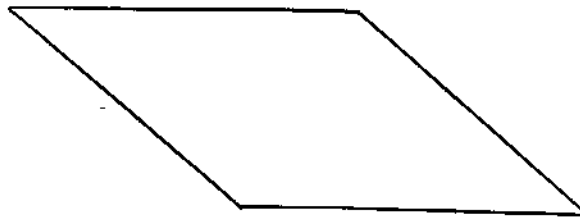

FIGURE 18. Showing rhomboid slightly lengthened.

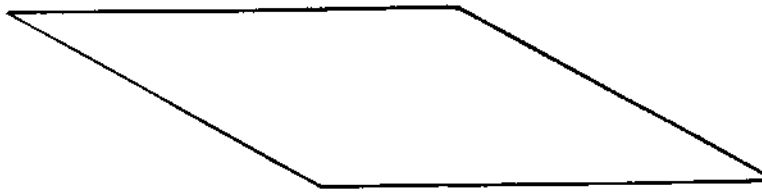

FIGURE 19. Illustrating the rhomboid much enlongated.

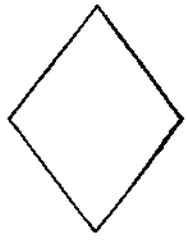

FIGURE 20. Showing the lozenge.

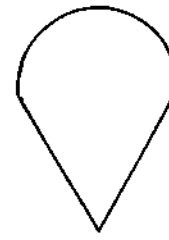

FIGURE 21. Showing the sector.

The First Method, or that of immediate Adduction.—In this method, of the figures here shown, the circle and the oblong rectangle can only be used when the surface of the defect is small. In the case of the circle, the opposite sides, in order to meet, must be carried at their middle point through half the diameter of the circle; and this could only be done where the breach to be closed is small; partial closure, however, could be effected, in which the circle would be reduced to a smaller polygonal figure,

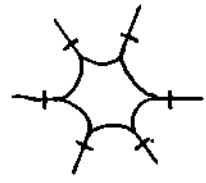

FIGURE 22. Showing closure of the circle.

as shown in Figure 22. In case of a rectangular defect, only in the event of the surface being diminutive could the opposite sides be approximated, and the lines of suture would be as shown in Figure 23.

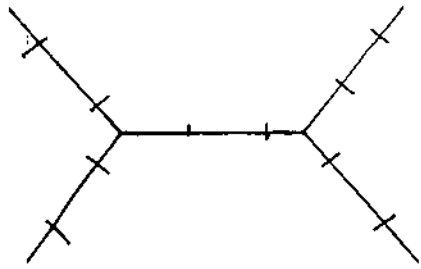

FIGURE 23. Showing closure of the parallelogram.

The oblong figure of the ellipse and oval renders them easier of closure by sliding than is the case with the circle; the long sides are to be apposed, and the result will be a straight line.

The closure of a triangular defect will depend on the figure of the triangle; if this be one with two equal sides and with a narrow base, juxtaposition of the long sides is easily accomplished, with the result of sutural lines resembling an inverted $\wedge$. Should the triangular defect be equilateral, then a large closure could only be made in the direction of the angles, and the result would be as shown in Figure 24, with a central space unclosed. A

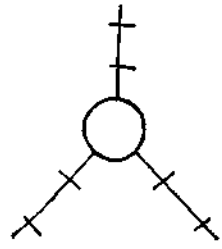

FIGURE 24. Showing closure of the equilateral triangle.

rhomboidal defect will be more easily closed, proportionately to the obliquity of its figure; for example, the same amount of space in Figure 17, will not be so easily closed by suture as that in Figures 18 and 19, of which the line of closure will be a long

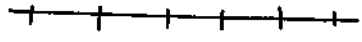

FIGURE 25. Showing closure of a rhomboid space; also of the ellipse and oval.

oblique line; for a defect of rhomboidal figure has the property that as the obliquity augments the long sides approach nearer to each other. A figure in the shape of a lozenge, which is similar to two isosceles triangles applied base to base, can be closed by direct sliding, provided the open surface is not large.

A figure which is compounded of, or derived from, the triangle is that shown in Figure 26; and occasionally a dermal defect

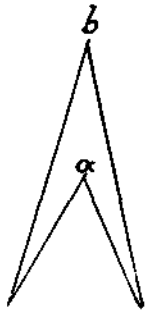

FIGURE 26. Showing a triangle with opening in base.

FIGURE 27. Showing closure of this space.

may be converted into this form. This figure consists of a triangle of two equal sides, with a small base in which there is a reëntrant or open angle. The space within the four sides represents the open defect, while the reëntrant angle represents sound tissue. A defect in such form can easily be closed by adductive sliding. The point *a* can be pushed still further inwards, and included in sutures which approximate the long sides. Such a figure can readily be closed; the sutural line is shown in Figure 27. The solid structure in the base being carried upwards will tend to support the structures above. This plan can be used to correct ectropic eversion of the lip or eyelid. And in case the defect is so constituted that structure can be preserved as a reëntrant angle in a figure which is otherwise circular, elliptical, oval or rectangular, such entering angular or ovular material will facilitate closure, and lessen sutural tension at one point.

In the first method of closure the displacement is done without any detachment of the skin, which is moved from the underlying structures to which it is adherent; and but little sliding can be done without subjecting the displaced integument to strain or tension. The small vessels which maintain the nutrition of the skin and which enter it from underneath and from the contiguous derm, are stretched, and the amount of blood which passes through these vessels is greatly diminished, the result being that the shifted skin is defectively nourished, and, consequently, can easily die. The physical law obtains here that when a tube is doubled in its length, there will flow through it but half the amount of fluid which passed through it when it was of half the length; and if the tube be reduced to one-half of its previous diameter, then the quantity of fluid which will flow through it

will be sixteen times less than the quantity which passed before any change was made in its calibre. It is evident that adductive approximation, as has been described above, both elongates the vessels of the displaced skin, and also diminishes the calibre of the vessels; and the result is a diminished supply of blood, which can easily reach a limit that can destroy the vitality of the skin. And if the skin itself does not die, the degree of tension to which the skin is subjected leads to its being cut by the sutures, and thus the healing is delayed and scarring follows. And what is more to be feared, when the sutures cut, they fail of their intended purpose, viz., to immobilize the shifted surface and to counteract retraction; for through the sutural cutting, the adducted parts are permitted to retract, and this may endanger the work done, since the approximated parts may fall asunder. Such result, which often attends the work of the inexperienced, soon forcibly teaches him that in closure by direct or immediate adduction, severe straining and stretching must be avoided.

In the second method, to facilitate the mobility of the part which is to be shifted, and thus by diminishing tension to favor the vitality of the transposed structure, there must be done some preliminary preparation. When the defect has been given an oval, elliptical, circular, triangular, quadrangular or rhomboidal figure, to facilitate adductive approximation of the marginal structure, the latter may be dissected from the subjacent parts. In this dissection the subcutaneous fascia must be uplifted with the skin; that is, the fascia and derm must be raised as one layer. Sometimes the fascia is so thin that it is nearly indistinguishable, and the derm seems to rest on the adipose layer without any tissue being interposed. The derm, in such a case, though it may be used, yet it is ill suited for plastic purpose; and when it is used, a thin layer of adipose tissue should be detached along with the derm. This subcutaneous detachment must not be too extensive, lest in the hollow space created, blood may accumulate, and delay or prevent healing. If the subscision should extend farther than an inch, this trouble might arise.

Incisions subsidiary to shifting may be made through the skin; and such incision may consist of cuts which are a continuation of one or more sides of the figure into which the defect has been converted; or it may consist of an incision made at a short distance from the breach to be closed; thus stretching is lessened, and sliding facilitated.

These preparatory cuts, as adjuvants in closure, are mentioned

by Celsus in the method which he describes for closure of a quadrangular defect. He advised to continue laterally the upper and lower lines of the four-sided defect; and if this does not suffice for closure, then a crescentic cut, directed towards the wound, is to be cut superficially through the skin. The Celsian plan of closure has already been explained. The lateral or outside accessory incision is not to be closed, but is to be allowed to heal by granulation; and this scar often left by the lateral cut warns the surgeon that he should be chary of its use; it is better to effect the sliding by subjacent detachment, of which the work will remain unseen. The open lateral cut is best done in situations in which the resulting scar will remain invisible. Cases in which it may be employed are those in which large breaches have been made in the surface, which it is desirable to close by a tegumentary covering. And as the site of such operation is often hidden by the subject's clothing, a scar from lateral subsidiary incision becomes unimportant.

The second method consists, then, of closure by the aid of accessory subscision, continuation of existing cuts and lateral incision; and it may be used for the effacement of any breach which has been converted into one of the forms before mentioned. A few examples of its application will here follow. A triangular defect may be treated as follows:—

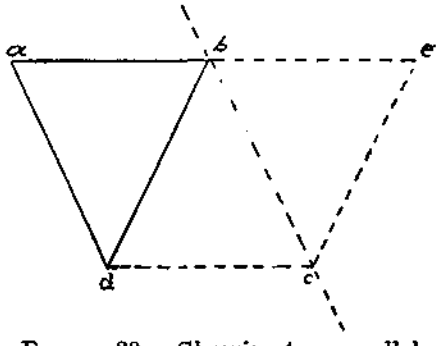

FIGURE 28. Showing two parallelograms resting on the same base *c d*.

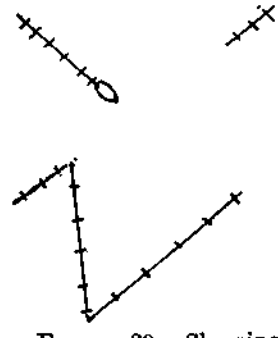

FIGURE 29. Showing result after closing defect represented in Fig. 28.

If in Figure 28 *a b d* is the defect to be closed, let the side *a b* be continued to *e*, and then an incision be carried from *d* to *c*, and the quadrangular flap *b d e c* be uplifted. The diagram if studied will be composed of the parallelograms *a b c d* and *b e c d*, which are geometrically equal to each other, since they rest on the same base, *d c*, and lie between the same parallel lines; hence the right figure can be slidden and superposed on the left one, which it will

fill; the sutural closure will then be that in which there only remains a small open space, and this may perhaps be effaced, if the sides *b e* and *e c* be subscised.

The material for closure can be taken on either side of the defect; and thus the sutural scars and the small opening left may be placed where they will be but slightly conspicuous.

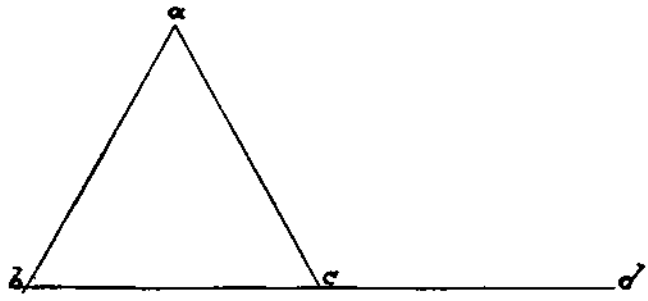

FIGURE 30. Illustrating one method of closing a triangular defect.

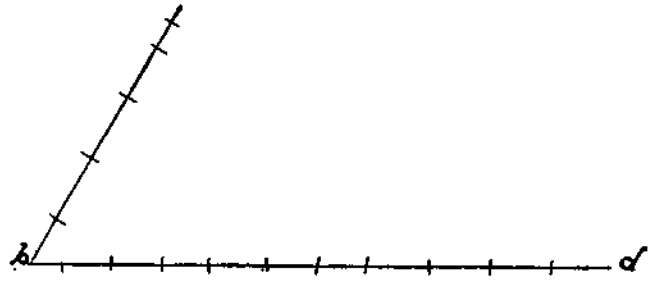

FIGURE 31. Showing the sutural line that remains after closure by unilateral sliding.

Or if the triangle stands as in Figure 30, closure may be done by subscising the derm *a c d*, and having drawn this to the left, suture it to the side *a b*. The remaining sutural line will be as seen in Figure 31. A defect in this method is that the surface beneath the line *b d* will, for a time, be folded or uneven. This unevenness will, in time, become less; yet, for a long period, the tense

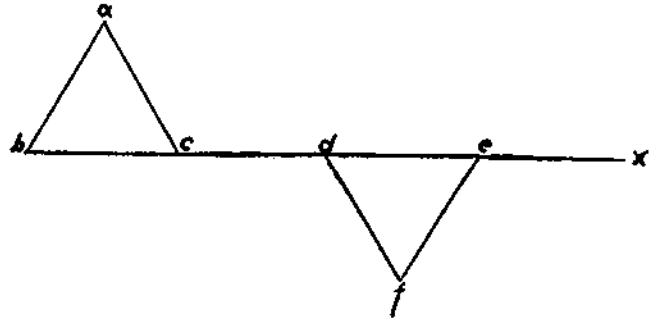

FIGURE 32. Showing Burow's plan of closure.

condition of the structures above the line *b d* will contrast with the loose state of the parts below the line. To give more uniformity to the surface, the ingenious conceit of Burow may be utilized; this is done as follows: On the extended line *b c x* let

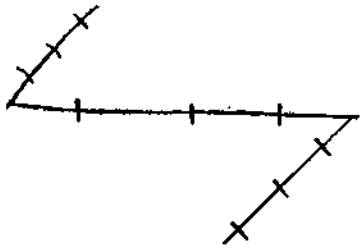

FIGURE 33. Showing sutural lines after closure by Burow's plan.

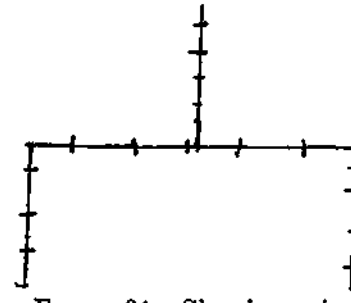

FIGURE 34. Showing sutural lines remaining after exsection of two triangles done according to Burow's plan.

there be excised from the opposite side the triangle *d e f;* when closure is made, the lines of suture will have the form here pre-

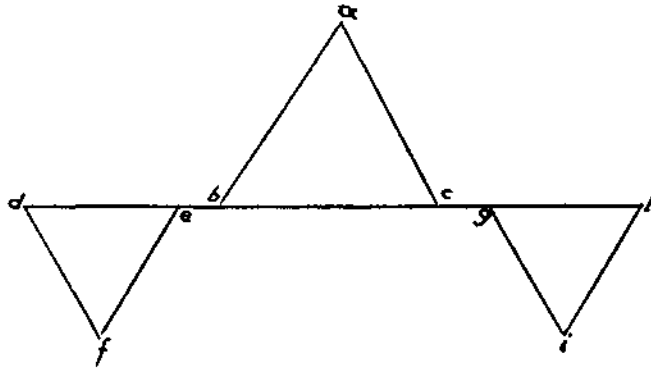

FIGURE 35. In which two triangles are exsected to aid in closure of *a b c*, as done by Burow. Closure is seen in Figure 34.

sented. Or the compensating subsidiary excision may be done, as presented in Figure 35, in which the base line is extended towards the left and the right; and these excisions need not be so large as the one which it is sought to close. The sutural union will present the appearance shown in Figure 34. A serious fault in Burow's mode of closure is that it involves some sacrifice of tegumentary structure; it also multiplies scar-lines. Tegumentary sacrifice cannot be made without detriment, derm once lost is irrevocably gone; nature has no resource by which it can be reproduced; and though plastic surgical art may close a breach in the surface by the procedure which we are considering.

yet if, through destruction or sacrifice of structure, much strain be left in the closed surface, such strain and tension will remain as a lasting annoyance to the patient. It is a fact, that should not be forgotten, that in the work of inclosure of the human organism, the hand of nature furnished no surplus material in the inclusive dermal and mucous teguments. In this furnishing, nature gives nothing for waste.

Instead of closing the triangle by rectilineal extension of one of its sides, the side may be prolonged as a curved line, towards the right or left, and then the line of closure would be along the line *a b* and *b c d*, as will appear if Figure 36 be studied.

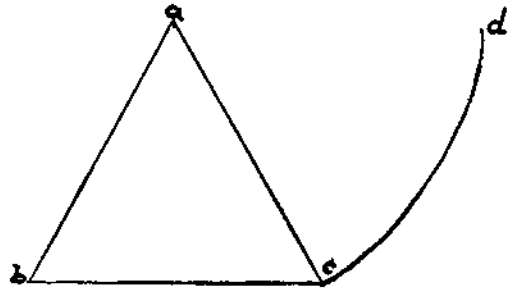

FIGURE 36. Showing the plan of closing a triangular defect by curvilinear extension of base *b c* to *d*.

The work of closing the triangle by means of subsidiary incision, subscision and excision may be employed to close the lozenge; for as this figure may be conceived as consisting of two triangles resting on one base, as shown in Figure 37, the

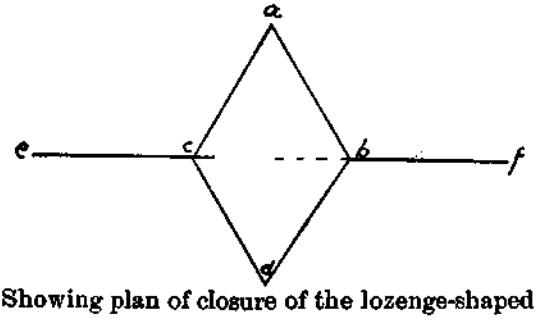

FIGURE 37. Showing plan of closure of the lozenge-shaped defect.

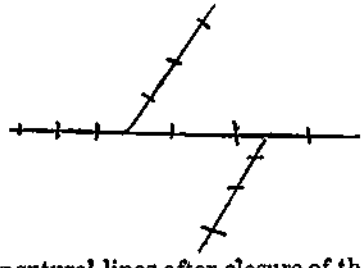

FIGURE 38. Showing sutural lines after closure of the lozenge-shaped defect.

repair of such a defect can be done by closing each of their triangles separately. The work is done by extending a central bisecting line towards the right and the left; then by subscision the right side is loosened, and the same is done on the left side; the right flap is now to be drawn towards the left, and the left one towards the right. Thus closure will be effected, since each triangle has the same relation to its fellow as does the triangle of Burow, which is excised to avoid an uneven surface.

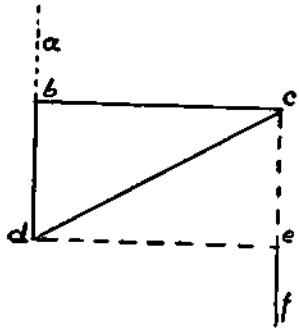

FIGURE 39. Showing the plan of closing a parallelogram by converting it into two triangles.

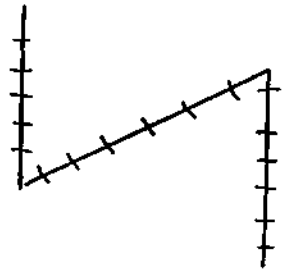

FIGURE 40. Exhibiting line of suture after closure of a quadrangular defect that has been divided into two triangles.

A quadrangular defect can be closed by employing the principles here given; viz., by the closure of the triangles into which a rectangle or parallelogram can be divided. For example, let the figure *b c e d* be converted into two triangles as shown in Figure 39. Next extend the side *d b* to *a*, and the side *c e* to *f*, and then dissect up the flaps *a b c* and *d e f*. These flaps can be drawn towards each other, when the sutural line will be as shown in Figure 40. The quadrangular defect may be closed in another

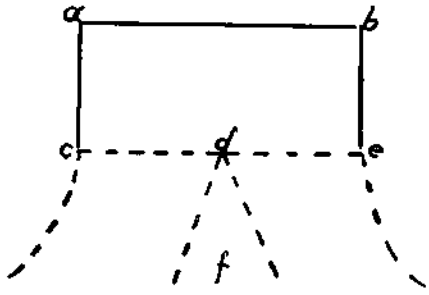

FIGURE 41. Showing a plan of closing a quadrangular defect.

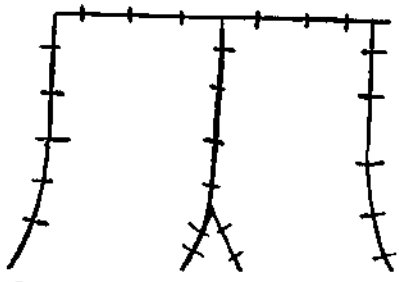

FIGURE 42. Exhibiting the sutural lines remaining after closure of the quadrangular defect, as indicated in Figure 41.

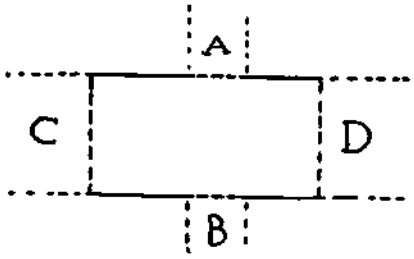

FIGURE 43. Presenting another plan of closing a quadrangular defect.

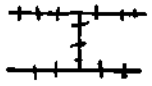

FIGURE 44. Showing sutural line which remains after closure of a quadrangular space, as indicated in Figure 43.

way, as exhibited in Figure 41, in which the replacing material is incised in the form of angular flaps; in this way the open parallelogram *a b c e* can be closed by sliding upwards the right and left flaps; meanwhile the adherent angular portion *d f* will aid in supporting and retaining in site the uplifted lateral flaps. This defect might also have been closed by incisions made as shown in Figure 43, in which median flaps are uplifted at A and B, and the lateral ones, C and D, are dissected up: thus a defect of moderate dimensions may be closed; and the sutural lines will appear as shown in Figure 44. The mechanical advantages

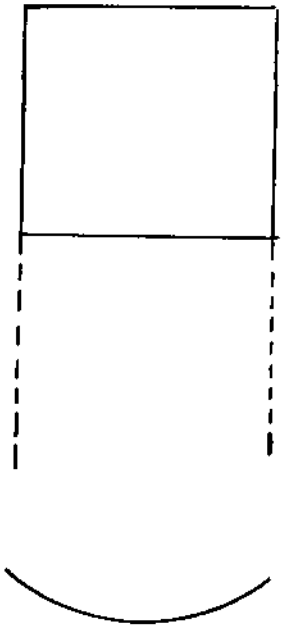

FIGURE 45. Exhibiting closure of a rectangular defect by sliding an adjacent flap into it. An adjuvant crescentic incision is shown beneath.

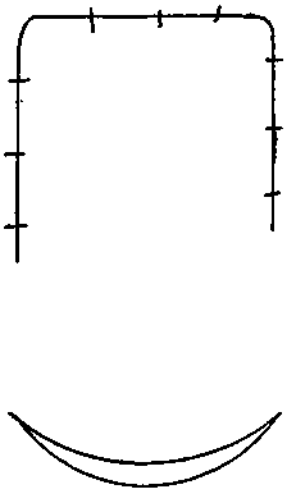

FIGURE 46. In which is shown lateral closure of a rectangle after replacement by a lateral flap.

gained by this species of closure are that the median and lateral flaps when fixed in position, mutually hold each other in place. Another plan of closing a rectangular defect is shown in Figure 45, in which a lateral flap being uplifted and thrust into the space and sutured there, the appearance will be as shown in Figure 46. If in the construction of the flap one makes a semicircular incision beyond its pedicle, as shown in the figure, the work of closure will be facilitated.

In the third method, in which a pedicled flap is traced out on the contiguous surface, and then incised, uplifted, and revolved into its destined site, closure of a shapeless or irregular defect may be done, provided the closing material has corresponding outlines; still, even here, the operator will solve the problem of closure more readily if he can convert his defect into a circular, oval, triangular, or quadrilateral figure. In the preparation of the repairing flap, since the pedicle is to be subjected to torsion, provision against tension should be made by having the flap long enough; for traction and torsion, and the tension consequent on these, can arrest the vitality of the shifted structure. Yet this is readily avoided if the flap have ample proportions.

As has been mentioned in the third method of the plastic procedure, the replacing flap must be turned through the entirety or the whole of a semicircle; and the surgeon should endeavor to render this arc as short as possible. The pedicle must be broad enough to insure a sufficient supply of blood to the flap; and to guarantee this, the foot-stalk, when median frontal material is used, should have a breadth of not less than two-thirds of an inch. The component tissue of the flap must be sound and not deteriorated by cicatrix or other defect.

A few examples of the employment of this mode will now be presented with diagrammatic illustration.

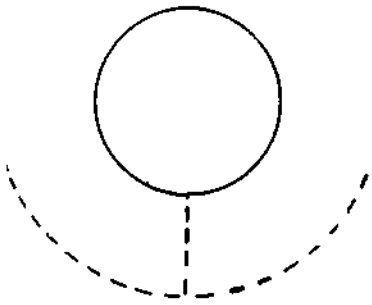

FIGURE 47. Showing a method of closing a circular defect.

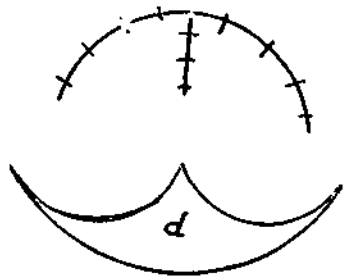

FIGURE 48. Exhibiting the appearance after closure of a circular defect by the use of subjacent flaps.

One plan of closing a circular defect by the use and circumduction of adjacent flaps is presented in Figure 47, and the appearance after closure is seen in Figure 48. The unclosed space *d* might be repaired by Thiersch's method of epidermal grafts.

The circular defect can be closed by another method, as shown in Figure 49. Let the flaps *a b* and *c d* be incised, loosened and

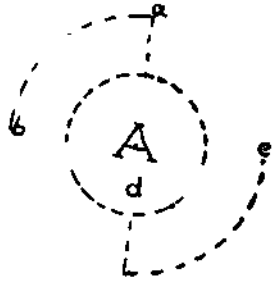

FIGURE 49. Showing closure of the circular defect.

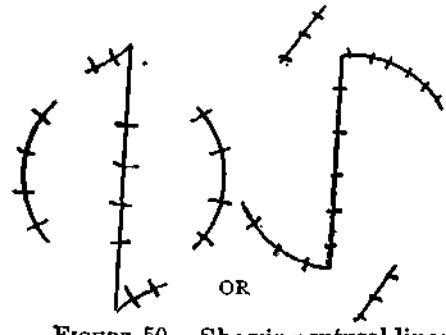

FIGURE 50. Showing sutural lines after closure of the circle.

turned, one upwards and one downwards, so as to occupy the circle; the line of suture is shown in Figure 50, and if the work be examined, it will be seen that the sutured flaps mutually hold and maintain each other in place. After completion there will remain an uncovered space at what a geographer would designate the upper and lower poles of the circle.

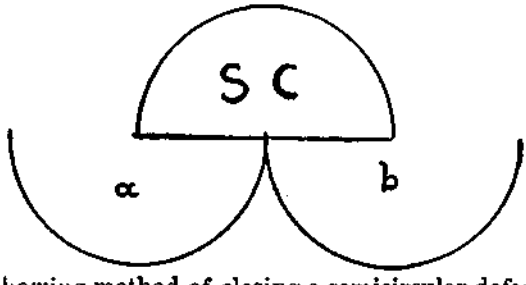

FIGURE 51. Showing method of closing a semicircular defect.

A semicircular space may be closed by uplifting the flaps *a* and *b*, in Figure 51, and turning them into and attaching them to the margin of the defect S C. The circle might have its component semicircles closed in a similar way. The oval and elliptical defect can be closed by the modes just presented for the closure of the circle and semicircle.

The third method of plastic repair, in which the work is done

by the circumduction of a pedicled flap of proper form to close the defect, is applicable to the repair of the triangular and quadrangular space; for example, the triangle A, seen in Figure 52,

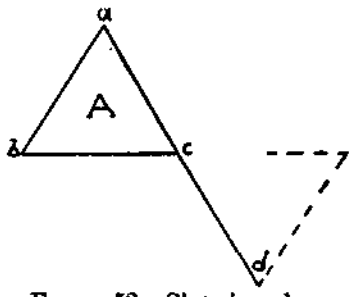

FIGURE 52. Showing closure of triangle A by shifted flap.

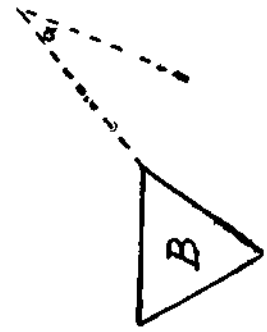

FIGURE 53. Showing closure of triangle B.

may be closed by a plan in which the flap *c d* is turned into the space *a b c*. Or the flap *a* may be shifted into the space *B*, shown in Figure 53; or this may be done by flaps taken from the right and left sides, as in the triangle *C*, Figure 54, which may be closed by the flaps *a* and *b*.

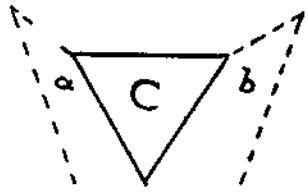

FIGURE 54. Showing closure of triangle *C*.

The quadrangle *A* may be closed by the quadrangular flap *c b d*, which, being prepared, is to be revolved into the space *A*, as seen in Figure 55. In thus closing, the angular portion of remaining tissue represented by *c* gives a support to the shifted flap *b*, and the surface will be closed except a small space lying at the right.

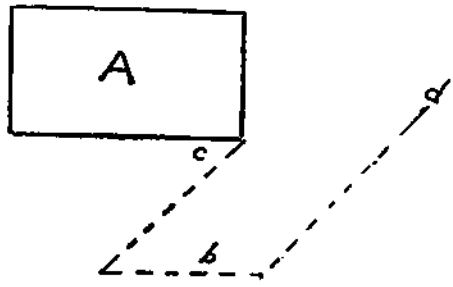

FIGURE 55. Showing a plan of closing a quadrangle *A* by the shifted flap *c b d*.

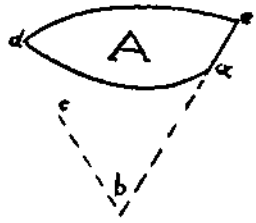

FIGURE 56. Showing closure of an oval space.

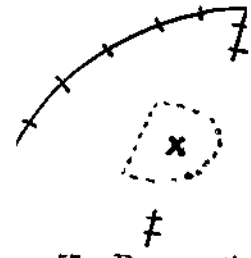

FIGURE 57. Representing the sutural line after closure of an oval defect.

An oval defect, as shown in Figure 56, may be covered by a flap, which, being dissected up, is to be uplifted until the side *d a* is brought in contact with the side *d e*, when the sutural closure will be as shown in Figure 57, with a space remaining open at *x*. A semicircular space, shown in Figure *B*, may be closed by

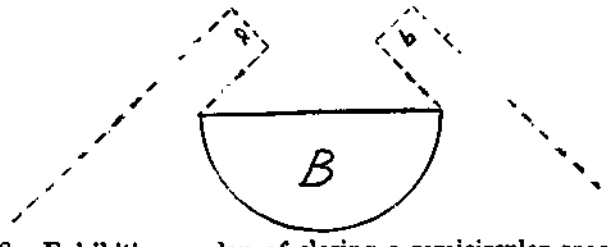

FIGURE 58. Exhibiting a plan of closing a semicircular space *B* by lateral flaps.

incising two flaps, *a* and *b*, at the sides, and turning these into the breach, when the closure will be as shown in Figure 59.

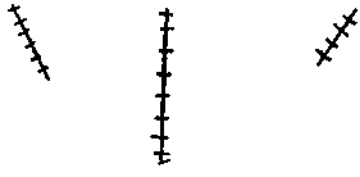

FIGURE 59. Showing sutural line after closure of a semicircular defect.

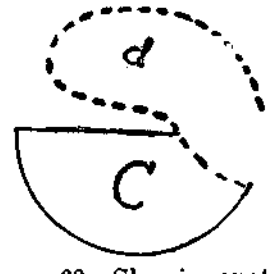

FIGURE 60. Showing another plan of closing a semicircular defect by means of a single flap.

The semicircular space *C*, shown in Figure 60, can be closed by a flap of similar shape, *d*, taken from the overlying surface. Instead of one large replacing flap, two smaller ones might be formed on each side above, as shown in Figure 61.

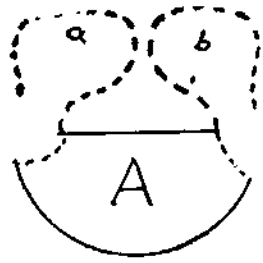

FIGURE 61. Illustrating closure of a semicircular space *A* by means of two flaps, *a* and *b*.

Having described the three methods of plastic repair by which a breach of surface may be closed, and, in a measure, concealed, if they be compared with each other, it will be found that the first is applicable where the surface to be closed is small in extent; the second is suited to cases in which the breach is larger, and the third method may be resorted to in cases in which the open breach is irregular or regular in outline, and the replacing flap can be selected and taken from the surface near to, but not continuous with, the border of the breach. The second and third methods add wounds to the one which it is sought to close. Yet the additional wound, in the case of a flap that is revolved, can, sometimes, be made where it will remain concealed or but slightly conspicuous. And as the flap is uplifted at a slight distance from the open defect, the secondary wound can often be closed; and any tension caused by this adjacent closure will not influence the wound into which the flap is turned. The transplanted flap should consist of sound derm which can readily be shifted. Muscular tissue is not adapted to such work, for it changes to fibrous tissue, which, contracting or shriveling, deforms. A flap clad with a thick mass of fatty tissue is unsuited as material for repair; but in case none other is available, it may be used; and then the entire thickness of the fatty couch, with the subjacent fascia, should be used. If the derm be separated from such adipose couch, it is apt to die; also, if a thin structure of adeps be retained with the derm, it ill performs the function of material for replacement, as the writer has often verified. The minute lobules of adeps constituting the fatty couch are so disturbed in their vitality when they are divided or split, that they contract but imperfect adhesions with other tissues. Dissolving adipose material is a medium more suited for the separation than for the union of wounded parts. The flap which has the best qualities for plastic replacement is one of derm with a thin stratum of fascia; and this will cohere to any structural compound of the

body; for example, it will unite with periosteum, denuded bone, or denuded cartilage, tendon, muscle, nerve and adipose structure. Union to adipose structure is promoted, if the latter has a fascial covering.

The transposed flap is influenced by the structure which supports it; if this be firm and immovable, for example, a flat bone, the flap will contract adhesions to it, and undergo but slight subsequent change; yet planted on an unstable muscle, the flap will undergo displacement and deformity.

The work of final closure must be preceded by complete staunching of all bleeding, especially when the work is done by the flap method. No vessel must be left bleeding beneath the newly planted tissue. Bleeding from the surface may be arrested by irrigating with ice water; or, should a vessel of some calibre continue to bleed, this may be closed by torsion. Ligatures should not be used. Closure should be done by knotted suture with fine aseptic silken thread. Fine wire may likewise be used; this may be made of copper which has been gilded or plated; and this may be either tied or twisted; and in whatever way closure is effected, care must be taken that the cord or wire is not too tightly drawn, for too tight closure pinches the patient and often kills the included structure.

In case of lateral sliding, in which the parts are tightly stretched in the approximative closure, the strain should be relieved by tension-relieving sutures. Such sutures should be of wire, and so introduced as to include from a half inch to one inch of the structures which are to be united. These strain-opposing sutures need be but few in number; two or three will suffice, and these should remain in place for not less than one week; and even a longer time is sometimes necessary; for if these supporting sutures be removed too early, the intermediate united edges may tear asunder.

Besides the strain-opposing suture and that of simple closure, as additional aids, one may resort, sometimes, to those species of sutures familiarly called the mattrass, quill and pin, or twisted suture. The mattrass suture can be used to bind down and fix in position a section of a flap which tends to rise from the subjacent surface. This suture, which should be of silk, is inserted by means of a needle which is strongly curved; the thread includes a small portion of the interior of the flap and the supporting substratum. It is well to use this device of fixation wherever the implanted flap is broad. The quill or brace suture

is advantageously used where the defect is an oblong breach, having the long sides somewhat parallel with each other. The brace or flattened rod of suitable length is to be passed through the looped ends of doubled sutures on one side, and a similar one laid on the opposite side of the defect is to be introduced between the other ends of the sutures, and the free ends are then to be drawn upon so as to close the breach; and when this is effected, the free ends are to be tightly tied on the second brace.

In this way, in a piece of plastic work done on the cheek, the writer has succeeded in closing a very wide breach of surface. Such suture must enter and emerge at a distance of not less than a half inch from the borders of the defect. And should the sutures cut the included tissue, the threads may again be tied more tightly. The quill or brace suture is but a form of a tension-relieving stitch. The pin or twisted suture may be used to sustain and immobilize approximated edges, or a shifted flap. An objection to it is that, in the later act of removing it, the healing parts may be disturbed or, possibly, torn asunder. The application of these more unusual forms of suture should be as limited as possible; they are complicated and demand experience for their successful use. In nearly all cases, the simple knotted suture will suffice. *Surgical work approaches nearest the line of perfection when its component technical elements are of the greatest simplicity.*

When plastic operations are done in the vicinity of natural openings of the body, of which the edges and lining are lined with mucous or semi-mucous membrane, it is necessary to restore this mucous investment in order to maintain the calibre of the opening and to prevent adherence of denuded surfaces. Such natural openings are the lips and oral cavities, the eyelids, the nostrils, the lining of the auditory meatus, the urinary meatus, vagina and its outlet, and the anal opening of the rectum. To counteract stricture, atresia and synechia, the denuded surface should have an investment of mucous membrane or derm. If the mucous membrane be used for this purpose, it must not be too thin, but the sub-mucous tissue should be uplifted with the membrane so as to insure the vitality of the transported structure. When the mucous membrane is closely adherent to the parts which it lines, it cannot be used unless a stratum of subjacent structure be uplifted with it; but in the cartilaginous portion of the nose, the close adhesion of both derm and mucous membrane to the cartilage renders it difficult or impossible to utilize them.

The plastic work being completed, an important duty yet remains in which both patient and surgeon have a share; this consists in protective care of the wounded parts; rest, most careful rest, should be given to the part, for the hand of nature in adjusting the delicate acts and processes of repair, tolerates no jostling or disturbing movement. Another adjuvant, having great bearing on this work, is that the patient should be in good health when the work is done; for example, if in the face or mouth, no plastic operation should be performed when the patient has a cough; from this cause failure has attended work done by the writer. The supervention of a diphtheritic attack rendered plastic work null and void; and it would be difficult to provide against such misadventure.

Where the work has consisted of the simple juxtaposition of opposite margins, after sutural closure, the remaining seam should be dressed by coating it with compound tincture of benzoin; and over this should be placed a layer of lint moistened with diluted alcohol. And, as further protection of the part, this lint should be retained in place by broad strips of rubber adhesive plaster. As soon as the wound has united, the sutures must be removed; if the suture remain too long in place, it will leave a scar, viz., a white point, which will remain permanent; hence where the suture merely maintains connection between opposed borders, and the parts are not stretched, the suture may be safely removed at the end of two days. An earlier removal, advised by some surgeons, is not in accord with the writer's experience. Should it be apparent that the stitches are irritating the structures, and that suppuration impends, then there should be no delay in removal. The tendency of the suture to irritate will be lessened if the thread or wire used be duly proportioned to the needle which carries it; the thread or wire must not be too large; for if this be so, and the suture exceeds the orifice through which it passes, then it will press on and destroy the tissue adjacent to it. And, again, the thread or wire must not be too small for the orifice, the rule being that the carrying needle should be slightly larger than the thread which it bears.

As a general rule for this work, a few sutures may be removed near the end of the second day; on the third day, others can be extracted, and, on the fourth, all may be removed except those which were introduced to oppose and relieve strain. The cutting and extraction of the sutures must be done with care; the cutting must be done on one side, and as close to the surface as possible,

after the suture has been slightly uplifted, so that the end to be pulled through shall have no dried excreta adherent to it, which, catching in the sutural canal, would cause tugging on the parts.

Should the united edges be torn slightly apart in the removal of the sutures, as sometimes happens, then the blood which exudes should be allowed to dry, and strips of Emplastrum Ichthyocollæ should be placed across the breach, so as to keep the parts at rest, and insure their reunion.

After healing has occurred, there often remain some minor defects in the parts operated on which require attention. In turning the pedicled flap to its destined site, the pedicle is often left in an irregular, twisted shape, which disfigures the surface. After healing has advanced so far that the vitality of the flap is guaranteed, even though the pedicle were severed, then any irregular eminence or contorted edge can be removed, and the surface rendered even. In this leveling work, the outer face of the derm should be saved if possible and employed to cover any wound which may be made. Again, in the union of margins by sliding, if one side exceed the other in length, there will remain a fold or two on the larger side. Such folds in time will gradually subside; they may also be lessened or prevented by one or more cuneiform excisions from the larger side. Such excised gap is to be closed by suture. Care must be used not to excise too much. In fact, though such excision of surplus material is generally practised, it is probable that, if it were not done, in time the unevenness would vanish through a process of involution, in which the excess would become merged in the common surface, and aid in relaxing the tension. In studies on the best means of disposing of the surplus integument, which remains after the removal of lipomata or other benign neoplasm, Sir William Fergusson strongly urged to save the exuberant derm which remained after the removal, on the ground that it will afterwards become gradually incorporated in the surrounding integument. In the history of plastic surgery one fact has repeatedly been verified, that there is an atrophic tendency in the structures which have been operated on; in time they invariably become lessened in volume; this has repeatedly been observed in the new-formed nose of inordinate proportions. In all such cases the new-formed channels which are opened for the vascular supply of the part are usually inadequate for the continuance of normal nutrition. Hence, in nearly all cases, the rule of guidance should be that the retrenchment of seemingly surplus

structures, instead of being done by the scalpel, should be intrusted to the cautious care of nature, whose unostentatious effort, if fair justice were done, would often be crowned with the adornment of laurels which are awarded to the surgeon's work.

As concluding lines of this chapter on plastic surgery, it should be stated that, though much is essayed, and much is done in this attractive field of art, yet the modest confession is due that when a calm survey is made of the best results which can be obtained, and the latter be compared with the unmarred human form, the best plastic procedure can seldom furnish more than a tolerable counterfeit of the excellent original.

Thiersch's Method of Cutaneous Transplantation.—Besides the modes of repairing breaches in dermal continuity which have been described, the work may be done by a procedure which is designated *grafting*, or *transplantation*. Experience acquired in the physiological and vivisective laboratory demonstrated the possibility of removing small portions of the animal body and transplanting the detached tissue elsewhere in the body.

The utilization of the animal graft was early heralded by Paul Bert, who announced that one day "those who are occupied with morbid physiology would derive the most useful results from it." Though grafting was essayed with many tissues of the body, it was chiefly in the repair of defects of the dermal structures that the first experiments were made.

To J. L. Reverdin, in 1869 and 1870, is due the honor of using small epidermal grafts for the closure of a breach, especially that due to an ulcer in the surface of the body. In the employment of his procedure, Reverdin had numerous collaborators among the surgeons of France, Germany and England; so that but a brief time elapsed before many reports were published highly favorable to the process, popularly known as *skin-grafting*.

In the method of Reverdin, the operator seizes with fine-toothed forceps the skin from which the graft is to be taken, uplifts the surface, and with a pair of small curved scissors he excises the uplifted point; the latter is then placed on the part to be repaired, and pressed somewhat inwards, and allowed to remain in its new site. From the islet of engrafted tissue lines of new material shoot out horizontally, and seem to be attracted by similar lines from neighboring grafts, the result being a great increase in the activity of cicatricial closure of the raw surface.

The method of Reverdin underwent modifications in the hands of other surgeons; in place of the thin cuticular section,

much thicker ones were used for transplantation, until finally those of the entire thickness of the derm were employed.

But by far the most important modification was that introduced by Professor Thiersch, of Leipsig, who discovered that epidermal grafts of almost indefinite length may be made to grow on a raw surface. This discovery was published in 1887, though Thiersch, it is said, had previously been studying the matter for some years; and his discovery was made during researches undertaken to solve the problem of the microscopic phenomena which are present in the healing of wounds, and especially the disposition of the vessels in an ulcerated surface.

In a microscopic examination of the ground of a chronic ulcer, Thiersch found that the capillaries in the upper and deeper portions have a different arrangement, viz., those in the upper stratum stand vertical, while the deeper capillaries are disposed horizontally. The tissue supplied with vertical capillaries has nearly lost the quality of further development; and before such a surface is fitted for cicatricial closure, Thiersch found that it required a preliminary preparation.

The Thiersch procedure, though first only used for the closure of ulcerated surfaces, has now been extended to fresh wounds involving any part of the surface of the body; and it matters but little whether the wound be dermal, muscular, adipose or osseous, the process has proved successful in all these sites.

Besides the repair of fresh wounds and ulcers recent or chronic, this method has been used and found a valuable aid in the treatment of burns, contracted scars, syndactylia and all abnormally coherent surfaces.

Though Thiersch was one of the first Germans who embraced the antiseptic plan of treating wounds, yet in the work of skin-grafting he did not apply antiseptic agents to either the wound to be closed or to the material of closure. Others, however, in the work do use antiseptics. Jungengel and Hüpscher, who have written on the procedure, have applied to the wound, ulcer, grafts and instruments, a two per cent solution of carbolic acid, or a $\frac{1}{1000}$ solution of sublimate. Thiersch used only a solution of chloride of sodium, known as the physiological solution, which contains six grains of the salt in one thousand grains of water.

The material for grafting is commonly taken from the subject on whom the transplantation is to be done, yet it has been derived from another person, also from the integument of amputated limbs. For several reasons it is better to be taken from the per-

son on whom it is to be used; and the sites from which it is most easily excised are the front surface of the thigh and the extensor side of the upper arm.

The surface furnishing the sections for grafting should be carefully cleansed, and this is done by first washing it with soap and water, then with a two per cent of carbolized water, and finishing with a free use of the solution of chloride of sodium above mentioned.

The surface to be closed requires some preliminary treatment. In case of a breach the site of ulceration, the superficial structure should be removed; and Thiersch and others do this with a sharp curette, but the author prefers to do this work by incision with a long-bladed scalpel. The scalpel prepares a much smoother ground than does the curette, however sharp this instrument may be. If the ulcer have borders of irregular outline, these should be converted by incision into regular figure. Closure is easy in a surface of oval form.

Besides the ulcer, fresh wounds, in which the skin has been lost, are suited for closure by Thiersch's method. Such breach must have a smooth ground.

If the surface to be closed is bleeding, care must be taken that the blood has been staunched, and that all clots have been removed; and for this purpose irrigation with the solution of salt must be carefully done.

The thickness of the grafts is the subject of difference among operators. Thiersch advises that the graft include the epiderm, papillary layer and a small section of the corium. Graser, Everbusch and Hübscher recommend the use of thinner sections, viz., such as contain the cuticle and the summits of the papillæ. The thickness of the graft will vary according as it is broad or narrow; when broad, the central portion of the graft must be thick, and contain at least the entire papillary layer of the derm.

The length of the sections for grafting must necessarily vary according to the surface to be closed. Elongated breaches have been closed by sections which were over a foot long. The longer and broader the grafts are, the more expeditiously the work can be completed.

For excising the grafts, a razor, or similar instrument, may be used; the one most appropriate is a razor-like blade, of which one side is plane and the other incurved. The microscopic student of former years, who used a razor and not a microtome to cut his sections, has acquired that use of the hand which makes

him expert in excising the skin graft. The instrument, grasped firmly, is to be brought in contact with the surface, and, being held at a very acute angle to the latter, the work of cutting is done by a rapid sawing movement.

The surface whence the graft is taken must be rendered tense; and if this be the upper arm or thigh, tension of the skin is to be made by an assistant grasping laterally the limb with both hands and stretching the intervening space; and the operator can aid also, if he slides the skin upwards or downwards from the cutting instrument.

The excised grafts may be carried immediately to their destined site; but if it is not convenient to complete the work at once, the sections may be preserved for some hours in the saline solution. If they are used immediately, they may be transferred from the cutting blade by letting a small current of the saline fluid trickle on the section, and float it from the end of the instrument to the surface to be closed. This transference can be aided by using a probe. The graft tends to fold towards its incised side, and, in placing it in position, this curling must be corrected with the probe and index finger, so that the raw face of the graft will lie directly on the surface that is to be closed.

Where more than one graft is to be used, the sections are to be so placed that the margin of the second graft will slightly lie on the edge of the first one,—the series lying like tiles on a roof. By thus proceeding, no interstices will remain, and the surplus margins will soon detach themselves.

The excision of the grafts may be done under anæsthesia, provided the breach to be closed has arisen from operative work in which the patient was anæsthetized. Yet it is sometimes done without anæsthesia, the patient then reporting that the sensation was similar to that of shaving with a dull razor.

The surface whence the grafts are cut soon heals under aseptic dressing; it remains discolored for a time, and in rare cases it becomes the site of a keloid growth.

After the grafts are in position, they often become uplifted by subjacent bleeding; and if this be considerable, the work will fail unless the blood be removed and the grafts be properly placed again. If the amount of blood beneath the grafts be slight, the grafts may become ecchymosed, yet still retain their vitality, and closure be accomplished.

As to the dressing of the transplanted surface, different modes exist. To protect the grafts and retain them in place, strips of

gutta percha tissue paper may be used. Such strips may also be employed to transfer the grafts from a solution in which they have been temporarily retained to the breach to be closed; and when the grafts are thus placed, the carrying tissue paper may be used as the protective covering; and as final dressing, dry or moist aseptic gauze may be placed over the closed wound.

If it becomes necessary to frequently change the dressing, gauze smeared with borated vaseline ($\frac{8}{100}$) is recommended for the purpose. Yet usually dry dressing is employed; and then the whole may consist of a layer of gutta percha paper on which dry sublimated, borated or iodoform gauze is placed; and to immobilize this an ordinary roller may be used. Some operators have simplified the dressing by merely sprinkling iodoform over the grafted surface; yet some retentive appliance is preferable, since the grafts are easily displaced from their site. Should such displacement occur from the patient's movements, the grafts should be restored to position again.

In one week the grafts contract close adhesion to the subjacent ground; and two weeks after the grafting the healing is complete. For two weeks after the healing a protective bandage should be retained about the part.

The surface which has been closed with skin-grafts tends to contract, and to rise: thus the site of the breach is lessened, and if it be superficial, it may rise to a level with the surrounding skin. In healing, the transplanted material becomes discolored or slightly pigmented, so that it differs in hue from the neighboring skin. The transplanted surface is less smooth than normal skin; and this unevenness is due to granulative elevations which appear under the grafts during the process of healing. Slight furrows are present along the lines of fusion of adjacent grafts.

The engrafted surface does not correspond in color to the adjacent skin; it is distinguished by an injected pigmentary appearance; and this is a serious objection to the Thiersch method in cases in which the cosmetic element must be taken into account. But the plastic methods before described are free from this objection, since the normal skin which is used for closure nearly or quite retains its natural tint. A point strongly in favor of the Thiersch procedure is that closure is very speedily obtained; the work is accomplished within two weeks. The other plastic procedures often require many weeks for complete recovery.

Therefore, in conclusion of this subject, it may be said that,

though the Thiersch method has seriously encroached on the older plastic procedures, yet the latter, though less often resorted to than formerly, must still continue to occupy a highly important place in operative surgery. And this is particularly true in operative work on the face; and especially in the repair of breaches made by excision around the eye, mouth and nose; for here the experienced plastician, by studied plan, can often cover or disguise unsightly lines left by the scalpel; or if this be denied, then such lines may sometimes be so shifted as to be invisible. By such work the plastician will win parental gratitude by relieving the face of childhood of unsightly scars; and surgical art will gratify age when it utilizes the latter's furrows for plastic disguises.

CHAPTER XII.

SURGICAL AFFECTIONS OF THE EYEBROWS AND EYELIDS.

Eyebrow.—The overhanging skeleton of the orbit above is embraced in what is designated the superciliary arch. The anterior inferior edge of this arch, named the supra-orbital margin, is formed by the union of the supra-orbital plate and the vertical portion of the os frontis: this margin ends so sharply that violence acting on the soft parts which rest on the edge, can cause a lesion closely resembling an incised wound; and to determine whether the wound which has arisen may have been caused by a cutting instrument, or by the osseous margin through forcible impact on it, has sometimes become a question difficult of decision. This margin near its middle presents a notch or foramen, through which passes the frontal nerve in its ascent towards the vertex of the head. The outer end of the supra-orbital ridge terminates in the external angular process, three-sided and prismoidal in form, of which the thin edge is directed inwards, and separates the orbit here from the temporal fossa. This prismoidal process by its outer broad and strong face becomes a protective bulwark of the eye; yet a missile or thin blade might readily pierce, from the temporal side, the deeper thin edge of the process.

The soft parts which lie on the superciliary arch have a resemblance to the hairy scalp; from without inwards lie the derm containing hair, the muscular structure, a sub-muscular layer of connective tissue, and the periosteum. To the dermal layer containing hairs the name eyebrow is given, the inner, middle and outer parts of which by the French writers are named the head, body and tail of the brow. The hair on the head or inner part of the brow lies pointing upwards; the remaining hairs point obliquely outwards. The glabella or hairless space between the brows may be so encroached on by the hair that the two brows are continuous across the space over the root of the nose. Or the brow hairs may be so sparse as to deform the countenance. The surgeon may utilize the brow hair to mask scars

which are made in the removal of small tumors seated under or near the superciliary derm. For this purpose, the brow should first be shaven, the growth removed through a horizontal cut, and the latter accurately closed by a temporary suture. Aseptic precautions must be used against suppuration, for if the latter occurs, hair roots will be destroyed, and, as result, both scar and absent hair will stigmatize and avenge careless procedure. The brow encroaching on the glabella renders the derm here unsuited for transplantation on the side of the nose.

Three muscles unite in the formation of the muscular layer, viz., the frontal slip of the occipito-frontal, the corrugator and the orbicular muscle. The commingled structure of these muscles is so closely connected with the skin that only by forced dissection can one separate the two: incision through the derm alone gapes so little as not to require suture; yet if the muscular coat be divided, sutural closure is necessary after shaving the hair. The corrugator muscles fold the intervening derm vertically; and incisions made here for any purpose, should lie in the infolded lines. Of the three muscles here lying the orbicularis is outside, the occipito-frontal intermediate, and the corrugator lies deepest.

Beneath the muscular structure lies a loose cellular structure which is continuous with the sub-aponeurotic layer of loose tissue in the scalp. This loose couch allows the superjacent structures to move freely over it. Here pus or blood may insinuate itself and travel.

Beneath the layer of loose tissue lies the periosteum, which is closely adherent to the frontal bone, and continues into the orbital cavity, lining the supra-orbital plate; and with it fuse the palpebral ligaments.

The soft structures of the brow have an ample supply of blood: externally, from the anterior temporal; at their middle portion the frontal artery reaches them through the supra-orbital foramen or notch; and internally, the supply is from the nasal branch of the internal carotid. In consequence of its abundant supply of blood the structure of the brow bleeds freely when it is cut; the arrest of the hæmorrhage is best done by means of sutures or circumscriptive ligature; the latter is best adapted for the control of hæmorrhage from the anterior temporal artery.

The vascularity of the brow favors swelling in case of contusion or subcutaneous laceration. A clot thus forming may remain, and, becoming organized, it can disfigure the part, since, besides the induration which may remain, the hair roots of the brow

may be destroyed and a naked, swollen point remain; and hence, though but an unimportant wound, such contusion should be carefully treated by cold and compressive bandage.

The region of the eyebrow is seldom the site of origin of a malignant growth; and though epithelioma may appear there, it is rather as a secondary development than as a primary growth. Cancer arising on the bulb of the eye or on the lids, in its progressive devastation, may invade and destroy the superjacent brow. The treatment in such a case should be excision or cauterization, and to be effective should be thorough and unsparing.

Of the forms of benign growths which appear here, the most common are the atheromatous or sebaceous cyst, and the dermoid cyst. The dermoid cyst is often seen beneath the outer end of the brow, resting on the external angular process. Its frequent appearance here is accounted for by the circumstance that in this part of the head there exists in embryotic development a branchial cleft, or gap between the primordial plates of the temperofrontal region. Through some inexplicable contingency, a point of cutis becomes caught in this gap, and becomes covered beneath the periosteum. The imprisoned dermal fragment contains the elements of hair, sebaceous glands and other cuticular components. These elements continue their development, and thence arises the content of the tumor, consisting of hair, sebaceous material and epidermal scales, the quantity of material and volume of the cyst being probably proportional to the primary fragment of included cutis.

This dermoid growth is soft and lies in a depression of the bone, beneath the periosteum. Its situation beneath the periosteum renders the cyst nearly immovable. The cyst wall is dense and strong. It is important to distinguish this growth from the sebaceous cyst; the following characteristics distinguish the dermoid cyst: it lies deep, cannot be moved laterally, and is depressible. On the contrary, the sebaceous cyst lies less deep, can be caused to slide laterally beneath the skin, and is of firmer consistence than the dermoid growth. In a few cases which the writer has observed, it was impossible to determine the nature of the tumor until it was removed; in one case, sebaceous content was found where the differential diagnosis had indicated a dermoid cyst.

The treatment of each species is extirpation; and this is more strongly indicated in the sebaceous cyst than in the dermoid; for the former tends to reach a larger volume than the latter, which often remains of small size. The removal of the sebaceous

species is done here, as on the scalp, by a simple incision in the long axis of the brow, through which the content is extracted; and with this should also be removed the filmy structure of tissue in which the material is included. If the dermoid cyst is small, and hence but slightly conspicuous, and has remained without further growth for a long period, it is better not to interfere with it. But if it be so large as to be unsightly, then it should be removed; and the removal is still more imperative if the tumor is growing. This extirpation is done through an incision made in or below the longitudinal axis of the brow; and this cut may sometimes be made, if the skin be drawn upwards, in the eyelid near the supra-orbital margin; in this site the resultant scar may lie in a natural sulcus of the surface. If some tact be needed to open and remove without rupture the content of a sebaceous cyst, there is still more care required to successfully extirpate the dermoid cyst. The entire cystic wall must be removed; a fragmentary portion of it left insures a recurrence of the growth in a more complicated form; the cicatricial tissue and adhesions will render another removal much more difficult than the first one. Hence, through a horizontal free cut, which has not opened the cyst, the latter must be dissected from its connections. Since the cyst is adherent to the periosteum, which is fused with the including sack, an incision to the bone, circumscribing the growth, should be made, and then the cyst, along with a periosteal segment, may be detached from the bone. The wound should be closed by sutures, and a small drainage tube or thread should be so placed in the middle of the wound that any excreta may easily escape. In one case seen by the writer, in which drainage had been badly done, final closure was only secured by reopening the wound, curetting, and allowing the part to heal from within outwards. Removal of the thread or tube used should be done as soon as the excreta cease to appear.

The brow is sometimes the site of black pigmentation; and with this discoloration there may be a growth of hair similar to that of the hair of the scalp. Two instances of the kind, originating congenitally, have been seen by the writer. The skin was of Nubian blackness. In each case the trouble was unilateral, and, besides the brow, one side of the frontal integument was implicated. The treatment consisted in each case in the removal of the discolored tissue, and partial closure of the breach made, by lateral sliding of the adjacent derm. As the children grew, the immense scar became less in its dimensions, and the cicatricial tissue was free from pigmentation.

Eyelid.—Anatomically, the eyelids consist of an upper and a lower one; the upper descends so far that it may conceal too large a gap made by iridectomy; also in cases in which the protective action of the lower lid has been lost through loss of the lower lid, the upper one when turned downwards can nearly cover the globe. Each eyelid, near the osseous margin of the orbit, presents a depression or sulcus; the superior one is deeper and is sometimes masked by an overhanging cuticular fold, especially in the aged.

The free edges of the lids are named their ciliary borders, and inclosure of the lids these borders are closely apposed, and do not leave an intervening space for the passage of tears, as some have taught. The lower border of the upper lid is slightly curved, while that of the inferior is slightly concave. On the free margin of the lids one can distinguish near the outer edge the insertion of the eyelashes, of which there are from one hundred to one hundred and fifty on each lid; and near the inner border there are seen the openings of the Meibomian glands; and there is an interstice between the cilia and the openings of the glands wide enough for division with the knife of the free border into two portions. About one-eighth of the free border towards the nose is occupied by the lachrymal canal. At the junction of the ciliary with the lachrymal portion of the free border is a small opening which leads into the lachrymal canal. The angular union of the free borders of the lids externally is named the external canthus; the inner one is named the inner canthus. In the inner canthus the conjunctiva and the cutis unite directly, without depression.

The component strata of the eyelid, if enumerated from without inwards, present themselves in the following order: the skin, the orbicular muscle, layer of loose connective tissue, the tarsal cartilage and ligament, fibro-tendinous layer and the conjunctiva.

The dermal layer is thin, pliant and easily moved; it contains rudimentary hairs and sebaceous and sudoriferous glands. The movement of the subjacent parts wrinkles this dermal surface; the folds and depressions thus formed, from their frequent reproduction, become permanent features of the aged, and senility when prompted with the desire of self-concealment, does not forget those markings, yet is seldom successful in hiding the footsteps which time imprints most deeply at the outer edge of the eye. The mobile nature of the palpebral cutis is often utilized in surgical work in this region. This mobility may act

injuriously; for in the case of a wound near the eyelid, which is followed by cicatricial contraction, the skin may be drawn upon so as to displace it, and prevent the closure of the eye.

The palpebral orbicular muscle is a species of sphincter that is concerned in the automatic act of wrinkling and closure of the lids. It is a cutaneous muscle lying next to the skin. It is pale in color, especially as it approaches the free borders of the lids; and here the non-striated or involuntary muscular fibre is found. The half of the muscle which lies on the lower lid is thicker and stronger than the upper half, since the former, in the act of closure, has more work to do. In closing, the edge of the lower lid moves towards the inner angle; this inward movement, which can be verified by a vertical line drawn on the united lids, amounts to over a line in distance. Such movement serves the purpose of carrying towards the inner angle tears, or particles of foreign matter, lodged in the eye. The palpebral sphincter may become the subject of continued or intermittent spasm, and become a source of annoyance or pain. From contracture of the muscle, a fold of skin may be drawn over the outer angle; and in the little pouch, thus formed, irritating matter can collect and denude the edge of the lid, and cause adhesion and shortening of the angular commissure. In the aged the muscle becoming weakened, the skin of the lid depends, that of the lower lid sinking towards the cheek and causing an apparent tumefaction there; this appearance is specially marked in the portrait of Dr. Franklin taken in his old age. In the upper lid such pendent tegument may fall within, and obstruct, the range of vision; so much so that the subject is compelled to lift the fold with his hand, in order to obtain free vision; but the screen may be retained in place by a strip of adhesive plaster.

The muscularity of the lids is innervated by the motor oculi and the facial nerve; the sphincter is moved by the latter, which, in its transit from the parotidean region to the eye, lies beneath the subcutaneous fascia; and thus this twig of the facial often escapes the knife in superficial excisions made in this region. But palsy of the nerve from division of it, or other cause, permits the downward sliding of both skin and muscle in both lids, and in the upper one, the dependent skin soon interferes with the due admission of light. The subfascial site of the facial twig referred to, which the author has verified by dissection, should not lessen care in the use of the knife here; yet it allows the indulgence of the hope that when incision is done here, the nerve may be spared.

Beneath the orbicular muscle there lies a layer of loose areolar tissue, which, similar to one existing in the scalp, permits of the free motion of the superjacent layer on the subjacent tarsal cartilage; and in this yielding space fluent materials, as blood and serum, may diffuse themselves; and the suppurative products of phlegmonous inflammation may also travel here. Beneath the lax structure of areolar tissue of the eyelid lie the tarsal cartilage and the tarsal ligament. The palpebral cartilages aid in maintaining the curved form of the lids; that of the upper lid is much the stronger one; it is crescentic in form and is comparable to a section of an orange. The superior one measures about one-third of an inch at the point of its greatest breadth. The lower cartilage is quadrilateral in form. These two cartilages, at their outer borders, become converted into a fibrous ligamentous structure, which, for each cartilage, radiates towards the orbit where it is inserted. This fibrous structure in the upper and lower lid is named the palpebral ligament; and the two, at the inner and outer commissure, converge, and, uniting, form the inner and outer palpebral tendons, which can readily be found and brought respectively into relief, if the lids be drawn horizontally inwards or outwards. The inner tendon is the greater one; it is the tendon of the orbicularis muscle as well as of the tarsal cartilages, and should be known to the surgeon, since it lies across the lachrymal sack.

This fibro-cartilaginous framework of the lids may be better understood when it is stated that the tarsal cartilages commencing at the border of the lid, after forming a supporting framework, become changed into fibrous tissue, which at each end forms rounded tendons; while between these lie intermediately the tarsal ligaments, so that each lid is firmly connected by this ligament to half the circumference of the orbit. Where the cartilages lie, the lid is not easily bent or curved, but such flexion can be made at the orbital border of the tarsal cartilage; and by virtue of this disposition, the lids may be everted so as to expose the inner surface. The eversion of the upper lid is more readily done than is the case with the lower one. To effect this eversion, seize the eyelashes, or lower margin of the lid, with one hand, and with the other hand let some blunt instrument, as a silver probe, or handle of a pencil, be fixed against the lid at the junction of the tarsal cartilage and its broad ligament; and pressure being made there as the free border is pulled on, the lower half of the lid is easily everted. Or the eversion can be effected without

any instrument by catching the ciliary border with one hand, and as this is pulled outwards, let a finger of the other hand press backwards on the middle of the outer face of the lid; in whatever way the work is done, the patient during the act must direct his eye downwards. In fact, the junction of the tarsal cartilage and the broad palpebral ligament of the upper eyelid, serves in the eversion just described, the office of a joint. The broad palpebral ligament permits the normal movements of the lids; and when the latter are closed for many hours, a condition simulating anchylosis is felt by the sleeper on awakening.

The conjunctival mucous membrane that lines the inner face of the lids, as well as a large zone of the bulb of the eye, forms a blind recess or fossa between the lids and the globe of the eye. The upper recess, or transition fold of the conjunctiva, is much the deeper one, and demands the attention of the surgeon, as in this hidden fold foreign bodies may lodge and remain undiscovered. Also, a growth in the upper part of the orbit may here make its primary appearance. The eversion of the upper lid and turning the eye downwards greatly lessen the depth of the upper fossa, and reveal anything which may exist there. Also, by drawing the lower lid downwards when the globe is rolled upwards, one will display the content of the lower conjunctival fold. A neglect to carefully unfold and search to its bottom the conjunctival fossæ has permitted a foreign body to lie hidden and continue its work of irritation, until a suppuration was induced, which only ended with corneal destruction and loss of vision. And should the lid be so swollen that it cannot easily be everted, then the work should be preceded by local anæsthesia with cocaine, or, what is more satisfactory if the case be a child, general anæsthesia.

On the inner edge of the margin of the lids lie the outlets of the Meibomian glands. These glands, akin in function to the sebaceous, lie imbedded in the tarsal cartilages, much nearer to the conjunctival face than to the dermal surface of the lid.

The bulbar conjunctiva can be easily moved on the eyeball; the palpebral conjunctiva is more firmly adherent; the mobility of the former may be utilized in operative work on the eyeball.

The veins of the lids empty their blood partly into the facial vessels and partly into the ophthalmic, which enters the cranium and opens into the cavernous sinus: and through this venous route, septic or infectious materials can travel and develop disease within the skull. The lymphatics of the lids and the conjunctiva

deliver their contents to the parotidean lymphatic glands; as result of such anatomical disposition, malignant disease of the eyeball or lids may reveal itself by glandular swelling in the parotid, the so-called parotidean bubo. Specific ocular disease may have a similar distal manifestation. The lymphatics of the inner angle of the eye pass to a gland situated on the masseter muscle, sometimes named the facial gland.

In regard to the embryonic development of the eye it may be briefly mentioned that, at the second month of uterine life, a layer of the epiblastic layer passes over the eye, becoming the conjunctiva. In the third month, another layer, in plicated annular form, surrounds the eye, and gradually grows by concentric development until it covers the eye. The edges of these primitive lids fuse together and remain so until two months before birth. The normal type may be deviated from in this work of fusion and separation.

Since the advent of the period when general surgery has been differentiated by specialism, the treatment of the diseases of the eye has fallen mainly to the hand of the oculist: nevertheless, the eyelid has remained a field shared in common by the specialist and surgeon, the latter having the larger share when one reckons the plastic operative work demanded by disease and defect of the eyelid.

Wounds of the Eyelids.—The eyelids may be the site of any species of wound; those occurring most often are the contused, lacerated, incised and penetrating.

The protective bulwark of the superciliary arch usually receives the violence which otherwise might impinge on and contuse the eyelid. A contusion of the brow or of the cheek near by, in its effects, often extends to the contiguous lids. The characteristics of contusion, whether it arises directly or indirectly, are swelling and diffusion of extravasated blood. There are present swelling from effused blood, and œdema due to obstruction of the lymphatics through diminution of their calibre by elongation or lateral pressure. The ecchymosed blood finds space for its diffusion immediately underneath the skin, and, especially, in the distensible space between the muscular and fibro-cartilaginous layers. A disagreeable concomitant attendant on this effusion of blood is that the blood penetrates the skin and becomes visible on the surface. The bluish, livid or blood-stained hue of the cutis, though unfelt by the patient, annoys the latter far more than the contusion itself. The sanguineous and serous effusion often swells

the lid to such dimensions that it hangs as a motionless veil, closing the eye, and wholly obstructing vision. And, what is remarkable, the source of such effused blood may be ruptured vessels situated at some distance, in the supra-orbital, temporal or malar region; in the latter case the blood travels upwards.

Palpebral ecchymosis may be symptomatic of a more remote injury: viz., it may arise from fracture at the base of the cranium, in which the escaping blood travels through the sphenoidal fissure, and appears in the eyelids. And the distinction between this form of ecchymosis and that which results from local injury of the lid, is this, that blood proceeding from fracture of the cranial base only presents itself some hours after the injury, while in the other case the ecchymosis occurs immediately. Hence, as seen, one may divide palpebral ecchymosis into two species, primitive and consecutive. The tardy supervention of the consecutive species indicates, very probably, an intra-cranial injury perilous to the patient's life. Such symptomatic ecchymosis occurs oftener in the lower than in the upper eyelid, since the former lies more directly in the course of gravitation; on the contrary, primitive ecchymosis appears equally in each lid.

In case of severe contusion of the lid, there may be a pouch-like collection resembling a hæmatoma; such contusion is seen in the prize-fighter; and the swelling may so obstruct his vision that he is compelled to seek relief from the surgeon.

The contused wound is treated, in the early stage, by massage, compression and cold application. After the effused blood has been somewhat dissipated by cautious kneading, compression should be made by means of compresses retained in place by a bandage encircling the head, horizontally. And the part may be maintained cold by moistening the compress with ice-water, or a small bag of crushed ice may be laid over the part. The cold must not be used to excess, lest the contused tissues, enfeebled as they are by impaired supply of blood, should die. Medicated solutions, which are elsewhere used to reduce swelling from contusion, are inapplicable here, since they would come in contact with and injure the eyeball. After three or four days, when the active stage has passed, the absorption or dispersion of the ecchymosed blood will be hastened by an exchange of cold for warm applications; and for this, tepid water should be used, applied by compresses.

If the lid be the site of a hæmatoma-like collection of blood, as seen in the boxer's eye, the effused blood must be evacuated by

an incision through the skin of the lid, made horizontally or parallel with the fibers of the orbicular muscle. After the blood is thus emptied, the lid is lessened in volume, and the lips of the incision close without suturing. The livid stain which remains for some time, as the result of palpebral contusion, is to the patient the most disagreeable accompaniment of his contusion, since nothing but the fingers of time can erase the stain, and the work of erasure passes through one or more of the prismatic colors, viz., red, green and yellow. Nature uses leisure, and her own convenience, for completing the task of obliteration. If the patient be a female, to whom such discoloration is most repugnant, a recourse may be had to the artful use of cosmetics, or even to the use of counterfeiting pigments applied by means of the painter's brush.

In case the sanguineous effusion be the consecutive result of fracture of the base of the skull, it becomes a trustworthy proof of such fracture; its treatment, however, is a thing of minor importance, since the graver injury will absorb the surgeon's attention.

Contusion of the lid is often associated with a lacerated wound; and the presence of the latter will lessen the tumefaction. Lacerated and contused wound here should be treated by trimming the fringe-like edges, so as to change it, as nearly as possible, to the form of an incised wound, and then close it by sutures, and dress with cold compresses.

Incised wound of the lid, if superficial and parallel with the fibres of the orbicular muscle, will often spontaneously close, and heal without the aid of sutures; should there be gaping, sutural closure must be resorted to by means of fine silken thread. And in all cases in which the wound lies vertical, to prevent the gaping usually then present, and displacement of the edges, sutures must be used. Should the incised wound divide the broad ligament of the lid, then union must be effected by deep stitches which will include the entire thickness of the lid, and secure accurate union of the parts. Also, in case the levator palpebræ superioris be severed, so that there is ptosis of the lid, then accurate sutural coäptation is an imperative necessity; and during the healing of the divided muscle, as also in the case of the divided broad ligament, the lids must be closed and retained at rest.

In case of wounds which involve the border of the lid, closure must be so effected that no gap will subsequently remain; for a

slight notch there is a deformity which attracts attention. To shun this, a suture should be placed near the border, both on the inner and outer face of the lid, but not on the border itself. If the suture include the border, the writer has seen that it is certain to leave some trace of itself, as an indentation.

In case a wound implicates any portion of the tear-conducting apparatus, great care is requisite to bring the parts into complete coäptation; a neglect of this may consign the patient to permanent epiphoral annoyance. A wound involving the border of the lower lid near the inner canthus, allowed to heal imperfectly, may leave a gap through which the tears will escape on the cheek; for such breach in the wall of the "tear-lake" does not let the tears rise to a level, in which they can be reached by the mouths of the lachrymal canalicules. If the wound has not healed, close it by sutures on the inside and outside; but if healing has occurred, then the edges of the gap must be trimmed, and united by sutures, which should remain in site for a week. In trimming the cicatrized border, more should be excised from the conjunctival than from the dermal surface; thus done, the tendency to ectropion which follows such closure will be somewhat corrected. Nevertheless, from the writer's experience, despite the pains taken there remained some eversion of the border.

Penetrating wounds which are limited to the eyelids, seldom occur; the wound generally passes beyond the lid, and injures the globe of the eye; and in some cases the wounding instrument or missile has penetrated still deeper, and, having passed through the walls of the orbit, or the sphenoidal fissure, has entered the cranial cavity, and wounded some encephalic structure. Thus the middle or anterior cerebral lobe, the ophthalmic vessels, the internal carotid artery, or the optic nerve may be injured. An unfortunate condition which attends such injury is that the missile may remain, or the causal instrument may leave its point in the dangerous site mentioned. Thus, a sharp fragment of wood, a needle's point, a fragment of wire, or a bullet or fine shot, may enter and lodge in the eyeball behind or outside of the bulb; or such object may pass into the cranial cavity and produce grave injury. Even though the traumatic agent be withdrawn, if it has entered the cranial cavity, it may have caused a fatal wound of the brain. The history of surgical curiosities is embellished with examples of the kind mentioned.

In the cases in which foreign bodies have entered and lodged

behind the eyeball, the wound on the lid has healed quickly; and this circumstance has deceived both patient and surgeon in regard to the extent of the injury. The surgeon should endeavor to discover the body and remove it. It should be mentioned that instances have occurred in which the body has remained, become encysted, and caused no inconvenience to the patient.

Erysipelas.—Erysipelas sometimes appears in the eyelid: either primarily, when the disease commences usually in the inner canthus; or the erysipelas beginning in the face or scalp, by migration, attacks the lid. The lid swells greatly under the action of erysipelatous inflammation; and an unfortunate event, which sometimes ensues, is suppuration. In cases seen by the author, the disease has assumed the virulence of phlegmon and caused destruction of a portion of the lid. The sloughing may be limited to the derm and muscle. The treatment of erysipelas here consists in the cautious use of the usual local remedies, care being taken that nothing enters the eye which may injure it. An ointment containing quinine, in the proportion of two grains to an ounce of vaseline, may safely be used on the lid. Should there be signs of suppurative action, haste should be made to open and evacuate. Where the swelling is so great as to arrest the blood supply and cause gangrenous destruction, this may be averted by pricking the surface with a very sharp lance, so as to give exit to the stagnant blood, and thus reduce the great tumefaction. And as a topical application, a decoction or cataplasm of chamomile flowers may be used.

Acute abscess occasionally appears in the eyebrow and eyelid, and takes a course similar to what is seen elsewhere. Chronic abscess is also sometimes seen, and is often connected with some morbid process in the tissues surrounding the bulb, or in the bony wall of the orbit, or parts contiguous. And in such cases the existence of the pus may reveal its presence by a swelling at some point of the lid near the margin of the orbit. Though such pus might arise from caries at any point of the wall, yet it originates oftener in the upper portion of the orbit; and occasionally, the disease begins in the frontal sinus, and, perforating the supra-orbital plate, appears in the inner half of the upper lid. In a case seen by the author arising from disease of this sinus, the purulent collection had for its anterior wall a great part of the upper lid; and on pressure it could be forced back into the orbit, but caused the eyeball to prolapse downwards and forwards. Such chronic abscess in its development causes

no pain, and, were it not for the swelling which it causes, it would remain undiscovered. The purulent collection may remain without increase of volume or other change for an indefinite time.

In the acute abscess it suffices to open and evacuate the contents; but in the chronic form mere evacuation would soon be followed by a reaccumulation of the content. Hence, to accomplish a cure, the cavity must be opened freely, and the point of osseous disease must be searched for, found, and removed. And to do this some exsection of the orbital wall will be necessary; and the excision of bone must proceed to the extent of wholly removing the diseased structure. If this removal is imperfectly done, the purulent collection will soon reappear. The origin of the intra-orbital abscess, as stated above, is sometimes from caries within the frontal sinus, whence pus arising perforated the supra-orbital plate. When thus arising, it is necessary to freely open the sinus through its antero-inferior wall, and remove whatever diseased structure is discovered; and to make sure work, as before described, it may become necessary to excise the entirety of the front wall of the sinus, and also a portion of the inferior wall, in the way which elsewhere has been described.

Burns.—The eyelid may be the site of burns, and these may vary from the innocently mild to the destructively grave; that is, there may be simple rubefaction, vesication, or the lid may be partially or wholly destroyed. The causal agent may be flame, boiling liquid, as water or oil, explosives, and molten metal. In severer cases the burn of the lid is the less important lesion; the graver one is the injury of the eyeball, which may be so burned as to impair or totally destroy vision.

In mere rubefaction or vesication of the lid, the only treatment necessary is the use of some mild local application. A favorite remedy is Linimentum Calcis, applied on lint to the part. And this may be applied to more severe burns. In place of this, Unguentum Cetacei may be employed.

In cases in which the dermal surface is destroyed, as the part recovers, the cicatrizing surface contracts and induces eversion of the lid; an important part of treatment is to antagonize this tendency. If mere vesication is present, the fibrinous coagulum beneath the epiderm should not be disturbed, and thus it may be possible to renew the normal cuticle. But if the derm be wholly destroyed, then the regenerated surface will consist of con-

tractile cicatricial tissue, with persistent tendency to shortening and displacement. To counteract this something may be done, if during the early stage of granulation the surface be covered with cutaneo-epidermal grafts. And instead of minute, fragmentary grafts, the method of Thiersch might be resorted to, in which large portions or patches of dermo-epidermal tegument may be used for implantation on the raw surface. As far as practicable, closure of the eye should be maintained during the time of healing. Even though recovery of surface in normal form may ensue, yet there usually exists a tendency to eversion for some time. This may be counteracted somewhat by gentle massage and voluntary movements, in which the eye is alternately widely opened and closed, motions which tend to maintain the normal breadth of surface. In case healing has just occurred and contraction is ensuing, the shortening may be lessened by a few incisions in the surface, with closure of the lids, and their fixation by means of adhesive strips placed vertically and horizontally; thus disposed, the gaping incisions will be filled with new material, and, as result, the surface will be broadened.

In the event of the burn having destroyed a portion of the lid, or so everted it that the eye remains permanently open, then some plastic procedure must be resorted to, of which a description will appear elsewhere.

Emphysema.—The eyelids are sometimes the site of emphysema, and the air in such case is infiltrated in the areolo-cellular spaces of the lids. The cause of such infiltration of air is to be sought for in a fracture of bones adjacent to the eye; such fracture may be of the nasal bones, the ethmoid, the frontal, or the superior maxillary bone, in which a cavity or sinus communicating with the respiratory passage is opened; and when such lesion is present, should the patient make a violent expiratory effort, as in the act of blowing the nose, the violently compressed air may enter the loose structure of the lids. The statement of the patient usually is that, when he blew his nose, the lids suddenly swelled and closed the eye. The entrance of the air is attended by a sudden twinge of sharp pain. In some cases the air is forced backwards between the bulb and the orbital wall, and extrudes the bulb forwards, causing, for a time, exophthalmus. The author once witnessed the supervention of such emphysematous swelling of the lids of one eye, and displacement of the eyeball, which occurred during an operation in which a polypoid growth was being removed from the nose. The patient being told to clear the nos-

trils the violent expiratory effort forced the air through the nasal lachrymal canal into the lids of the right eye and tissues about the bulb. The sudden closure of the eye, and the enormous distention of the lids, which prevented them from opening, equally surprised both patient and surgeon.

Some difficulty has been met in distinguishing this infiltration of air from that in which the content is blood. The diagnosis can readily be made if one attends to the different origins of the two: emphysematous swelling appears instantly as the result of a violent effort through the nose, and the swollen part is pale, and resonant on slight digital percussion or filliping with the finger; effusion of blood occurs more tardily, the skin is lividly discolored and yields no resonance on percussion. In case of emphysema, if the part be pressed on, the displacement of the air in the areolar spaces of the tissue reveals itself by a sensible crepitation, in most cases.

Emphysema of the lids will disappear in a few days through spontaneous absorption. In the case which the author saw, the swollen parts were punctured, and the most of the air was forced out through the openings made. A very important thing is that, for some days, the patient should make no strong expiratory effort through the nose, lest air again be forced into the palpebral tissues.

CHAPTER XIII.

DISEASES OF THE EYELID.

Hordeolum, Acne Ciliaris or Sty.—Ciliary acne, or sty, as it is commonly named in English, is an inflammation of the matrix or follicle in which is imbedded an eyelash. It occurs oftener in the upper lid. It may be single or multiple. It begins as a slight swelling on the border of the lid, accompanied by slight itching and discomfort at the point. The conjunctiva covering and adjacent to the affected part is intensely red. The tumor reaching the dimensions of a small wheat or barley grain (whence its name), becomes filled with tenacious pus. Ciliary acne is oftenest seen in the young scrofulous subject. In such person the disease often recurs, and is often concurrent with conjunctival and corneal disease. Besides the local inconvenience of the disease, it menaces, by its frequent recurrence, the ultimate destruction of the ciliary matrix, and, consequently, the loss of some of the eyelashes, and a permanent deformity of the lid. Its causation is probably referable to a microphyte.

Treatment.—The first thing to be done is the removal of the eyelash which is lodged in the diseased follicle; the tenacious pus should be scooped out with a small curette, and the edge of the lid smeared with the following ointment:—

℞. Ol. Jecoris Aselli.. ... .℥ss
Ung. Hydr. Nitratis. .. ..ʒss
Misce.

This ointment may be smeared on the outside of the eyelids, near the roots of the eyelashes, as the patient is going to bed.

It must be borne in mind that constitutional remedies should be given; as such the following may be resorted to: bark, iron, and arsenic, also sea-bathing has proved beneficial.

Chalazion, otherwise known as tarsal, gelatinous, or fibrinous Tumor of the Eyelid.—The chalazion is a small, flatly rounded tumor imbedded in the eyelid, and usually lies nearer the conjunctival than the dermal surface. It occurs oftener in the

upper than in the lower lid, and is situated about midway between the free and the attached border of the lid.

This tumor may develop more towards the inner or the outer surface of the lid; in the former case there will be found a slight prominence on the outside when the lid is lifted or everted from the bulb; but if the tumor develop chiefly outwards, a small rounded prominence will appear in the skin. There may coëxist two or more chalazia contiguous or near each other. The growth is usually painless, yet if it presses against and forces the conjunctiva inwards, the latter will become inflamed, and is the site of an itching sensation.

Pathologists usually refer the origin of this tumor to a degeneration of the Meibomian gland; others find the causation in a degeneration of an isolated portion of the tarsal cartilage. It is probable that the affection starts in a Meibomian gland, and thence attacks the tarsal cartilage, in which the gland is lodged. The development is slow, and the course of the tumor may extend through a period of many months. When opened, a content of heterogeneous material is found: pus cells, red gelatinous matter, partly degenerated and partly calcified material. If the suppurative elements predominate, and the tumor press chiefly against the conjunctiva, the latter sometimes acutely inflames, and opens, and permits the liquid content to escape; and in this event, after the rupture of the inner wall, there protrudes a small mass of fungous tissue. Though much of the content thus escapes, nevertheless healing is very tedious; the spongy extruded tissue will remain for a long time without much change of volume, and by its presence there is caused some irritation of the bulb. Instead of thus rupturing, the chalazion may be the subject of regressive change, in which the softened tissue is lessened by atrophy and absorption, so that there finally remains a dry calcified concrement; and this simulates the veritable hailstone, from which this tumor has taken name. This encysted concretion may remain indefinitely without change or causing functional disturbance.

Treatment.—The chalazion, when it has assumed the calcified form, need not be interfered with, unless its volume is such as to make it a conspicuous deformity; in such a case the hardened material may be extracted through an incision in the conjunctival surface, done when the lid is everted.

But if the tumor has not reached the concrete or cretaceous form, its removal is indicated; and this should be done from the

inner side. The lid must first be everted, so as to fully expose the site of the growth. The bright redness of the conjunctiva over the tumor will indicate the volume and limits of the latter. A dimpled point often corresponds to the central part of the growth. A tenaculum must be made to transpierce the inner wall of the tumor, and a circumscribing incision be made around the tumor. Thus an oval section of the conjunctiva and tarsal cartilage is excised. With a small curette, or Daviel spoon, the remaining gelatinous or granulative material is to be carefully removed, and the wall adjacent should be well plied with the instrument, so that a thin stratum of the wall may be removed. For if this precaution is neglected, there will be a recurrence of the tumor after a few months. The treatment, as just described, is the same should there coëxist two or more chalazia. Also, in case the growth has opened, and a pouting mass of soft tissue protrudes, the remaining structure should be excised, for, if left remaining, it would only tardily heal, to reopen again sooner or later. In case the tumor has developed more outwards, and is so adherent to the skin that it is difficult to wholly remove it from the inside, then it can be done from the outside, through incision or excision, done parallel with the orbicular muscle; such external cut should lie in the fold which normally lies in the outside of the lid; thus done, the scar will afterwards be invisible, or, at most, insignificant.

Palpebral Deformities.—There are several varieties of deformity which are met with in the lids, and these, in the main, are reducible to two classes. In the first class the deformity arises from too great breadth, or narrowness of the palpebral slit; and in the second it consists of an inversion or an eversion of the lid. Also, deformities of each class may coëxist.

From excessive breadth of the palpebral slit the condition is named lagophthalmos, or hare's eye; in this too large a surface of the bulb is exposed. This stare usually depends on some functional aberration of the muscularity of the lids, or it may depend on a swelling, tumor or abscess of the structures adjacent to the bulb of the eye. Protrusion of the bulb is sometimes an attendant on goitrous tumor; and vivisective research here finds the causation to be an irritation of the cervical sympathetic ganglia which supply innervation to the non-striated muscularity of the eyelids.

Treatment.—When the stare is from intra-orbital swelling tumor or abscess, this cause must be sought for, and treated as

the conditions indicate; pus should be evacuated through the most dependent route, and a growth removed, if possible, without lesion of the bulb.

But if the exposure of the bulb does not arise from the causes just cited, but is dependent on imperfect closure of the lids, then some relief may be gotten by shortening the slit at the outer angle. This operation was originated by Walther, and consists in removing at the outer canthus a small section from the upper and lower lid. The part excised should be from one-fifth to one-fourth of an inch long, and should be from half a line to a line in depth. Care must be taken to remove the bulbs of the eyelashes. The opposite raw margins are to be brought and retained in union by two or three sutures; and over the wound isinglass plaster and an occlusive bandage should be placed. After this procedure, the outer commissure may be drawn upwards in the movements of the bulb, and give an upward aspect to the eye; to counteract this, Græfe has proposed to excise a small triangle from the integument beyond the angle, according to a plan practiced by Dieffenbach. To do this, trim only the border of the lower lid, then excise from the temporal skin near by a triangular portion of skin. The base of this inverted triangle should be a continuation of the commissure, and the apex should look downwards towards the outer part of the cheek. The freshened border of the lower lid is next drawn outwards and attached to the base of the triangle by sutures. The result of this work will be to draw the lower lid outwards, and to uplift it, so the palpebral slit will be lessened in its surface. The wounds made must be closed by fine wire suture.

Should the lagophthalmos depend on a goitrous tumor, this should be removed. The writer's experience inclines him to think that protrusion of the bulb arises oftener from the parenchymatous than from the cystic form of goitre; the solid structure of the latter causes more disturbance of the innervation of the eye.

From palsy of the lower lid, the lower portion of the bulb may be exposed; likewise, the tears may not be carried towards the inner angle, but they escape over the lid upon the cheek. The abnormally exposed portion of the bulb becomes irritated, and the conjunctival vessels become congested, and give the eye an unsightly appearance. In such cases a canthoplastic operation may be performed, in which the commissural borders of the lids are pared and united by suture. Or, in place of this, the gap-

ing commissure may be closed by a strip of adhesive plaster fixed to the pendent lid, and fastened in a vertical or oblique direction. In this way the writer has known a patient to satisfactorily correct the faulty position of his drooping eyelid.

Ankyloblepharon, Blepharophimosis, or Narrowness of the Palpebral Opening.—Blepharophimosis may occur congenitally as the result of a defective separation of the lids in the embryo; it may, as an anthropological characteristic, be the normal disposition of the eyelids. In the Japanese and Chinese it is seen, and when exaggerated it becomes a striking feature indicative of the Mongolian race.

It is frequently acquired, and the cause then is to be found in some antecedent inflammatory condition; or it can arise from a permanent spasmodic state of the orbicular muscle. The most common cause is an inflammatory or ulcerative condition of the lids, especially of the outer commissure, terminating in adhesion of the raw surface, and a consequent lessening of the space between the lids. Also a wound, especially that produced by a burn in the adjacent temporal region, may, in the process of cicatrization, cause outward traction of the commissure, and thus produce narrowness of the palpebral slit. A lupoid ulcer on the temple may act thus.

Blepharophimosis is often complicated with adherence of the lids to the bulb, and this complication renders successful treatment much more difficult.

The narrowness of the palpebral slit, besides being a conspicuous deformity, may, when extensive, disturb the patient by contracting the field of vision. Thus, when the eye is rolled upwards, the upper lid may shut off a part or the entirety of the visual field, and similar interference may be caused by the lower lid.

Treatment.—When the closure depends on cicatricial adhesion, the treatment will vary according to the character and extent of the coalescence. Fractional marginal adhesion is overcome by simply severing the united bands, and subsequent frequent movement of the lids. At night the patient must occasionally be awakened, otherwise the closed lids would soon cohere again.

But a different treatment is demanded where the narrowing depends on complete closure of the outer commissure; mere separation of the united borders would be followed by reunion; to prevent this, several plastic procedures have been resorted to. The aim in this work is to cover the wounded borders with a

coating of skin or mucous membrane. The simplest plan is that of Von Ammon and Richet, which is as follows: The closed angle is to be slit outwards; and this may be done with a bistoury, or a pair of scissors, the incision being carried horizontally outwards the distance of a fourth or third of an inch; and this cut must include the entire thickness of the skin to the conjunctiva. The cut should be straight. Some bleeding will ensue, which, however, if it does not spontaneously cease, can be controlled by torsion. The adjacent conjunctival membrane is now to be dissected up, and attached by suture to the elongated commissure, so as to give to each raw edge a mucous coating, which will not permit reunion of the wounded surfaces. It is well to preliminarily detach for some minutes the conjunctiva which is to be used for covering the wound, and thus permit it to retract as much as it tends to do, before it is transplanted to the surface which it is destined to cover; thus excessive tension will be avoided. The sutures should be removed in about forty-eight hours. The result of this operation is fairly satisfactory; however, it often occurs that there remains some impediment to the inward motion of the bulb; in such movement the conjunctiva is lifted at the outer commissure into a slight ridge. In the operation described, Von Ammon pulled the conjunctiva outwards, and attached it directly to the divided derm. Richet split the conjunctiva, and then turned one part upwards and the other downwards, attaching each by sutures to its adjacent border. Instead of lining the wounded border with conjunctiva, Cusco inverts the skin, which has been loosened somewhat from the incised border, and attaches this to the conjunctiva by sutures. The last mode has the objection that it creates some deformity of surface. In whatever way the commissure is elongated, for a few days the eye should be closed, and a compress wet with water must be retained upon the wound.

Symblepharon or Bulbo-palpebral Union.—In this condition of the eye, the lid is adherent to the globe, and that adherence may be partial or complete. Partial adhesion may affect one lid alone, or both may be implicated. Such limited symblepharon may be direct in which the lid coheres to the bulb, or the connection may be through the medium of a longer or shorter band. The prospect of treatment being successful is much greater when the adhesion is by a band; but when the adhesion is immediate and of large extent, the surgeon meets a problem which is extremely difficult of solution. Functional impairment is great when the

adhesion involves the most of the conjunctival covering of the bulb; movement is then hampered, and the normal condition of the tears being disturbed, they escape on the cheek.

Symblepharon is often caused by burns; hot water, steam, or molten metal coming in contact with the conjunctiva can cause a burn from which the mucous surface of the lid and bulb becoming ulcerated, the parts cohere. Lead and other metals brought by heat to fusion, during their use in the mechanical trades, by careless handling or through explosive action, may be thrown into the eye and lodge beneath the lids. Such lesion often leads to adhesion of the lid to the bulb. Again, a chronic inflammation arising from trachomatous affection may finally end in partial or complete obliteration of the space between the lids and the bulb.

Treatment.—When the adhesion is limited, and indirect, by means of a band, the treatment consists in severing this band close to the bulb, and also close to the lid, and then closing each conjunctival wound by fine suture. These sutures should remain in place until the wounds are securely closed. Again, if the adhesion is direct, and limited, the lid should be dissected from the bulb, and then the two wounds closed in the manner just described.

In case the symblepharon is on a large scale, and either or both lids are directly adherent to the globe, then the operator is confronted with a task which has awakened the best efforts of surgical invention. The object sought for is, after separation of the parts, to obtain a covering for one or both of the surfaces which will not readhere.

The earliest recorded method of operating was that of Fabricius, who, two and a half centuries ago, sought to maintain the separation of the parts by means of cicatricial tissue. This idea was more recently pursued by Himly, who proceeded as follows: A leaden thread was introduced through the connecting material at its deepest portion, corresponding to the site of the transition fold of the normal eye, that is, the bottom of the pocket formed by the palpebral and bulbar conjunctiva. This thread of lead is left in site until the pierced parts cicatrize around it. After an opening has been established, surrounded by scar-tissue, the remainder of the connecting structure is divided. The results of this method were such as to encourage the endeavor to find a better one.

Arlt, Teale, Knapp and others have each announced and

published ways in which they have been successful in obtaining separation. If the condition of the eye is such as to permit the transplantation of a conjunctival flap into the bottom of the cul-de-sac formed by the separation of the lid, then a successful result can thus be obtained. Such shifted conjunctiva should be taken from the bulb and have its pedicle, for vascular maintenance, near the bottom of the new-made cul-de-sac; this flap is to be fastened by small sutures. After this implantation the remainder of the opposite raw surfaces must be kept asunder by means of gutta-percha tissue; and in the absence of this, the silk tissue might be interposed. Instead of the mucous tissue of the conjunctiva, should it be impossible to obtain the latter, a slip of dermal tissue from the lid or adjacent cheek might be carried through a slit made in the lid, and implanted in the bottom of the space formed between the bulb and lid. The operative principle involved in these methods is that where synechial adhesion exists between parts, whether of congenital or accidental origin, the surgeon, if he hopes to obtain permanent separation, must cover the bottom of the angle of divergence, which the opposite surfaces form, with non-adherent tissue, viz., cicatricial, mucous or dermal. This is the principle involved in the relief of palpebral adhesion, the webbed finger, or the narrowed openings into the alimentary canal. And, if possible, kindred tissue should replace kindred tissue, viz., derm should replace derm, and mucous membrane replace mucous membrane.

The skin-graft, introduced by Reverdin as an aid in closing raw or granulating surfaces, has found more extensive use than its author foresaw. Conjunctival grafting has been resorted to for relief in palpebral adhesion; and for this purpose, the conjunctiva of the rabbit and dog has been transplanted to man's eye. Thus Wolfe and De Wecker report successful operations. The mucous membrane of man has been used, viz., that from the mouth of the patient has been transferred to his eye to replace deficient conjunctiva. Where this transplantation has been done, it has been noted that the transplanted grafts were absorbed after they had served the end of separating the parts.

Ectropion.—Ectropion implies eversion or turning outwards: and this condition is not unfrequently seen in the eyelid. It occurs in the upper and lower lid; yet oftener in the lower one.

The most common cause of palpebral eversion is a wound of the surface of the lid, as from a burn, or some affection which induces ulceration of the outer face of the lid. Also a wound of

the adjacent surface, which in healing cicatrizes, contracts, and, pulling on the skin of the lid, displaces the free border of the lid outwards; that is, the free border is drawn towards the attached one and the lid is everted. Thus a burn on the lid, or on the skin around the eye, may act. Affection of the bony wall which surrounds the eye may end in inflection of surface, and become the cause of one of the most obstinate forms of palpebral eversion. Where the cause of ectropion is a scar, it will be more complete in proportion as the cicatrix lies at right angles to the long axis of the lid; and it is greatest in such case, if one end of the scar is attached to an adjacent bone.

There is a troublesome species of ectropion in which the derm of the lid is the site of no disease or change, but the eversion is produced by a reflex irritation originating in a diseased condition of the cornea and bulbar conjunctiva; in the effort to close the eye to exclude light, the orbicular muscle is violently contracted so as to force the conjunctiva forwards, and cause it to be caught between the lids, where it appears as a mass of red swollen tissue, similar to what is presented by the mucous membrane in preputial paraphimosis. The spasmodic ectropion, as is evident, differs widely from that of cicatricial origin; the former will disappear under appropriate treatment of the disease of the eyeball, which is the prime cause, while that caused by a scar is only removed by some surgical procedure.

An accompaniment of eversion from cicatricial cause in its worst form, is an elongation of the free border of the lid. Cicatricial ectropion is slow in its development, since it is only after a long lapse of time that scar tissue reaches its final point of contraction; and this precautionary fact must be remembered in the selection of the time for operating, for the work should be delayed until the vascular tissue has become transformed into fibrous structure.

Two indications are present in palpebral eversion; first, to cover the exposed bulb and thus protect the latter against irritating agencies; and, secondly, diffusion of the tears over the front of the eyeball, and their conduction away by the natural channels of escape. The procedure to be adopted will vary greatly, according to the grade of the eversion. As a rule, the lower lid is the one which oftener requires correction. The operations may be classified as those done on the lid, and those done on the surface adjacent to the eye, or a combination of the two. Some plastic device involving transplantation or shifting of tissue is often required.

A method in vogue among French surgeons is to unite the two lids directly or indirectly. Tarsorrhaphy may be done directly by trimming the opposite edges of the lids and then uniting these by suture; and such sutural union may be limited, or done to such an extent as to wholly close the eye. A serious objection to this method is that in trimming the lids the follicles of the eyelashes may be injured, so that when the patient is cured he is left with a deformity. To avoid this, Mirault has proposed to close the eye by lifting a V-shaped flap from one lid, and, having made a vertical incision on the opposite orbital border, to implant the apex of the V in this cut, so that when it has healed in the new position, it will maintain closure of the lids. This triangular flap is so disposed that its dermal face is turned towards the dermal face of the lid across which it is carried. This way of closing by means of a dermal bridge, or that in which the borders are directly sutured, to be effective, must be continued for several months. Ectropion is not always cured in the manner here described; for after the liberation of the lids, eversion sometimes recurs.

To rectify ectropion, Graefe advises the following method: An incision is to be made along the border of the everted lid

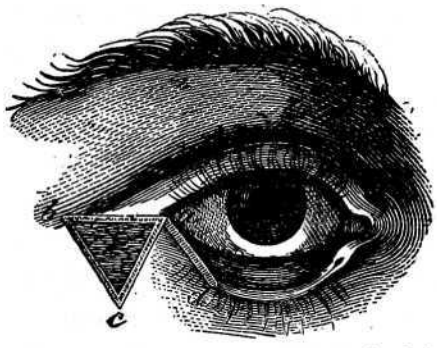

FIGURE 62. Showing Dieffenbach's method of operating for the relief of palpebral eversion.

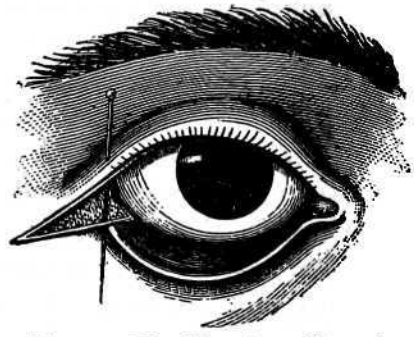

FIGURE 63. Showing Von Ammon's plan of operating in ectropion.

from the outer commissure to near the punctum lachrymale; by this cut the free border is split into an inner and an outer stratum. A crescentic flap is next to be formed by cutting through the dermal layer of the lid; this flap, which is convex towards the attached border of the lid, is to be so detached from the subjacent structure of the lid that the eversion of the latter can be corrected, when the flap is to be fixed in its rectified site by sutures.

Palpebral eversion is corrected by Dieffenbach and Von Ammon, by operations resembling each other. Dieffenbach

excised a portion of the commissural border of the lid which is everted; then an equilateral triangle, with apex downwards and base continuous with the commissure, is excised from the temple adjacent. The sides of this triangle should not exceed one-third of an inch. The trimmed border is next drawn outwards and sutured to the base of the triangle; thus the lid is rectified by lateral sliding. This method is shown in Figure 62.

Von Ammon's plan is to excise an elongated isosceles triangle, of which the narrow base rests against the bulb within the commissure, as shown in Figure 63. The sutural closure of this triangle will bring the everted lid or lids into normal place. The twisted or hair-lip suture may be resorted to with advantage to close and immobilize the parts. These two methods just described, tend to shorten the border of the lid, which is too long, as has before been remarked; this is specially so in Dieffenbach's plan, in which the outer portion of the border is excised.

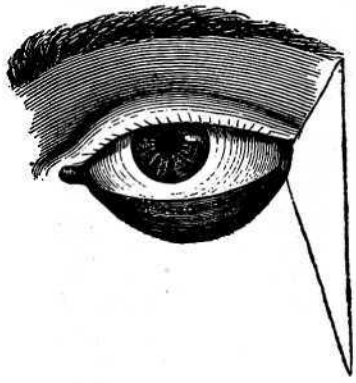

FIGURE 64. Elucidating Szymanowsky's method of operating for relief of entropion.

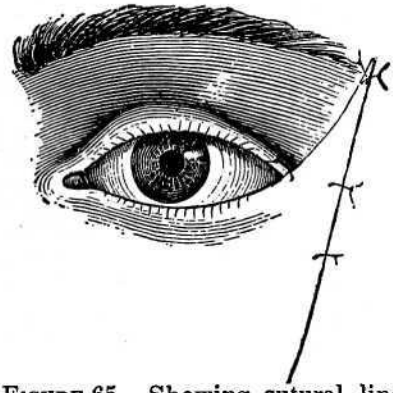

FIGURE 65. Showing sutural line that remains after Szymanowsky's operation.

An operation cognate to those just described is that of Szymanowsky. This consists, as shown in figure 64, in the excision of a triangular portion of derm from the temporal region, adjacent to the commissure. Two sides of the excision start and diverge outwards from the commissure; these divergent lines include a small section of each lid, and are to be sutured to the third or temporal line. The sutural closure, shown in Figure 65, has had the effect of restoring the everted lids to normal position.

As before mentioned, tarsorrhaphy is much practiced by the French surgeons; and the work is done by trimming each free border so that, united by sutures, they will unite. The inner edge of the free border is trimmed off, care being taken to spare

the bulbs of the eyelashes. The outlets of the Meibomian glands must necessarily be interfered with in this work; yet their closure does not seem to be followed by such trouble as might be apprehended; no cyst by retention has followed such occlusion. Fine silken thread is used for the sutures, which may be removed after three or four days, when the union will be found quite complete. Along with this closure, some work may be required on the everting cicatricial structure; for example, the scar may be divided and become, by interstitial growth, somewhat elongated; also, plastic operations on the lids are facilitated by this immobilization.

The effort to overcome cicatricial eversion by division of the scar and filling the wound with lint, was an old method, which theoretically would seem to promise much, but put into practice it has yielded so many disappointments that this plan of treatment has been nearly abandoned.

Bonnet rectified the cicatrized eversion by making a horizontal incision in the lid, as seen in Figure 66; then by lifting, if it

Figure 66. Showing Bonnet's plan of treating eversion of the eyelid.

were the lower, or drawing down if it were the upper lid, the wound is converted into a lozenge-shaped figure; closure is now done while the wound is thus shaped by horizontal sutures. The result will be to broaden the lid.

T. Wharton Jones rectifies the ectropion by making, as shown in Figure 67, a flap, the pedicle of which is directed towards the free margin of the lid. This triangular flap is dissected up so that it liberates the lid, and, the flap being lifted towards its attachment, the remaining open space is closed laterally by sutures. Thus done, the closed space becomes a prop to the uplifted flap; and the result is lengthening of the vertical span of the lid.

Guérin's method, shown in Figure 68, is to make an incision in the form of a W, and dissect up the lateral angular flaps; and,

having forced these towards the free border of the lid, they are united together over the intervening angular point, which is left remaining adherent.

The writer has employed in his practice several of the preceding methods for the relief of ectropion; yet the relief, which was

FIGURE 67. Showing T. Wharton Jones' operation for the relief of ectropion. Sutural closure is seen on the left side.

aimed at, was not always realized; in fact, the result was often unsatisfactory. And, though at the time of the operation restitution to normal position was secured, yet, after healing, the former mal-position gradually reappeared; the wounds made in cicatrizing, shortened the surface, and the previous deformity was present again. The usual cause of this is that scar tissue caused by a burn, or similar wound, being the constituent of the surface which is operated on, the elements of inevitable recurrence are

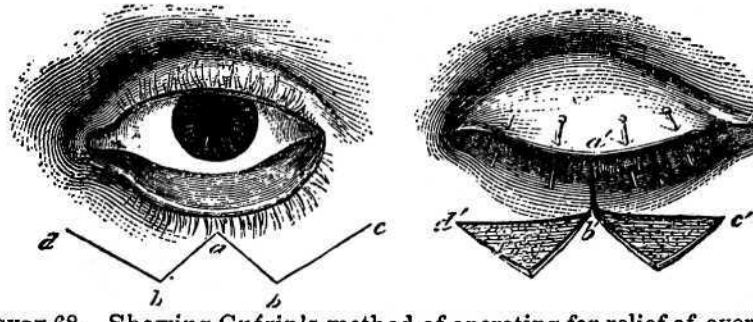

FIGURE 68. Showing Guérin's method of operating for relief of eversion of the lower lid. Sutural closure is seen on the right side.

present. These circumstances have led the writer to attempt rectification of the everted lower lid by a plan differing from any of those before described. His first operation was done in 1870, as follows, upon a lower eyelid everted by a burn: First make an incision through the lid a half inch long near its attached

border. Next between this opening and the free border a flap is to be uplifted from the conjunctival side with its pedicle towards the free border. This flap should be a half inch broad, and should be divested of its conjunctival covering; that is, it should be raw on both sides. It contains tarsal cartilage and portions of the divided Meibomian glands. The free end of this flap is to be drawn into the horizontal slit first made, and retained there by sutures placed on the outside, and traversing the derm of the lid. The traction on this flap and its fixation in the cut through the lid, will correct the eversion if this be not very great; that is, the method is most applicable to cases in which but a part of the lid is involved. But in cases in which the correction cannot be wholly accomplished by this plan, still it may aid other accessory plastic work. The advantage of utilizing this intra-palpebral flap is that it surely disposes of the unsightly mass of pouting tissues which so disfigures the eye, and uses the same for a support of the lid. No trouble arises from the divided and shifted Meibomian glands. The author has only resorted to this method for the correction of eversion of the lower lid; it might, however, be used in the upper lid.

There is sometimes seen a deformity of the eye, in which there is a depression of the outer angle; and this is associated with some eversion of the lower lid. For relief in this case, Denonvilliers has planned an ingenious operation, shown in Figure 69, styled an exchange of flaps. To do this, make an incision

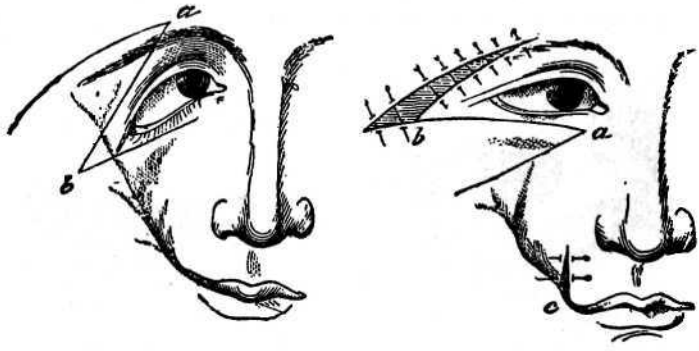

FIGURE 69. Showing Denonvilliers' plan of elevating the outer angle of the eye. Closure is shown on the right.

above and below the eye, converging and meeting a few lines beyond the outer commissure. From the inner end of the upper incision, and from over the middle of the brow, carry a curved third incision downwards and outwards, ending on the temple. Thus a flap is described, which is uplifted and carried down-

wards and sutured below the eye. As this is done, the angular flap beyond the commissure is carried upwards and occupies some of the space left by the upper flap. A small space will be left above the brow, which may be closed by stitches, or allowed to cicatrize, and draw the brow upwards.

A scar causing the eversion of the lid may be of such a character that the work of correction can only be done by excising the cicatrix and substituting in its stead healthy tissue borrowed from the adjacent surface. This plastic work will be easily done if the eyelashes still remain; then the operation (the steps of which demand special planning in each case) will, in the main, consist of excision of the scar tissue, and then, for the upper lid, uplift a pedicled flap from the frontal or temporal region; or if it be the lower lid, form the flap from the temporal or malar derm, and then transpose and suture the flap in its new position. If a portion of the free border of the lid be involved in the scar, this may be excised and replaced by the transplanted flap. As the flap will shorten, it should be longer than the remaining border of the lid. If considerable allowance is not made for such retraction, the new-formed border will be too short, as happened in a case operated on by the writer.

In some cases in which the scar is small, this may be excised, leaving a triangular space, as shown in Figure 70; the closure

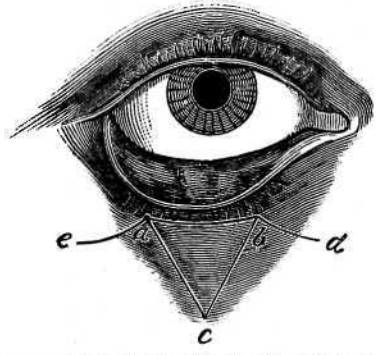

FIGURE 70. Showing a plan of Dieffenbach of correcting ectropion.

may then be effected according to the plan of Dieffenbach, in which the incision *a b* is extended to the right and left, when the adjacent derm *a c* and *b c* is to be uplifted, and the sides of the triangle are to be united by suture; the effect will be to force the everted border upwards. Though in this way the position of the lid can be improved, yet, as the writer has found, some pouting of the border will remain.

A remarkable operation for the relief of cicatricial ectropion

was done by Wadsworth, of Boston, in 1876. After preparation of the part to be operated on by removal of its surface, a flap was taken from the arm and at once transplanted on the lid. The flap thus transplanted was two and one-half inches long, one and one-fourth inches broad, and one-half inch thick. Wadsworth found that the transplanted piece contracted greatly, and he directs that due allowance for this be made. The material was retained in position by means of gold-beater's skin and an overlying compress. After the lapse of four months, the result was satisfactory.

This plan of Wadsworth differs from that of Thiersch, who covers raw or granulating surface by material from the upper structure of the skin, in which only the apices of the papillary layer are included.

Entropion.—Entropion, or inversion of the lid, has a pernicious effect on the eye through the mechanical action of the free borders of the lid and the eyelashes impinging against the bulb: the eyelashes are the chief causes of the mischief. The general causes of palpebral inversion may be classified under three heads, viz., cicatricial shortening, spasm of the lid, and lessened volume of the eyeball; the first and second causal agencies frequently exist together. The upper lid is the one oftener affected. Its superior, pendent position, and the larger tarsal cartilage contained in the upper lid, give it an advantage over the lower one, where the agencies of inversion are present.

Cicatricial inversion is seen in those cases in which trachomatous disease of the inner surface of the lid has continued until the affected structure becomes changed to scar-tissue. The hardened points which stand on the cicatrized surface irritate the bulb, and, like foreign bodies, they produce spasmodic closure of the lids. Meantime the ciliary portion of the orbicularis muscle hypertrophies and contracts more violently. The continued irritation of the eyelashes and of the border of the lid against the cornea causes opacity of the latter, and finally ends in almost complete loss of sight. Aside from trachomatous disease, any cause, which constantly irritates the eyeball, may produce entropion through continued spasmodic closure. In the cases mentioned, especially in those in which there is trachomatous cicatrization, the tarsal cartilage softens and atrophies, so that it can offer but slight resistance to the involution of the border of the lid.

Again, entropion may arise from lessened volume of the eye-

ball; this may appear as sequel of an inflammation of the eye; it is not unfrequently seen in the aged as the effect of the atrophic changes resulting from senility.

Continued inversion of the lids ends in producing corneal opacity, and a diversion of the tears from their normal channel, and the latter, flowing on the face, irritate and excoriate the skin; to avoid these serious troubles surgical aid is sometimes invoked.

The inverted lid may be attacked only on its outer surface, or the operative procedure may involve the entire thickness of the lid.

Shortening of the outer surface and restoration of the lid to normal position have been attempted by cauterization of the outer surface; and this can be done by the actual or potential cautery. This procedure, which dates from antiquity, is most safely done by actual cauterization. This is best done with the wedge-shaped point of the thermal cautery, which may be so applied as to make a horizontal eschar in the middle portion of the lid; the contraction resulting from this will correct the inversion.

Instead of this plan, portions of skin may be excised from the outside of the lid; this excision is done by pinching up and excising one or more folds of the skin, and then closing by suture; or they may be allowed to heal by granulation. These excisions are commonly made horizontally, yet one surgeon prefers to make them vertically.

The work of correction may also be made by means of ligatures passed through the derm and tied. In this way Gaillard operated; his procedure consisted in passing threads vertically through and underneath the derm, one near the inner angle and another near the outer angle; these threads are to be tied so as to include a section of the skin as well as the orbicularis muscle. In each ligature there is included nearly an inch of vertical surface. And a third ligature may be placed in the middle of the lid, should the inner and outer ones be insufficient. These tightly tied ligatures include, destroy, cause cicatrization, and have the effect of shortening the outer surface of the lid, and thus eversion is effected.

This method of treating entropion by ligatures may be advantageously combined with Von Ammon's operation of canthoplasty, in which there is excised an elongated triangle from the derm at the outer commissure, as before described in the treatment of ectropion.

To overcome the spasm of the orbicularis muscle, often the

chief causal agency of entropion, the muscle may be divided, or a small section of it may be excised. The fibers of the muscle nearest the free border of the lid should be attacked; or the division of the outer commissure may accomplish the same purpose. Others have divided the orbicularis muscle subcutaneously to control spasm of the latter. Instead of dividing the muscle, others have divided the internal palpebral ligament, that is, they have performed tenotomy.

These operations have been limited to the dermal surface of the lid or the orbicularis muscle: that is, the tarsal cartilage is neglected; and since this cartilage, through alteration of form and structure, often figures as the chief cause of entropion, hence the operations described often fail to permanently cure entropion. In the worst cases the surgeon must attack the tarsal cartilage.

Sir Philip Crampton was one of the first to include the cartilage in the operation for relief of obstinate cases of entropion dependent on trachomatous cicatrization. His operation consists in making two vertical incisions a half inch long, one of which is external to the punctum lachrymale, and the other near the outer angle; the incision traverses the tarsal cartilage, so that it becomes easy to evert the portion of the lid between the incisions. Next, by means of a species of eye speculum, he retained the lid everted for some days, until the wound healed. Retention of the lid in eversion is better accomplished by Guthrie's plan, who, after making the vertical cuts, excises a horizontal section from the surface of the outfolded lid, and then closes the wound by suture, thus fixing the free border in eversion that remained after the wound had healed. During the period of healing, Guthrie holds the lid in suspension by three ligatures, which, being passed through the lid near the border, are to be fastened on the forehead or cheek by adhesive strips. During the time of healing the eye must be covered with lint coated with a bland ointment, such as simple cerate or spermaceti ointment. The method of Crampton, as modified by Guthrie, the author has successfully employed in the treatment of trachomatous inversion. In one case in which sight had been nearly lost by corneal opacity, caused by friction of the eyelashes against the bulb, this operation caused a restoration of average sight after a few months. In this case the oblong dermal excision penetrated the tarsal cartilage.

Since the time of Crampton and Guthrie, ophthalmic surgeons in such cases of obstinate trachomatous entropion, have sought

to correct the position of the lid by operations confined to the cartilage. Thus Streatfield operated by making an incision a couple of lines from the border through the skin and muscle to the cartilage; and then from the latter a strip is to be excised; and afterwards, the wound being sutured, the result is shortening of the lid and eversion of its border. Wells operates somewhat similarly, excising a section of the skin, and a wedge-shaped strip from the tarsal cartilage, with sutural closure.

In mild cases the operation of Anagnostakis may be tried; this consists, as will be seen in Figures 71 and 72, in making an

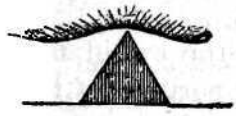

FIGURE 71. Showing the triangular excision made by Anagnostakis for the relief of entropion.

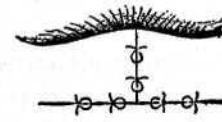

FIGURE 72. Showing the sutural line remaining after the operation of Anagnostakis.

incision eight lines from the free border, parallel with the border; then excise a triangular section of skin with apex towards the border, and base on the first incision; dissect up the sides of the triangle, and unite these by suture. Graefe operates similarly, yet makes his incision near the free border, and his excised triangle rests on this cut, and has its apex towards the brow.

Congenital Deformity of the Eyelid.—The lids may be absent, or nearly so, and then the bulb is quite uncovered in its anterior section. A condition quite the reverse of this may exist, viz., the eye may be closed by coherence of the normally free borders.

Treatment.—Where the lids are absent, some plastic procedure might be resorted to; to wit, flaps from the neighboring frontal, temporal or facial derm, might be thrown over the uncovered bulb, and thus the absent lid may be, in a manner, replaced.

In congenital ankyloblepharon, if there be no symblepharon, relief might be obtained by separating the coherent lids. If the eyelashes were absent, the operation would be assured, if the dermal and conjunctival surfaces were united over each border.

Congenital coloboma, or cleft of the eyelid, has been seen; it is, however, very rare, only a small number of cases having been seen. This cleft is triangular in outline, similar to that in hare-lip, and in the most of cases observed, the cleft was in the upper lid, viz., in ten of thirteen cases it was thus situated. In such cases there is a breach in the tarsal cartilage, and there are no eyelashes in the gap. The affected lid, at the site of opening, is

usually attached to the adjacent cornea. Such cleft is found in the inner half of the lid, near the inner or greater angle of the eye.

Many ingenious theories have been offered to explain the origin of the palpebral cleft; the most satisfactory explanation is that it has arisen from an arrest of development, during the early period of embryonic evolution. This theory is rendered still more probable by the fact that such cleft is often concurrent with other congenital defects: for example, hare-lip, palatal or facial cleft may exist with palpebral cleft, in all of which the primal cause is non-closure of clefts or openings normally existing in the embryo.

The treatment of congenital cleft of the eyelid is similar to that of hare-lip, provided the remaining portions of the lid will permit their closure; then the borders must be pared and united by metallic sutures. And should the lid be adherent to the bulb, as is commonly the case, this must be detached. In the work of closure, should the existing portions of the lid be so short that their closure would cause too much tension, then subsidiary lateral incisions must be made, which will permit of lateral sliding.

Epicanthus.—There is a rare deformity of the eye exhibited in Figure 73 in which a fold of skin of crescentic form lies over

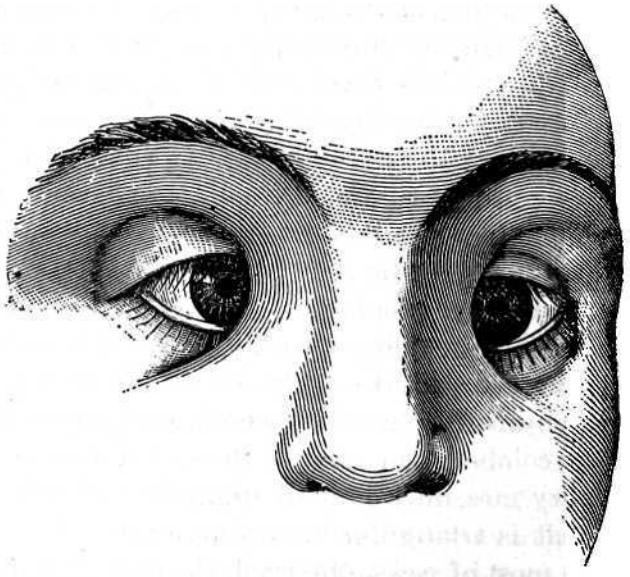

FIGURE 73. Showing the deformity known as epicanthus.

the inner angle; and this circumstance gave the name of epicanthus to the deformity. This cutaneous fold, starting from the

inner end of the eyebrow, passes downwards on the side of the root of the nose, and then passes across the angle, so as to have a semilunar form with concavity looking outward. A hollow space lies underneath. The effect of such a fold which is present in the angle of each eye is to limit the field of sight of one eye, when vision is directed laterally, since the pupil is carried partly or entirely under the fold. These folds are movable, so that when the skin on the root of the nose is pinched up and folded on itself, the defect is made to vanish, yet it returns as soon as the skin is liberated.

Epicanthus is often associated with some other ocular defect; there may coëxist internal strabismus, defective action of the upper lid, or smallness of the bulb. Epicanthus has likewise been seen at the outer angle of the eye; and then it was associated with other defects of the eye. The author has seen a well-developed case of epicanthus at the inner angle of the eye, in which there was no other defect of the eyes. The girl's parents did not have the defect.

Epicanthus is often seen in the Mongolian race; and in them, as well as in all thus deformed, the face is broad, abnormally flat, and the nose is less prominent than usual. The new-born child, in whom the nose is normally without character or shape, is often accompanied by epicanthus in which the flattened root of the nose slightly overhangs the inner angle of the eye. There may be epicanthus in the congenitally scrofulous or syphilitic subject.

Treatment.—Only in very prominent cases of epicanthus is interference necessary; should this be demanded, the work is best done by removing a vertical section of the derm on the middle of the nose, and then dressing by sutures. As this simple procedure would probably leave the parts too tense, and dispose to an early reappearance of the deformity, it would be well to guard against tension by incising the displaced derm horizontally, and if need be vertically.

Blepharoplasty.—The eyelid may be lost in part, or in entirety, by disease, injury or the surgeon's knife; the operative work done for the purpose of repairing such loss is designated blepharoplasty.

Blepharoplasty may be done in two ways: (1), by uplifting a flap and turning this into the defect; (2), closure by sliding.

The flap procedure is known as the method of Fricke; in this a flap is uplifted from the region of the forehead, temple or cheek, and is shifted into the defect. Since the

skin when severed retracts, the flap must exceed in every direction the space which it is to occupy; it should be two or three times longer and broader than the defect. The axis of the flap should make an acute angle with that of the defect, so that torsion may be diminished. The margins of the flap should be cut perpendicularly, so as to insure their vitality; and its distal side should be from three to four lines longer than the nearer side; thus torsion will be rendered more easy.

After moving the flap into its destined position, some surgeons apply sutures at once; others use these later; and all counsel to attach the free border of the flap to the subjacent conjunctiva. After the work is done, the parts must be covered with lint bearing some bland ointment; and both eyes should be covered with a compressive bandage.

Probably a majority of the cases demanding these plastic operations have arisen from excision, in which a portion of the lid has been removed, in the extirpation of an epitheliomatous affection of the lid. Such removal is oftenest done at or near the commissures. If this be at the inner angle, the lachrymal sack may be interfered with; and then, besides repair of surface, it may be required to remove the lachrymal gland. To restore the angle is no easy task. A solution of the canthoplastic problem both at the angle of the mouth and eyelids has often baffled

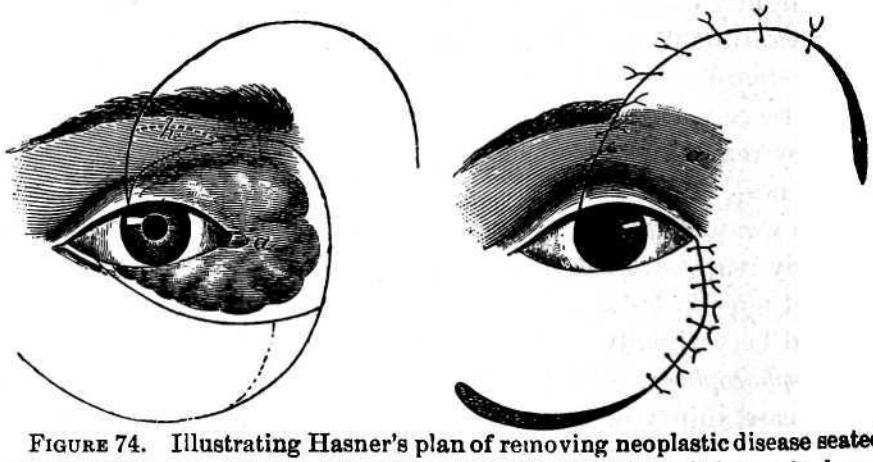

FIGURE 74. Illustrating Hasner's plan of removing neoplastic disease seated in the eyelids at the inner angle; the appearance after sutural closure is shown at the right.

or puzzled the adroit surgical hand. A single flap with an open or reëntrant angle may be used; or two flaps may be used. The method with two flaps is the more usual one. Hasner thus filled a large defect at the inner angle by means of an upper and

lower flap, falciform in shape; the beak-like end of one flap looks outwards, while the other points inwards. These flaps form an angle when folded together.

When the defect is triangular, and beneath or above the eye, and its base occupies the greater part of the border of the lid, the breach may be closed by means of a rhomboidal flap. This is to be formed on the side of the defect: on the temple for the upper lid, and on the cheek for the lower one. This rhomboidal flap may be formed more or less obliquely, according as circumstances demand. The wounds made can be closed by suture.

The triangular defect below or underneath the eye may also be closed by lateral sliding, after subjacent dissection of the replacing derm. But as the contiguous surface will be wrinkled in the act of closure, this can be obviated by the excision of a triangle, according to Burow's method. This method has been described in the chapter on Plastic Surgery, and is shown in Figure 75.

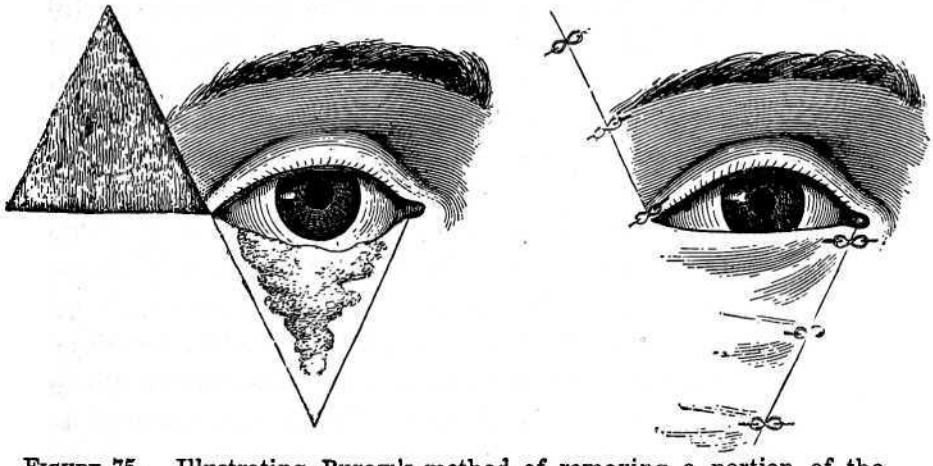

FIGURE 75. Illustrating Burow's method of removing a portion of the lower eyelid; also subsequent closure after excising a triangle from the temple; the sutural closure of the wounds is shown at the right.

In the work of blepharoplasty there has been an attempt made to transplant a flap with the semblance of eyelashes. This has been done by so incising a flap that it should contain on its margin some hairs of eyebrows. This ingenious conceit, like many others, though laudable in purpose, would rarely accomplish more than to mar an eyebrow, and form an unsightly eyelash. The work will be better done by him who, in the probably near future, learns to transplant hair bulbs.

In case the lachrymal sack must be opened, and its wall so

destroyed that there will be an escape of tears afterwards, a recourse may be had to removal of the lachrymal gland. It has been found that the conjunctiva retains its moisture though this gland be absent. The moisture is maintained by the secretion from glands which exist in the cul-de-sac, or concealed recess of the conjunctiva. In fact, the secretion of tears is intermittent, only occurring under the influence of emotion, or an irritation of the membrane: for example, from a foreign body lodged in the eye. These structural conditions permit the eye to dispense with the lachrymal gland, in case some defect in the tear-conducting passage may demand the removal of the former.

The lachrymal gland was thus extirpated by the writer in a case in which the lachrymal sack was destroyed in an operation for the removal of a cancerous growth. The work was done by extending the outer commissure by a horizontal slit; thus the upper lid was uplifted in its outer half, and the gland extirpated. Instead of elongating the outer angle, the work may be done, as Tillaux advises, through an incision made horizontally above the external angular process of the frontal bone; this cut is made an inch long, through all the soft parts to the bone. These parts, including the periosteum, are then to be reflected downwards, following the bone into the orbit, until the gland is reached. This lies between two layers of the periosteum, one of which separates the gland from the bone, and the other layer separates it from the conjunctiva. Through such a route the gland can be reached and removed without entering the cavity of the conjunctival pouch. It will facilitate the operator greatly in this work if he precede his operation on the living subject by one on the cadaver. To distinguish the structure of the gland from adipose tissue is not so easy as the inexperienced might suppose. Without occasional anatomical rehearsal, facts which have been firmly fastened in memory become loosened and obscure. The site and relation of parts, however firmly chained in the mental field, gradually relax their tethering. These conditions and limitations of our knowledge demand attention, whenever the surgeon's scalpel essays an unfamiliar task.

Tumors Arising from the Orbital Wall.—The bony wall of the orbit is the occasional site of tumors which demand surgical intervention; as such may be mentioned the osteoma and the myxoma.

Examples of the osteoma springing from the bony wall have been observed, in which the growth, not being interfered with,

attained such size as to crowd on the eyeball and disturb or even destroy vision. Such osseous growth may spring from any portion of the wall; or it may arise from one of the adjacent fossæ, as the frontal or maxillary, and proceed thence towards the orbital cavity. The growth may spring from the bone or from its investing periosteum. In structure it may be similar to normal bone, or it may be of ivory hardness. The pedicle, when such exists, has but little tendency to enlarge; the growth is more eccentric, and may attain considerable dimensions; one removed by Maisonneuve measured seven inches in circumference. On section, the normal osseous tumor presents cartilaginous content; but when it is of the eburnated or ivory species, it is wholly solid. This eburnated osseous tumor arises nearly always from the ethmoid or frontal bone. When divided by the saw, it presents a stratified appearance. It is probable that the ivory form differs only from normal osseous tumor in being older; that is, it has become hardened by greater age.

The intra-orbital osteoma when seated deep may remain for some time, without any visible indication of its existence, except some pain in the eye; later, the bulb protrudes; signs of compression on both vessels and nerves become then more manifest; the eye is congested and painful, and as the tumor enlarges, it forces the eye in a direction opposite to the site of the growth. And this deviation aids in diagnosing the tumor's location.

Treatment.—The intra-orbital osseous tumor, when of small volume, and when it has ceased to grow, may be allowed to remain; the removal of it would cause more disturbance to the eye than the osteoma itself. It is seldom that it has this harmless character; for, continuing to grow, its encroachment on the eye will finally prove fatal to that organ. Thus Textor saw and operated on a case, in 1865, which had reached the enormous volume of a child's head; the tumor had crowded on and wholly destroyed the eye. Textor removed this tumor by splitting it, and extracting the fragments in sections. There remained a great breach, opening into the nose, and antrum of the upper jaw. With hints from the disaster which may result from permitting such developing tumor to pursue its own course, it should be removed early. And this is done by a horizontal incision through the attached portion of the lid; or, instead of this, a route may be made by slitting outwards the external commissure. By one of these routes carried inwards alongside of the bony wall, the growth can be reached and detached from the wall, by means

of a chisel and mallet, or a gouge; and if the growth be voluminous, it should be divided with a resection saw or bone forceps. The base or pedicle should be wholly removed, so as to prevent recurrence.

A growth similar to the osteoma is the osseous cyst. An example of this kind has fallen under the observation of the writer. This was seated in the inner portion of the orbit, occupying a quadrant of the orbital margin. It was mistaken for a solid osseous tumor until its true nature was revealed by the operation undertaken for its removal. The tumor was found to have a wall less than a line thick, and to be filled with a myxomatous material, and more than a half ounce in amount. The cavity, in which this was contained, reached upwards into the frontal bone, and, internally, it occupied the right lateral mass of the ethmoid bone. The lachrymal bone was uplifted and formed a part of the wall of the tumor. A section of the right nasal bone was likewise uplifted. The structure and connections of the tumor were such that in its removal a breach was made into the contiguous bones. The removal was done through a semilunar incision with concavity looking outwards and somewhat downwards; and the investing soft parts were carefully uplifted, and afterwards reclosed, over the breach, by metallic sutures. Drainage was maintained through a tube, of which the lower end passed through the right nasal passage, escaping through the nostril. Through this tube the cavity of the wound was daily cleansed by irrigation. The wound healed rapidly, and the skin, which closed it, did not sink so as to disfigure the boy's face. The tear passage into the nose was wholly destroyed in the operation. Yet the secretion found its way through the remaining canaliculus into the breach which had been made. After a period of two years there was no recurrence of this growth, though the myxomatous nature of the neoplasm rendered it probable that the operation would give but temporary relief.

Tumors Originating within the Orbit.—Tumors benign as well as malignant arise within the orbit. Of the benign species the lipoma and fibroma occur here.

The lipoma has been observed here in a few cases; its more frequent occurrence might have been suspected, when one takes into account the adipose couch on which the globe of the eye rests. Such growth when verified should be removed through an incision made in a properly selected site. A drainage tube of small calibre should be introduced in most cases, and a com-

press saturated with cold water should be retained on the eye for a few days.

The fibroma occurs as an orbital tumor, and, like the lipoma, it is slow in its development. It may become so large as to fill the orbit and destroy the eye. It may likewise present eccentric development, and penetrate the adjacent cavity of the nose, or the frontal or maxillary sinus. This tumor arises from the periosteal covering of the orbital wall; and, also, some claim, from the fibrous sheath of the optic nerve. The treatment should be similar to that of the lipoma, viz., removal with the knife.

Ryba, in 1853, described a wartlike growth arising from the ocular conjunctiva, which was probably fibromatous in character. Four cases were seen in man and two in the eyes of animals. This growth was white, yellowish or reddish white in hue, and was covered with hairs of different lengths, color and size. Some of the tumors which were examined were found to resemble normal skin which produces hairs. And from this dermal resemblance Ryba proposes as name for this tumor, conjunctival dermoid tumor. Perhaps it may be a heterotopic production of embryonic life, in which fragmentary segments of derm have become displaced.

The proper treatment of this dermal fibroid is through extirpation; and, to prevent recurrence, there should be applied to the site of the operation some astringent application, as the sulphate of copper, or nitrate of silver; likewise the tincture of opium may be applied.

Sarcoma and epithelial and melanotic cancer have their origin in the soft parts of the eye.

A form of sarcoma seen by several observers presents numerous small cavernous spaces in its structure, and from this circumstance, it has been denominated cavernous fibroid. According to Virchow, it has its origin in the adipose tissue of the orbit. It is usually seen in the young subject. Through encroachment on the bulb, exophthalmos finally arises. It may send prolongations into the adjacent cranial, nasal or maxillary cavities, and, through pressure, cause functional disturbance in these situations. This tumor rarely ulcerates, nor is it attended by the cachexy of cancer.

The proper treatment is radical extirpation; yet the removal is commonly followed by a regrowth of the tumor. Nélaton, Péan and others report cases of sarcoma in the orbit, in which there was recurrence, and repeated operations were done. The

author has observed three cases, all in children, in whom there was a recurrence, and repeated operations were done until death occurred from exhaustion. In order that the removal should be done as effectually as possible, the work of the scalpel should be followed by that of the thermal cautery. The actual cautery can scarcely be employed with safety where the eye is retained, lest the latter be endangered; also, when heat is employed in the upper part of the orbit, the thinness of the supra-orbital plate should be remembered.

Epithelial cancer may commence in the lid; more frequently it is an immigrant from contiguous structures which were primarily attacked; and in the latter case, the most frequent site of the growth is the derm of the adjacent side of the nose. The writer has seen many cases in which the epithelioma appeared secondarily in the eye; attacking then the lid, or entering the commissure, the disease appeared on the conjunctiva. In several cases the epithelioma began on the cheek and traveled thence to the lower eyelid. In all these cases, the growth commences as a slight elevation of the surface, of rounded border, and consists of a multiplication of the epithelial strata. This initial growth has a whitish aspect, and, if the epidermal covering be removed, the subjacent papillary layer will be seen to be prominent. Such a growth commences to disintegrate at its central point, and as this ulcer enlarges, the peripheral border advances. It develops peripherally; and if near a palpebral commissure, the advance is more rapid in that direction than elsewhere.

The treatment should be removal of the growth with the knife, or its destruction by cauterization. If the knife be resorted to, it should be used early and unsparingly. The author has been taught by unfortunate experience that economizing the tissues for the purpose of avoiding a scar is certain to be followed by a return of the epithelioma; and, to shun this, if excision be resorted to, let it, besides including the affected structure, pass three or four lines beyond into the sound surface.

Unfortunately, malignant disease does not limit itself to the superficial species here described, and carcinoma of the most intractable character, viz., melanotic cancer, frequently attacks the eye. This growth occurs in childhood and youth, and is seldom seen in mature or advanced age. Melanoma, as the disease is designated by the pathologist, has been the subject of disagreement among those who have clinically studied this growth; while many have pronounced it eminently malignant,

others declare it curable by an operation; thus Pamard, in 1853, finding that the disease did not recur after removal, decided that it is not malignant; on the contrary, Stoeber found that it recurred, and reappeared metastatically in distant parts, viz., in the liver.

Sichel, in 1856, in his study of melanoma seated in the orbit, found that the disease commences in the fundus of the eye; thence it grows forwards, and finally pierces the anterior wall. The melanotic material was found to be similar to that contained in the choroid membrane, and in this matter were found carbon and iron.

St. Lager and Hervier think that melanotic material arises from an excessive production of the normal pigment of the body. When the melanoma occurs in other parts of the body, these writers find that it may be encysted or non-encysted; and in some cases it may appear in liquid form; also in the form of a membrane

The writer has seen a few cases of melanoma seated in the eye; and all were in children. In its early stage, since it is then painless, it may escape detection for a time; later, the eyeball protrudes until, finally, the lids cannot be closed; and, at length, the distended ball bursts at some point, and, through the rent, there is forced out the gelatinous melanoid material characteristic of the tumor. The site of the rupture is commonly in the anterior portion of the sclerotic coat. When the disease has reached this stage, its most remarkable feature is rapidity of growth. Vision is lost at an early period. Like all rapidly developing malignant growths, there is an absence of glandular affection.

Heyfelder and other surgical authorities, who have written on the treatment of malignant disease of the eye, advise an early removal of the affected part; thus doing, Heyfelder thinks it possible to preserve the eye. This conservative action, the writer is convinced, is rarely the proper one; he has never had to regret too extensive excision; but pursuing the contrary method has, in several cases, been followed by a recurrence which brought with itself the necessity of a more wholesale sacrifice than primarily would have been necessary. Whether a cell, liquid content, or a microphyte be the factor of propagation, this agent soon finds unsuspected lodgment in the contiguous structures, too often beyond the line of excision. Hence, as a guiding rule in all cases of malignant disease situated in the structures which lie

around the eye within the orbit, the bulb, including the intra-orbital tissue, should be removed. And the same rule should be followed if the case be melanotic cancer affecting the eyeball. Enucleation, with retention of a portion or the entirety of the ocular muscles, so that an artificial eye may be worn, is nearly always followed by a reappearance of the disease. This has been verified several times in the author's practice. Excision conservatively done was followed by recurrence, demanding a second, and then a third, and a fourth operation, until nothing more remained to remove. His experience leads the writer to formulate the rule that, wherever the ocular tissues have become the seat of sarcomatous or carcinomatous disease, the knife should only be stayed by the naked walls of the orbit. In work thus done, the bare bony wall does not become necrosed, as might be expected, but it becomes covered with a cicatricial investment. Should the bony wall be attacked, then the affected surface should be removed with a chisel or gouge, and the remaining structure be thermally cauterized. The cautery must not be applied to the supra-orbital plate, lest the heat should injure the superjacent cerebrum. The writer has known death to occur from such inadvertency.

Foreign Bodies in the Eye.—From the grave affections of the eye just considered, the writer passes by a pleasant transition to a matter of minor moment; this is a foreign body which has accidentally lodged on the surface of the eye, the removal of which often calls forth an outburst of gratitude from the relieved patient. The pain from this corpuscular object is greater when it is lodged between the bulb and the lid than when it lies on the free surface. The pain is very acute when the object has become imbedded in the exposed portion of the cornea. A grain of sand or iron when lodged in the eye, if rough in surface, as it usually is, is extremely painful, and, owing to the insolubility of such object, it will continue to irritate until the object is removed.

Of all the objects which lodge in the eyeball, there is none more perilous than the arista, or awn, of certain grains. This awn, or beard, as it is familiarly called among farmers, is the sharp projecting process in which ends the husk containing the grain of barley, rye, wheat and oats. This little object, barbed as it is laterally, when it becomes entangled in the conjunctival structure, tends to penetrate and become faster in its hold. And the danger is especially great when the awn has entered the cul-de-sac of the conjunctiva, and has become concealed through

swelling of the conjunctival tissue. In such a case the movement of the eyeball and the compression and motion of the lid tend to bury the object and wholly conceal it. Thus situated, the awn has led to suppuration and destruction of the cornea.

Treatment.—In the case of an object which is of smooth surface, the irritation awakened acts reflexly on the lachrymal gland and causes profuse lachrymation, and the object may thus be floated out of the eye. To aid in this washing out, the patient should close his eyelids until the tears have collected underneath; then, suddenly opening the eye, the offender may be borne away in escaping flood. Or with a little self-control, if the eye be committed to its own unaided actions, the object may be expelled spontaneously.

But if the object be a fragment of metal or a cinder or grain of sand with sharp edges, and is partially embedded in the corneal or conjunctival structure, then the removal demands address and tact on the part of the surgeon. The first act will be to prepare the eye for manipulation by applying to it a five per cent solution of muriate of cocaine. Such a solution in ten minutes deprives the eye of sensation, so that the bulb can be touched, and no pain or unpleasant feeling is experienced by the patient. The patient should also be told that the cocainized eye will, through the mydriatic action of the agent, be rendered unfit, for a short time, for common vision; this will vanish in a few hours. If not visible, the object must be searched for by turning each lid outwards. The patient is rarely able to locate the object correctly. To search, draw down the lower lid, while the patient rolls the ball upwards. If not found there, evert the upper lid by folding it on the proximal border of the tarsal cartilage, or which may aptly be called the joint of the upper lid. During upward eversion, the eye should be directed downwards, since thus the superior conjunctival pocket will be unfolded, and its complete exploration is easily done. In the majority of cases, the body will be found adherent to the palpebral conjunctiva. The object is usually of gray or black hue, thus contrasting with the red color of the deeply injected conjunctiva.

Where the object is non-adherent and merely lies on the eyeball or the lid, it can readily be wiped off with a soft linen or silken cloth; but if it has fixed itself in the corneal or conjunctival structure, the removal is more difficult. In such a case, if the particle be lodged in the bulb, it will be necessary to

fix this by means of forceps. The blades of the forceps should be smooth and not serrated, since the latter, in their clasp, wound the structure. The cocainized bulb being thus caught and held, the foreign body is to be detached with the needle-pointed instrument used by the oculist for discission of the cataractous lens. If the object be fixed in the cornea, the detaching needle should be passed under one of its sides, and then uplifted. In case the body be a particle of iron which leaves a stain of rust on the cornea, this stain should be carefully removed with the detaching-needle; since, if allowed to remain, the iron rust may, like a salt of lead or silver, become afterwards incorporated with the corneal tissue. After such manipulation, the eye should be covered, for some hours, with a compress wet in cold water.

In case the irritating body is not found, and is suspected to be lodged in the bottom of the conjunctival pocket, that recess must be diligently explored. Such search is often rewarded by discovery of the irritating body. If the fatal awn of a member of the Gramineæ be hidden there, its presence will soon be revealed by tumefaction in the part, from local conjunctival inflammation; and in the midst of the pouting swollen tissue, the object is buried. Likewise, particles of exploded molten metal may enter, and remain hidden in this conjunctival cul-de-sac. To aid in the search, after eversion of the lid, the rounded end of a silver probe may be used; thus metal is readily detected. The history of the case must give some indication of the object to be sought for; especially, if the eye has been injured by melted metal. Again, if a child, whose sports expose him to the awned Gramineæ, becomes suddenly affected with tumefaction of one or both eyelids, a pretty accurate guess of the causal agent can be made; and in such case the tumefied structure should be thoroughly searched.

The barbed sides of the awn favor advance and not return of the object; and thus, after a time, it invariably buries itself, and, if not found and extracted, it will later reveal itself in a shred of gangrenous tissue, when the eye has been lost through destruction of the cornea; to avert such a catastrophe, the surgeon must early find and remove the destructive agent.

CHAPTER XIV

SURGERY OF THE MALAR AND PAROTIDEAN REGIONS OF THE FACE.

A LARGE portion of this region of the face in the male is covered with beard; the surface thus invested varies in individuals. Paucity of beard is a characteristic of the Mongolian race. The subcutaneous adipose couch over the most of these regions is closely adherent to the derm; this is especially true of the malar region; and, owing to this fact, the derm here is not well suited for operative plastic work. Commencing in front of the parotid gland, contiguous to the parotidean duct, lies a layer of adeps, which is augmented in mass in front of the masseter muscle; and this adeps, lodged beneath the front border of the masseter, loosely surrounds the terminal end of the parotidean duct. Tension of the duct is thus lessened, and the discharge of the escaping saliva is not hampered by the varying volume of the masseter in mastication. The muscles situated in these regions may, when functionally considered, be divided into two classes. In the one class concerned in mastication are the masseter and buccinator; while the other group comprises muscles which, besides lifting and depressing the lips, are mainly concerned in emotional and other mental manifestations. These muscles concerned in expression are imbedded in, and adherent to, the subcutaneous adipose tissue, and they differ from most muscles in having no sheaths within which they can glide; and, hence, wounds severing these muscles, gape but little. If the surface of the face be examined in the adult, and especially in the aged subject, certain furrows will be found, which arise from the action of underlying muscles. There are three series of such furrows; the first series is situated on each side of the root of the nose; a second series on each side of the wings of the nose, and the third includes the angles of the mouth. Attention to the site of these furrows is necessary in certain plastic procedures in this region. Lines of incision following such normal furrows will

leave less conspicuous cicatrices. Thus the adroit plastician hides the vestiges of his work in the footprints which time has left, or will leave, on the human face.

The supply of blood to this region is mainly derived from the facial and the transverse facial branches of the external carotid, and from the temporal arteries. The deeper structures below the eye are supplied by the infra-orbital artery; thus they get their blood by a circuitous intra-cranial route from the internal carotid. The variability of volume of the facial artery should be remembered; it often reaches the ala of the nose as a vessel of moderate calibre; or it may be so attenuated on the side of the face as scarcely to demand a ligature if it be opened. The arteries of the face are remarkable for their intercommunication; they anastomose freely among themselves, and also with the arteries of the opposite side. Hence, compression of the facial artery, where it lies on the lower jaw, as is sometimes done to control bleeding during operations on parts supplied by its branches, controls the hæmorrhage only imperfectly; torsion or ligation should be done at the site of injury.

The facial region is traversed by the facial vein, which soon acquires some magnitude; this vessel is found below the inner angle of the eye and passes down from that point to the angle of the lower jaw, where it turns inwards to meet and end in the internal jugular vein. The facial vein lies behind the facial artery; a slight interval separates the two until they reach the anterior inferior angle of the masseter muscle; here they lie close to each other. In their transit on the face the artery and vein lie on the buccinator, and beneath the zygomatic muscles.

The terminal branches of the facial nerve are distributed to the muscles of the face; and if one or more of these branches be severed, there will follow a corresponding palsy of the parts.

Wounds of the Cheek and Side of the Face.—The exposed situation of the cheek and the side of the face renders this region the frequent site of injuries. Such lesions are, most frequently, laceration and contusion, and the incised wound. The gunshot wound has occasionally its site here; and, oftener than the projected missile, the powder leaves traces of its action on the skin.

Contusion without laceration is frequent. In this injury the tearing of the subcutaneous vessels pours out blood, whence isolated swelling quickly occurs. The amount of the tumefaction is a fair measure of the grade of violence. If the bruise

be on the lower part of the cheek, the tumefaction will be confined to that part; but if the injury be near the eye, the effused blood quickly finds its way to the eyelids, which often swell so as to close the eye. This frequent result of facial contusion is one of its most disagreeable accompaniments; for the "black eye," as it is called, socially banishes its owner for a few days. Also the effused blood often leaves at the point where it is poured out an induration and enlargement for a long period. Hence, from the circumstances mentioned, the facial contusion is sufficiently important to demand careful treatment. The objects aimed at by the treatment should be to prevent the effusion of blood, or, if effused, to favor its dispersion and absorption. If the case be seen at its onset, the escape of blood into the tissues may be impeded by methodical pressure made over the injured part. For this a sheet of paper folded into a compress and laid on the part and retained there for twenty hours, by means of broad strips of adhesive plaster and a roller, will prevent further effusion. But if the effusion has occurred, then dispersion can be accomplished by massage or kneading the part; and in this work, as far as is possible, the material should be forced from the eyelids. In the event of there being a considerable collection of blood already effused, direct evacuation of this has sometimes been done through an opening made through the skin; the experience of any surgeon will pronounce against this way of proceeding, since, despite aseptic precautions, suppurative action often ensues and a tedious healing with scarring is the result. Should, however, the effused blood be near the oral cavity, an intra-buccal incision might be made through which the blood could be evacuated.

In case the wound be a laceration with contusion, the effused blood finding outlet does not require attention as in the preceding case; but the torn wound must be treated with unusual care to avoid a disfiguring mark; and, for this purpose, the fringed borders must be carefully trimmed off and the edges accurately coaptated by fine catgut or metallic suture, after the wound has been well washed with a sublimated alcoholic solution. The wound should afterwards be covered with a compress, which must constantly be retained moist with the same solution. Sometimes the author has dressed with lint saturated with the compound tincture of benzoin, which is placed and retained on the part with adhesive plaster. Thus union with slight scarring may sometimes be obtained; yet there is more danger of failure from

suppuration than if the moist dressing just mentioned be used. Under the benzoated application the sutures may remain longer than they should under the sublimated alcoholic dressing; in the latter case the sutures, if metallic, should all, or nearly all, be removed at the end of the second day. If catgut suture be used, it rarely requires removal, since it usually disappears by absorption. When the dressing is frequently changed, there is the advantage that the condition of the wound can be inspected; so that if there be signs of suppurative action, as shown by redness and swelling of the part, then the lowest angle of the wound should be opened, and the semi-purulent fluid allowed to escape; and this escape will be favored by the moist compress; thus watchfully treated, such a wound may heal almost as rapidly as by first intention.

An open contused wound of the face may closely resemble an incised one, viz., a wound over one of the bony prominences which has been caused by a fall or an attack with a blunt object, as a club or stone. The site of such wound may be the margin of the orbit, the malar bone, the zygomatic arch, and the angle or the margin of the lower jaw. The wounds of this class sometimes lie within the domain of forensic medicine; and their causal agencies are favorite matters of controversy on the part of legal counselors in their efforts to balance the scales of justice; efforts which sometimes rather jostle than adjust the equipoise of these scales. In such cases the surgical expert should be as blindly impartial as Themis, before whom he stands. Should, however, the expert become a partisan, he debases his science, and usually reveals his false position by being drawn into contradictions, in which disloyalty to truth surely entangles him. The treatment of such wounds is similar to that of the incised class; in most cases the edges should be trimmed, and union accomplished by sutures. The moist aseptic dressing before mentioned should be used; and if suppurative action impends, the sutures (or certainly some of them) must at once be removed.

Incised wounds in the anterior portion of the face, as a rule, gape less than wounds in other parts of the body. Bleeding is not profuse unless the facial artery is severed. One or more filaments of the facial nerve may be severed, and palsy of the muscles which are supplied by the injured nerve may result; thus an awkward expression of the face can originate. Such might arise from a deep wound, running in a vertical direction, that is, at right angles to the branches of the facial nerve. And

this fact should be borne in mind in making incisions in this region; if possible these should lie in the horizontal and not in the vertical plane of the face.

The incised wound here is to be treated in the same way as elsewhere; bleeding should first be wholly arrested, and the margins of the wound accurately apposed and retained so by sutures. Though all wounds here bleed freely in consequence of free vascular inter-communication, yet, unless the facial artery be opened, such hæmorrhage usually ceases spontaneously if exposed to the air for a few minutes. Should some arteriole continue to bleed longer, the suture may commonly be so introduced as to arrest the bleeding; to do this, the suture must pass beneath the open vessel; if it pass above it, bleeding continues unseen and separates the walls of the wound. Should the facial artery be divided, it may be closed by ligature or torsion; the author prefers the latter. The vessel should be caught at its end and twisted three or four times around its axis. The dressing should be the alcoholic sublimated compress.

In case of a gunshot wound, the missile, if lodged, should be removed if it is accessible and extraction is practicable. The removal of the bullet, if it will not entail additional violence, should be attempted, for such removal delights the patient, pleases his friends, lulls the public clamor usually present for the extraction of the missile, and possibly facilitates the recovery of the patient. The wound in the soft parts should be managed similarly to that of an incised or lacerated wound, according as it resembles one or the other.

A lacerated wound of the cheek, if the causal agency be violent, besides tearing the soft parts, may also fracture the subjacent bone. Such injury the writer has treated a number of times; in the most of cases the cause was a blow from a horse's hoof; in one it was from the thrusting blow of the horn of a cow, and in another, from the shaft of a rocket. The wound of both soft parts and the bone is generally in the form of a stellate rent. In the adult, pieces of bone wholly detached from the soft parts may be found forced into the maxillary sinus; this is less often in the child and when the antrum is but slightly developed. In both the adult and the child, the osseous fragments are generally found adherent to the flap-like soft parts. There is commonly not much bleeding, and the pain is not violent; since the violence acts like the écraseur in occluding the vessels, and by its concussion deprives the sentient nerves of their sensibility, the

hæmorrhage is seldom great, and the pain is small in proportion to the violence done.

The wounds of this class necessarily entail deformity, which, in some instances, frightfully alters the patient's face. In the wound seen by the author in which a cow's horn was thrust into the cheek of a girl, the malar and superior maxillary bones were fragmentarily broken. The cheek and lower eyelid were torn, with the effect that the features on that side were blotted out and replaced by radiating scars, and the eyelid, as a misshapen mass, remained folded downwards. Some plastic work, done after the wound had healed, somewhat improved the wretched figure of the child. The wound caused by the rocket was of a yet more severe character; the eyeball, the lower lid, and a portion of the soft parts of the cheek were lacerated. The front face of the superior maxilla was broken into several pieces. The wooden shaft was left remaining in the wound, and, in the attempt to extricate it by some non-medical hand, it was broken, and a portion of it remained behind. The first surgical aid endeavored to remove the part imbedded in the skeleton of the face, and this was thought to be done until, the wound not healing, further search discovered another fragment of wood. After this the wound healed, leaving a fragmentary cheek.

The author would remark that in all similar wounds on the face or elsewhere, caused by the penetration of a pointed fragment of wood, in the act of extraction there is always a risk of leaving a portion behind, especially if the material be the redwood, so much in use on the Pacific Coast. If such fragment is left, the time of healing will be indefinitely prolonged, and will only terminate when the wound has been explored to its ultimate recess, and the foreign body removed.

The region of the face here under consideration is seldom the site of neoplastic development, except the superficial angioma, which is a frequent occupant of the cheek. The treatment is similar to that which has been heretofore explained.

Scrofulous Ulcer.—There appears here an obstinate form of ulceration, which is analogous to tubercular disease. In some cases seen by the writer this ulcer appeared as a single point; in others, as multiple points about the middle of the cheek, and oftenest over the line of the duct of Steno. The affection first appears as a soft tumefaction of the skin, and not exceeding a line in breadth. This grows peripherally, but does not penetrate deeper than the skin. The outer portion of the affected part

becoming detached, there remains an ulcerated surface, which is moistened by an adhesive, serum-like fluid. The affection may appear at several separate points, which, pursuing the course mentioned, may fuse together and occupy a large portion of the cheek; or the ulceration may spread from a single center. Similar to other ulcers, the affected surface may heal centrally while it is spreading peripherally; healing, however, is rare, unless the case be properly treated.

The tubercular or scrofulous diathesis obtains in the subjects of this ulceration.

Treatment.—The cachexia present must be combated by appropriate means: iodine, arsenic, iron, proper food, and life in the open air. If the local affection be yet limited to a small point, it may be removed with the knife, and closure by suture be effected; to accomplish this, however, scrupulously aseptic work must be done, else the operation will be followed by a tediously cicatrizing wound. And even despite such care, failure to obtain immediate union so often occurs that the writer usually follows another treatment. This plan was only arrived at after trials of other methods; these, in the main, consisted in first thoroughly curetting the diseased surface, and then applying one of the following agents: iodoform, subiodide of bismuth, powdered rhubarb or ergot; under these local remedies, such a diseased surface may heal, yet often it will not do so. A better method was found to be to first curette the part thoroughly, cauterize the borders with the thermal cautery, and then, having washed with a $\frac{1}{2000}$ solution of sublimate, let the part be covered with gutta percha tissue paper. And this dressing, retained in place by adhesive plaster, may remain unchanged until signs of suppuration show themselves. At each dressing the surface should be washed with the dilute sublimated solution. Under this treatment the author has succeeded in effecting the cure of an obstinate example of the affection here referred to, which occupied a large part of the right cheek.

As remarked, when the affection is limited, it may be treated by excision, yet an objection to this plan is that occasionally, instead of the resulting wound healing properly, there may develop in its site a keloid scar, which will be difficult and sometimes impossible to eradicate.

Parotidean Region of the Face.—Of all the parts which lie within the region of the face, none is more surgically important than the parotidean district; hence, an accurate knowledge of

the region is so necessary to the surgeon that the writer finds a excuse for the extended section which here follows.

The parotidean boundaries vary in length as the head extended or flexed, and in breadth according to the movement of the lower jaw. Its superficial limits are the following: above it is bounded by the auditory meatus and the temporo-maxillar articulation; in front, by the posterior border of the maxill inferior; behind, by the anterior border of the sterno-cleido mastoid muscle and the mastoid process; and below by a band o fibrous tissue, which is connected with the sterno-cleido-mastoi muscle and the angle of the lower jaw.

If these bounds be viewed together, they form an oblong fig ure, of which the horizontal lines are much the shorter.

The gland is contained in a fascial envelope, of which the sides originate and are arranged as follows: The aponeurotic or fascia sheath of the sterno-cleido-mastoid muscle, after reaching the anterior border and completely enclosing the muscle, divides into an anterior and a posterior layer. The anterior one passes in front of the gland and fuses with the masseteric fascia. The posterior stratum passes behind the gland, and forms a wall between it and contiguous structures, and this partition is imperfect at the deepest part, where the gland lies near the wall of the pharynx. This internal fascia is fastened to the styloid process and gives off processes which surround the muscles which are attached to that process. The internal or deep layer of fascia, after reaching the anterior border of the gland, fuses with the anterior layer of fascia; and the united fascial structure passes forwards and covers the masseter muscle. Between the sterno-cleido-mastoid and the parotidean fascia there lies a mass of tissue, trilateral in form, which may be the starting point of fibromatous tumors which have no close connection with the parotid gland.

If the fascial wall be examined in respect to its inferior portion, it will be found complete and in relation with the fibrous band which extends from the sterno-cleido-mastoid to the mandibular angle, and thus the wall here becomes strongly fortified. But the superior part of the wall is incomplete where the gland adjoins the cartilaginous portion of the external auditory canal. The parotid gland, there, is completely isolated from the surrounding structures by a closely fitting fascial wall, except at its upper part, and at its internal or deepest part, where a process like the end of a finger reaches through the containing fascia

above the styloid process and the internal carotid artery. Between the deep portion of the gland and the wall of the pharynx lie the following very important parts: the internal carotid artery, the internal jugular vein, the pneumogastric nerve, the spinal accessory, the glosso-pharyngeal, the hypoglossal, and the sympathetic nerves,—parts so important that on their integrity depends the continuance of life. The anterior border of the gland is molded on the deep and superficial faces of the ramus of the jaw; the superficial portion is continued forwards on the masseter muscle, and ends in the duct of Steno, its outlet. This anterior process is sometimes named the accessory parotid.

The parotid and submaxillary glands, though analogous in being racemiform glands, yet differ greatly in respect to their fibrous stroma; while that of the submaxillary is loose, that of the parotid is compact, dense and resistant. And this unyielding stroma interferes with swelling of the parotid, and renders such swelling painful.

Two important structures traverse the parotid gland: the facial nerve, which enters the deeper portion of the gland and passes transversely through it and divides into branches, which pass to the temple, cheek, and lower jaw; the other structure is the external carotid artery, which, emerging from behind the ramus of the jaw, at the union of the lower third with the middle third, enters the gland. This vessel enters the deep portion of the gland and passes thence towards its surface; that is, after the artery enters the gland, it is continually becoming more superficial. The external carotid, while it lies in the gland, divides into the temporal and internal maxillary arteries; and these terminal branches lie for a short distance in the upper part of the parotid. The external jugular vein lies imbedded in the gland. The external carotid is separated from the internal carotid and the nerve, before mentioned, by the deep fascia, the styloid process and the styloidean muscles; hence, in case of the tumor invading this site, the styloid process becomes a signal-head of warning to the surgeon against penetrating deeper into this region, bristling with anatomical perils.

The arteries mentioned, in their transit through the gland, are closely adherent to the fibrous stroma of the gland; the vessels lie in no loose sheath by which they may be separated from the gland, so that, to reach them, the parotidean structure must be literally dug out or removed piecemeal. The facial nerve, on the contrary, is so loosely attached to the structure which it trav-

erses that it can be dissected out in the normal gland; if this, however, is diseased, such dissection might be impossible.

An examination of the gland, proceeding from without inwards, will meet successively the facial nerve, the external jugular vein, the external carotid artery and lymphatic glands; the glands vary in number and position.

The anterior prolongation of the gland lies on the masseter muscle, and sometimes reaches to its anterior border; this process, as well as the duct which continues from it, lies between the two fascial layers before mentioned, which extends as far as the point where the duct passes into the buccinator muscle. The anterior prolongation of the gland lies in a line on the masseter which is midway between the zygomatic arch and the lower border of the maxilla inferior. This prolongation of the gland is accompanied by the transverse facial artery and branches of the facial nerve.

The canal of outlet of the parotid gland, named the Stenonian or Stensonian duct, or the duct of Steno, lies deeper than the normal subcutaneous fascia, and has an outer sheath formed by a prolongation of the parotidean fascia; and within this outer sheath there is another which surrounds the duct directly and lies in contact with it. The parotidean excretory canal may be divided into a masseteric and buccal portion, which lie respectively on the masseter and buccinator muscles.

The masseteric portion appears as a white cord, a line and a half in thickness; and from its beginning, though it is slightly curved, it pursues its course forwards, until, reaching the anterior border of the masseter, it is bent inwards, almost rectangularly, and this sudden bend is an obstacle to the passage of a sound into the canal. The canal, finally dropping its two fibrous sheaths, curves suddenly inwards, and opens into the buccal cavity opposite the first upper molar tooth. A cutaneous line drawn from the aural tragus to the labial commissure overlies the parotidean duct (Tillaux). Hyrtl places the anterior end of the canal somewhat higher; according to him the duct runs in a line drawn from the tragus to the middle of the naso-labial sulcus. No valves exist in the duct, yet the sudden infractions which occur at two points are obstacles to the entrance of foreign materials. The canal is about sixteen lines long, and it opens into the buccal cavity about sixteen lines behind the angle of the mouth.

The excretory canals of the parotis and the submaxillary

gland differ in regard to their structure: that of the latter is soft and analogous to that of a vein, while the parotidean duct is much firmer, and has been compared to the tense vas deferens.

Inflammatory Affections of the Parotid Gland: Parotitis.—The leading constituent elements of the parotid gland are the fibrous and the glandular; Tillaux claims, in opposition to most authorities, that inflammation of the gland begins in the fibrous element; Virchow, on the contrary, teaches that the inflammatory process begins in the glandular element, and extends thence to the adjacent tissues.

Virchow, in 1859, claimed that the swelling is chiefly located in the peri-glandular tissues, and the process is similar to that of catarrhal pneumonia, prostatitis, and inflammation of the middle ear. The inflamed glandular elements are red, and, in the commencement, yield a thin catarrhal excretion; this excretion later becomes purulent in nature. In the pus, one finds salivary corpuscles and pus-cells. In severe cases, the glandular elements become disintegrated and mingled with the pus. Virchow found portions of the gland thus destroyed, while the intermediate connective stroma was not broken down.

The parotis has the same relation to the buccal mucous membrane as the prostate gland has to the genito-urinary mucous membrane.

Pyæmia may result from such inflammation, and this may be of the ichorrhæmic or of the embolic or metastatic form.

Virchow and Bamberger divide parotitis into three classes:—

1. Primary catarrh, which usually occurs epidemically; this is limited to a simple catarrhal discharge, with no tendency to suppuration or ulceration.

2. Secondary catarrh, in which pus and abscess appear, and there is a coëxistent oral or aphthous affection, or disease of the middle ear.

3. A specific catarrh, almost always ending in an ichorous discharge; and this is commonly associated with some remote ichorrhæmic or embolic metastasis.

Causes of parotitis are erythema or catarrh of the mouth; and the weather has an influence, as it appears oftenest in the cold months of the year.

A single gland may be affected, yet both may be, and then one usually precedes the other.

As events of parotitis are obstruction and swelling of the veins

of the temple and cheek, with œdema. The head in general, and the adjacent eye may suffer. From retarded movement of the blood in the veins, coagulation can occur; and such clots may decompose and become ichorous. Meantime, the contiguous lymphatics and glands may become affected, and pus can form in them.

Besides the constituent parts of the parotis, structures adjacent may become implicated: viz., the adjoining muscles, the middle ear, and even the temporal bones and the subjacent dura mater may become affected. And in the worst cases, the morbid process passes through the meninges and attacks the brain.

The diffusion of the disease is by continuity and contiguity; it may travel along nerve trunks, and in this way it may enter the skull. Another route for intra-cranial invasion is along the veins which traverse the inferior orbital fissure; or the clotted material may pass down through the jugular vein to the heart. Thus the inflamed parotis, ending in suppuration, may be the source of morbific materials, which may awaken disease in the brain, heart and other regions, near or remote.

There is an increase of temperature analogous to that which accompanies inflammatory and suppurative action elsewhere, the range of temperature being proportionate to the violence and extent of these processes.

The aponeurotic envelope and the unyielding fibrous stroma of the gland impede the flow of blood through the veins and favor coagulation. The same constricting tissues tend to force out pus which may form in the parotis.

Suppurative parotitis usually falls within the domain of surgery as a metastatic pyæmic affection; and often it is a secondary event of a severe wound in some other part of the body; its appearance should excite grave apprehension.

Treatment.—From the facts presented, it is clear that suppurative parotitis is an affection which may imperil and sometimes destroy life; and, hence, its treatment should be prompt and energetic; the milder grades of parotitis, however, seldom demand attention on the part of the surgeon. Where the evidences of pus are presented, as denoted by local tumefaction, increased heat and general rigor, an incision should be made so that the pus imprisoned within the unyielding fascia may have free escape. Since the most accurate anatomical knowledge cannot locate the vessels and nerves of the gland with absolute accuracy, the opening should be made in such a manner as to give these structures the

greatest safety; and for this purpose, the incision with the scalpel should not penetrate beyond the superficial fascia; and then the opening should be continued by means of a blunt dissector, or a small pair of dressing forceps, which, being thrust in, may be opened and withdrawn as Hilton directs, so as to make a free opening. Thus the pus may be reached, and any vessel or nerve which might be met will be displaced, and not seriously injured. As two or more separate pus-centers may coëxist, each of these may be opened in a similar manner. Thus, by prompt and early action, the suppurative process may be arrested. The openings made are slow in healing; a serum-like fluid may exude from the wounds for a long period. This material contains saliva, which is derived from the wounded glandular structure. If none of the larger secondary ducts of the parotis be opened, the wounds under proper treatment will finally heal.

Parotidean Growths.—The parotid gland, complicated as are its structural constituents, is suited by nature to be the natal site of numerous neoplasms; every species of growth, from the simple cyst to the gravest types of malignant tumor, occurs here; and, beginning with the simplest, cystoma first offers itself for consideration.

As varieties of cyst, the following have been observed here: the sebaceous cyst, the simple serous cyst, the salivary cyst, and cysts in which two or more species are associated.

The cyst of sebaceous or atheromatous content occurs in this region. It belongs rather to the derm than to the gland. It is usually small, though the writer has removed one of rounded form, of which the diameter exceeded two inches. Such sebaceous tumor causes but little functional disturbance; as a deformity, however, its removal is indicated. This may be done by a horizontal or vertical cut through the skin and the filamentous capsular envelope of the cyst. The only structures which might be endangered in this enucleation are branches of the facial nerve. But as these nerve filaments are beneath the fascial envelope of the gland, which structure intervenes as a well-defined septum between the cyst and the nerves, the latter could only be wounded through careless dissection. If the wall of the cyst be well exposed through a horizontal cut, the growth can be enucleated from the lateral and subjacent structures by means of a blunt dissector. And if the proper parotidean fascia be left intact, the branches of the facial nerve will not be wounded.

The cyst of purely serous content has been observed in a few

cases in the parotidean region. The contained fluid has none of the reactions of saliva. This cyst may be disposed of by excision; but before resorting to the knife, an effort to cure should be made by injecting the cyst with the tincture of iodine.

A cyst similar to the one just mentioned, is that in which the content is salivary; such a cyst, of small or large dimensions, may arise from the retention of saliva in one of the ducts which convey the secretion from a lobule of the parotis. This cyst resembles that of purely serous character; yet the two can be distinguished from each other by the fact that that of salivary content yields the characteristic reaction of saliva, viz., it converts starch into grape sugar. The salivary cyst is difficult to cure. Two modes of treatment have been advised; in one there is established a communication between the cyst and the buccal cavity; in the second plan there is an effort made to destroy the walls of the cyst, and thus through suppuration to obliterate the cystic cavity. Such destructive action with subsequent obliteration may, sometimes, be accomplished by cauterizing the cavity thermally or potentially. As a potential escharotic, one might use the sulphate of zinc, with which, in small crystalline form, the cystic cavity may be filled. Thus the inner wall is destroyed and an action is set up in the subjacent tissues which may end in obliteration of the salivary cyst.

Salivary Concretion.—The calcareous salivary concretion named sialolith, frequently observed in connection with the submaxillary gland, has also been seen, though seldom, in the parotis. The source of this calculus is the mineral constituent of the saliva; and this consists, in the main, of phosphate and carbonate of lime. How the initial nucleus begins, since it is not seen, has, like vesical calculus, been rather a matter of conjecture than of actual proof.

The sialolith has been a matter of study by Immisch, who in his publication in 1861 classifies these concretions in those which lie in the gland, and those occurring in the excretory canal of the gland. As assignable cause of such formation, Immisch thinks the starting point may be a chronic inflammation in a duct, whence arise elevations and depressions of the surface. In this way the outflow of saliva is impeded and from the retained fluid precipitation may occur. And the concrete material may close the duct; or it may form in such a manner as to leave an opening through which the saliva, which is screted behind, may still find escape.

A possible method in which the sialolith may form is about a body which has penetrated and lodged in the gland. Possibly, such foreign body might penetrate the common duct from the buccal cavity.

The most usual site of such concretion is the duct of Wharton; it rarely forms in the duct of Steno, and most rarely, if ever, in the sublingual duct. The facility of escape of the secretion from the parotis and sublingual glands may account for the infrequency of the sialolith in these glands.

The sialolith is seldom seen in the young; it has been seen oftenest in those between thirty and forty years of age. It is usually rounded or amygdaloid in form.

The sialolith may remain for a long time without causing much disturbance; finally, by encroaching on parts contiguous, it awakens inflammation, and finally pus is formed. If in the common excretory canal, it can, by impeding the escape of saliva, cause much more trouble than if lodged in the structure of the parotis.

Since the tumefaction caused by the concretion might arise from other growths, a differential diagnosis is best made by means of a fine acupuncture needle. In a few cases recorded of parotidean sialolith, the true nature of the affection has been revealed by an opening occurring spontaneously, or made by the surgeon, through the outer surface of the cheek, through which the calculus could be seen or touched with a probe.

Treatment.—The calculus should be removed, and, to avoid a salivary fistula, the opening, as a rule, should be made to the site of the concretion on the inner side of the cheek. This may be done by slitting up the buccal ending of the Stenonian duct, as Manec has advised; or the opening may be made directly to the calculus from the inside of the mouth. In the event of there being an opening to the body from the outside, as not unfrequently is the case when the patient first comes under observation, this opening should be enlarged, and the calculus thus extracted. From the report of cases treated in the latter way, it would seem that no salivary fistula remained afterwards.

Benign Tumors.—The class of benign tumors is well represented in the parotidean region; the angioma, lipoma, fibroma, adenoma and chondroma occur in the parotidean region, each of these arising from a normal anatomical element of the gland.

Angioma.—The angioma here may be dermal in site and present itself in different grades; and such dermal growth may

be treated in accordance with methods which have previously been explained.

Angioma involving the structure of the parotis is a much more formidable affection than that of dermal site. This form is congenital, and at the birth of the child, it may be voluminous and occupy the entire gland. Such tumor is cavernous in structure, yielding to pressure, and variable, somewhat, in volume, viz., it has the character of erectile tissue, and is swollen during expiratory efforts of the child. The overhanging skin, without participating in the vascular growth, may show some widening of its capillaries, and through the skin the bluish red color of the subjacent vascular structure may be perceived. The growth arises from abnormal development of the normal veins and arterioles; the veins in number and volume exceed greatly the arterioles. These widened veins present cavern-like dilatations.

The author has treated three cases of parotidean angioma; two were in children five and eight weeks of age, respectively, and the third in an adult, in whom the affection was present at birth, and, besides involving the parotid gland, it involved the subcutaneous soft parts of the right cheek from the zygomatic arch to the lower border of the maxilla inferior. This patient had a frequently recurring spasmodic movement of the facial muscles on the affected side, a movement resembling that induced in muscles by the Faradic electric current. The posterior portion of the gland in the adult case was not affected, but in the two infants the entire parotis was occupied by the growth. Besides, in one infant, the vascular tumor reached below the lower jaw, and embraced also the adjacent submaxillary gland. In each case the angioma was a marked deformity, for which relief was sought at the hands of the surgeon.

Treatment.—The treatment, most usually resorted to, has been removal of the tumor by excision. In the adult seen by the writer, there had been made an effort in infancy to obliterate the structure by subcutaneous strangulation, which was done by means of long needles, which pierced the growth deeply, and then the outer ends of the needles were included in twisted suture. The result obtained was only a partial success; and the portions which remained, developed so as to greatly deform that side of the face. For relief of this, the patient was operated on by the writer, as follows: A crescentic or rather a paraboloid cut was made through the skin, which, beginning at the malar bone, extended towards the angle of the mouth, and thence passed

downwards and backwards to the lower edge of the maxilla inferior, vertically beneath the point of beginning. This flap being reflected and drawn well backwards, a large part of the vascular growth was exposed. This was found to involve the anterior portion of the parotis, and to extend along and beyond the Stenonian duct almost to the angle of the mouth. The fatty mass around the terminal end of the duct had undergone the vascular transformation. The removal of the angiomatous structure was done piecemeal; this was the only way in which it could be done, since the remaining cicatricial adhesions of the former operation prevented any attempt at removal in mass. The flap was closed, yet, owing to secondary hæmorrhage, the internal wound was tedious in healing. The face was much improved in appearance; and the choreic movement, already mentioned, of the risorius Santorini and zygomatic muscles of the face on that side which had harassed the patient greatly, disappeared after the operation.

In the two infants the treatment pursued was excision. In one, a portion of the parotid gland and of the submaxillary gland was extirpated. The result obtained was that the young patient was delivered of the tumor, but there remained permanent palsy of the muscles of the lower half of the face. Twenty years afterwards, when the young woman was seen, it was gravely questionable with the author whether the chagrin entailed by the operation was not greater than that which would have arisen from the unoperated tumor. In the second infant, under two months of age, a large cuneiform section was excised from the tumor, and the wound was closed by deeply including sutures. This child survived the operation only a few days. Hence excision of the congenital parotidean angioma, advised by general authority, from the results obtained by the author in the two cases mentioned, was unsatisfactory. In such a case, subcutaneous thermal cauterization might be essayed with the hope of better results. This may be done by means of a long needle, which, being inserted one-half its length, the external portion may be heated by means of a spirit lamp in the manner already described. This cauterization should be done in horizontal lines so placed as to avoid the parotidean duct. If cauterization were thus done, there would be less risk of injuring the branches of the facial nerve.

Another plan of treatment which might be tried is continued pressure maintained on the angiomatous tumor. For this pur-

pose a disk of India rubber might be retained on the tumor by means of an elastic bandage. To accomplish much, such compression should be continued for several months.

Lipoma in this region may be situated merely beneath the skin, or it may be imbedded in the gland. The only appropriate treatment is extirpation of the growth.

The fibroma occurs in the parotis; an example of this was seen by the writer. In its extreme hardness, this growth resembles carcinoma; the fibroma, however, may be distinguished from carcinoma in this, that the latter continues to develop without limit, while fibroma grows more slowly, and, having reached a certain volume, it may not become larger. It is claimed that fibroma under the influence of some inflammatory agency may become malignant. The proper treatment of the parotidean fibroma is removal through a horizontal incision.

The lymphatic glands, which lie on the parotis, or imbedded in its structure, may inflame, suppurate and open through the skin. A slowly healing sinus may thus arise. Such cases should be treated by curetting the affected structure and dressing the wound with an ointment of iodoform or of subiodide of bismuth.

Lymphatic glands, here situated in the scrofulous subject, may enlarge and remain so without suppurating. The application of iodized collodion often reduces such; if this fails, the glands may be excised through a horizontal incision. In the lower portion of the parotidean region such enlarged glands are often seated so deep that, in their excision, the filament of the facial nerve which passes behind, and close to, the mandibular angle may be injured, unless the operator seeks for and isolates the nerve. If such filament be injured, the lower lip and angle of the mouth will be disturbed in their movements.

Enchondroma has been observed in the parotis; and this may be associated with fibroma; and it is probable that enchondroma here is the offspring, or successor, of fibromatous structure. The cartilaginous tumor may be removed through a horizontal cut.

Busch, in a study of the benign tumors which develop in the parotis, finds that they most ordinarily appear in the inferior part of the region, viz., in that which lies between the mastoid process and the angle of the jaw. In this site the cartilaginous tumor is oftenest found bound tightly down by the parotidean fascia. Being thus tightly bound down by this dense fascial stratum, as soon as the latter is opened, the tumor rises through the gap made, so that enucleation is facilitated.

Where the tumor is from the degeneration of one or more lymphatic glands, it lies outside of the fascial covering of the parotis; and in this site it is movable under the skin.

Busch finds that in partial removal of the parotis, the resultant palsy will depend on the part of the gland which is extirpated. For example, in excising the lower portion, nervous filaments to the neck will be severed; if the middle portion be excised, filaments to the mouth will be injured; and, finally, if the upper portion of the parotis be removed, the nervous filaments to the eyelid will be cut. Allied to the benign growths described may be mentioned the syphilitic affection of the lymphatic glands here situated, which may become infected and swell in case of primary chancrous ulcer having its site in the lips or mouth. Care must be taken not to confound such disease with that which might arise from tubercular disease. When the syphilitic nature of the case has been diagnosticated, the treatment should be similar to that of constitutional syphilis.

In case ptyalism supervenes during mercurial treatment, the parotid gland swells; and the accessory portion of the gland may swell as a small isolated tumor in the cheek. Such tumefaction would gradually vanish with the subsidence of the salivation.

Malignant Growths of the Parotid Gland.—Sarcoma is a frequent occupant of the parotidean region; and the growth presents itself here, as elsewhere, in its diversified form, viz., as fasciculated, encephaloid, myxomatous and cystic sarcoma.

The most common form is the fasciculated type, which, appearing in circumscribed form, is, at first, firm and solid in texture; and later, as it attains larger volume, it is lobulated, softer and rich in vessels. The microscope reveals elongated and spindle-shaped cells. And, imbedded in the same structure, one finds proliferated or multiplied epithelial cells. Sarcoma, in its subtle and shifting morphology, sometimes baffles definite classification, and escapes from the well-built bounds of the descriptive histologist. Thus, as just stated, sarcomatous structure is commingled with degenerated epithelial elements, which are of the nature of epithelioma; also, cystic dilatations are often found in the sarcoma, arising from the dilated cul-de-sacs of the initial glandular ducts. The encephaloid species of sarcoma, constituted of round cells, is soft in consistence, and develops rapidly, and often contains dilated ducts and degenerated epithelium. Akin to encephaloid sarcoma is the melanotic tumor, which has been seen here by Weber.

The cystic dilatations may contain material similar to liquefied gelatine; and a tumor thus formed is named myxomatous sarcoma. This thickened, jelly-like content is a product of the glandular structure, that has wandered quite away from its predestined function of secreting saliva. The cyst, containing sarcoma, is nodulated in its form.

The sarcomatous parotidean tumor appears in the youthful subject, or in those who have not reached the declining period of life. It is so painless in its advent that it may have attained some size when it is accidentally discovered, as an eminence causing irregularity of surface of that portion of the face. The sarcoma is not inclined to become generalized; and this characteristic of isolated action renders the tumor a more proper one for extirpation than is the case in carcinoma. Leading authority favors the removal of the sarcomatous neoplasm; and in the event of there being a recurrence, a second or third operation has sometimes been successful in curing the patient.

Epithelioma, primarily arising in the parotis, has been the matter of discussion among pathologists; some doubt whether this growth in pure form arises in the parotis. O. Weber claims the case to be epithelioma when the degenerated acini of the gland have lost their limiting membrane, and the multiplied epithelial cells encroach on the interstitial structure.

Delorme prefers the name epithelial adenoma for these growths; and as anatomical characteristics Delorme enumerates the following: in form it is spherical, ovoid, nodulated or regular in outline; in consistence it is soft or elastic, and is definitely separated from adjacent structures, and is rarely accompanied by facial palsy. The tumor has commonly been observed in the youthful subject. If ulceration occurs, the process is similar to that seen in the non-malignant tumor. There is rarely glandular infection, and the general health is seldom depressed. On section the tumor presents a granular aspect; and, if the part be compressed, cylindrical bodies resembling vermicelli will be forced from the incised surface. Under the microscope a complex structure appears, in which fibrous, cartilaginous and myxomatous tissues are seen; also epithelial cells dispersed in cylindrical or bird-nest form.

Epithelioma.—Epithelioma may commence primarily in the parotis, or it may appear there secondarily, viz., in a lymphatic gland, the disease appearing metastatically in the gland from an epithelioma seated in the eye, the cheek, the lip or the mucous

membrane of the buccal or pharyngeal cavity. Also an epithelioma, which has originated in the dermal glands overlying the parotis, may penetrate through the skin and attack the gland.

Carcinoma.—Cancerous disease may appear in the hard and soft forms, that is, as scirrhous and encephaloid cancer. The disease may appear here as an aboriginal product; or it may migrate to the parotis from a neighboring part where it first appeared.

These two forms of carcinoma differ radically from each other in structure. Scirrhus is firm, of wood-like hardness, is intimately adherent to the contiguous parotidean structure, and the boundary between it and the unaffected glandular structure is scarcely discoverable. On the contrary, the encephaloid growth has a more definite boundary; it is both soft and elastic, and, examined microscopically, encephaloid cancer presents a fibrous stroma, in the meshes of which are found fluid and cells of variable form. Both forms, besides implicating the gland, sooner or later become adherent to the skin and cause puckering of surface, especially so in the case of the scirrhous form. These growths have no tendency to limitation, but sooner or later invade and press on adjacent parts; and in this way grave functional disturbance is caused. Thus mastication is rendered difficult through pressure on the muscles concerned in that act; also, thus may arise palsy and pain in the region of the face. The growth may compress vessels, or even penetrate them. The overlying skin is finally perforated by ulceration, and exuberant and vascular granulations protrude through the breach. The pus excreted is of foul odor. In from six to twenty-four months the patient dies; and death may arise from exhaustion induced by diffusion and migration of the disease to important viscera, as the lungs or brain; also, through ulceration, vessels may be opened and recurring hæmorrhages ensue. Hence the prognosis of carcinoma of the parotis is highly unfavorable.

Melanotic cancer has been observed here, and is remarkable for its rapid progress, speedy recurrence after extirpation, and early fatal termination.

The accessory parotid gland seated on the Stenonian duct has been the site of neoplastic formations similar to those which appear in the parotid gland itself.

Treatment of Malignant Tumors of the Parotis.—This treatment has been the matter of sharp controversy, some espousing the side of non-interference in case the tumor has attained large

dimensions and occupies a large part of the parotis; others, again, ardently contend that the affected gland should be removed. Topographical anatomists have taught that it is extremely difficult to remove the parotis in the cadaver; and they have argued, from this, the impossibility of such removal when the gland is degenerated or changed through disease. Says Hyrtl: "It is well known to the anatomist how difficult it is to dissect out the sound parotis without leaving fragments of it behind; what is, then, to be expected in the attempt when the parotis is dissected? Truly, says one of the leading French authorities, *the extirpation of the diseased gland is an operation quite impossible.*" Allan Burns said, in his "Surgical Anatomy of the Head and Neck," in 1811: "The extirpation of the gland is quite out of the question; its impracticability is proved by reviewing the connections of the gland. Whoever has in situ injected the salivary duct with mercury, and then, even when the gland is healthy, where it was free from preternatural adhesions, and limited to its natural size, has tried to cut it out, would be convinced, when he saw the mercury running from the innumerable pores, that the gland extends into recesses into which he could not trace it in the living body.
On the dead subject I have attempted the extirpation of such tumors, but, even there, have never succeeded in clearing fully away the diseased substance."

Such teaching deterred many from operating; a few surgeons disregarded the edict of the anatomist, and in 1841 Bérard published a work on the subject in which were reported fifty-two extirpations of the parotid gland. Bérard finds that the removal of the parotis is not more perilous than other capital operations; for of the fifty-two cases no one died during the operation; and in only two or three cases did death supervene two or three days afterwards. And he claims that it is no longer a question whether the parotis can be extirpated, but rather whether the disease can be entirely removed from the cavity occupied by the diseased gland. Bruns has collected a much larger list of extirpations of the parotis, which shows that the operation is practicable, and not especially perilous; where death occurred it was from some extrinsic complication.

Extirpation of the parotis endangers the external carotid artery, the internal jugular vein and the facial nerve. Strangely enough, some claim to have removed the gland and to have left the artery and nerve intact. Malgaigne declared in 1858 that the parotis can be removed without lesion of these parts. Burns

denies the possibility of this, and claims that such extirpation has only been the removal of a conglobate gland, of which there are two in connection with the parotis: one in the center of the parotis near the division of the external carotid, and one division underneath its lower lobe. In proof of this, he cites cases which he saw operated on; and, in the discussion of the subject, Burns gives glimpses of professional rivalry which animated both pen and scalpel in his day.

To guard against hæmorrhage, the primitive carotid has been tied, likewise the external carotid; or, instead of directly tying the vessel, some have used a provisional ligature; that is, a cord has been passed underneath the artery, and afterwards tied, if the vessel was opened. Others have depended on compression made by the hands of a competent assistant. Each of these plans has had advocates of its superiority. The ligation of the external carotid, and not the primary trunk, is the preferable plan; and in whichever way it is done, blood by reflux soon finds its way through the ocular branches of the internal carotid into those of the external carotid artery; but this vascular compensation occurs sooner when the external and not the common carotid is ligated, since the blood in the internal trunk is then subjected to more pressure. In case the extirpation of the parotid be but partially done, or if the growth be capsulated, and hence so isolated that it may be removed without removing the gland itself, then the hæmostasis may be accomplished by indirect compression, that is, by pressure on the primitive trunk, or, better yet, by pressure at the bifurcation of the common trunk.

The entire extirpation cannot be effected without lesion of the external carotid, though some have asseverated to the contrary. And the same is true of the facial nerve; its branches will be severed, and the face palsied on that side. And of this condition, to which the operation invariably consigns the patient, he should be plainly foretold. The mouth will be drawn to the opposite side; the emotional movements will be lost on the side operated on; the movement of the corresponding eyelids is lost, so that the eye will remain staringly open, and, as the result of such exposure, the eyeball becomes congested and red through irritation, and augments the patient's unsightly appearance. Such a picture of the resultant condition should be traced before the patient by him who will remove the parotid gland.

There is a general concurrence of opinion in regard to removing the malignant parotidean growth. So long as it is of moder-

ate dimensions, as Weber advises, this should be done in cases in which the growth is a scirrhous tumor which can be detached from the parts around it; and also in case it be an encephaloid tumor which has not perforated the aponeurotic wall on the side of the pharynx. But if the tumor has opened into the pharynx, or has penetrated the internal jugular vein, or involves the bones adjacent, the knife should be withheld.

Operation.—The instruments required for the operation are scalpel, retractors, hæmostatic forceps, blunt dissector, silk and catgut thread, aneurysmal needle, blunt scissors and materials for sponging and for final dressing.

Various dermal incisions have been proposed for exposure of the diseased parotis. Weber directs to open the skin, by an incision parallel with the posterior border of the lower jaw; and, should this not offer an ample field for the operation, this is to be enlarged by a horizontal cut corresponding to the lower border of the maxilla. The skin being dissected up so as to expose the tumor, some, as Stromeyer and Liston, advise to open the aponeurotic covering, and then to continue the work by enucleation. Weber urgently opposes this plan, as well as that of Roser, who removes a section from the diseased gland in order to lessen its volume; but, retaining the fascial covering intact, Weber prosecutes the dissection of detachment outside of this capsule. When the external attachments are divided, then Weber endeavors to get behind the tumor by uplifting the lower lobe, and thence he continues the detachment upwards; thus the external carotid is reached first in its proximal portion. Should the adherence be so firm below that one cannot enter there, then Weber would commence above, or at the sides, either in front or behind; and thus the tumor is to be loosened and uplifted from its deep connections. Tie vessels which are met, doubly, and divide between the ligatures. Finish the deeper part of the extirpation with care, and do not spoil, with undue haste, the concluding steps of the work. Such, in brief, are the directions for the total removal of the parotis given by Otto Weber, whose diligent researches in surgical pathology and equally thoughtful work as an operator, render him, in the opinion of the writer, one of the most trustworthy guides who have appeared in this century. Weber pronounces total extirpation of the parotis to be one of the most delicate, subtle and beautiful surgical operations, and which, with due care, can be done without much loss of blood.

Delorme, in an elaborate exposition of the principles which should govern in the extirpation of tumors involving the entire parotis, makes three stages of the work: 1. Incision through the skin, which may be done vertically, crescentically, crucially or by an elliptical cut in which a portion of the skin is excised. 2. Detachment of the overlying derm. 3. Separation of the tumor from its deeper connections; and in this act some dissect from below, upwards; others from above, downwards; and others again detach from the sides. Bérard advises to first dissect up the anterior border from the ramus of the jaw; then to loosen the posterior border from the sterno-cleido-mastoid muscle. If necessary, tie the external carotid, and do this as low down as possible, since in this way it will not be necessary to tie the vessels which arise beyond the ligature. Avoid, in the dissection, the submaxillary gland, the facial artery, and, especially, the internal jugular vein, which may be endangered in the deeper portion of the detachment. Tie doubly the external jugular vein, and divide between the ligatures. The scalpel must be dropped as early as possible, and the work continued with the fingers or a blunt dissector.

The writer, in the treatment of malignant neoplasm involving the parotis, has several times removed the gland. The work has been done through a vertical cut through the skin corresponding to the vertical axis of the gland; and to this was added a short horizontal one in the line of the Stenonian duct, and to control hæmorrhage, the external carotid was tied as the first act. In the enucleation, the capsule of the gland should be included. Veins, which are opened, should be ligated if torsion fails to control the bleeding. Care should be taken that no glandular fragments be left behind, since salivary oozing from them would prevent closure of the wound. In a patient of sarcoma of the gland, operated on in the manner here briefly outlined, the writer obtained complete union of the wounded structures in less than two weeks.

Sometimes the tumor has developed independently of the parotis, and, in its growth, it has pushed the gland beyond it, so that the two are separate from each other; in such condition, the growth may often be removed without ligation of the external carotid artery, and without division of the branches of the facial nerve.

In complete extirpation of the gland the following arteries may be met in the dissection: the external carotid, the temporal,

internal maxillary, transverse facial, posterior auricular, occipital, and numerous small branches distributed to the parotis. The external jugular vein and its derivative confluents must be divided. The former operators who removed the gland without first tying the external carotid, were compelled to tie its several branches just named; and the plan was to tie each doubly and divide between the ligatures. And even though the external carotid be tied, compensating reflux occurs so speedily that the writer has found it necessary to tie some of the divided branches.

The operative incision should be closed by suture in its upper portion; the lower portion should be left open. The wound, which is made, causes, for a time, difficulty of swallowing, so much so that MacClellan was obliged to nourish his patient for a period through a tube passed into the œsophagus. There have been cases in which there temporarily occurred disturbance of hearing.

Cases have been reported in which secondary hæmorrhage occurred. In such an emergency the writer would use aseptic sponge as a compress on the bleeding part. And the sponge would do more effective work were it first saturated with dilute alcohol, and sprinkled with tannin. Such hæmostatic compression should be continued for from eight to twelve days; in such time the opened vessels would become securely occluded with clotted blood.

The facial palsy may be complete or incomplete; when it is complete, in a few cases, the palsy of the face has afterwards partly vanished; and this can only be explained by the supposition that certain branches of the nerve have not been severed.

Parotidean Fistula.—Parotidean fistula may arise from lesion of the parotid gland, or of its excretory duct.

The fistula proceeding from the parotis is caused by a wound or an abscess which, implicating the gland, severs one or more of its component lobules. The wound causing it is not unfrequently produced by the surgeon himself in the course of operative work done in this region. The site of such fistula should be taken into account, since it serves to distinguish the glandular from the Stenonian fistula. The glandular fistula may be situated above or behind the ear, in any point of the parotidean sulcus. Or it may open on the cheek in front; and then the cause is often an abscess which has opened remote from its source, or which may have been seated in the accessory parotis. And finally, the fistula may pass some distance under the skin, and open through the skin more or less remote from the starting point.

The opening may be as fine as a hair, or so large that a large sound can enter it; and this is generally in the center of granulative tissue; and, commonly, the skin around is sound.

The diagnosis of such fistula is usually easily made, since, during the act of mastication, the saliva flows from the orifice in greater or less amount. Such fistula often closes spontaneously, in this particular differing greatly from the Stenonian fistula, which often taxes surgical art to its utmost to effect a cure.

Treatment.—A variety of methods have been resorted to to obtain closure; these can be summarized under four heads: compression, cauterization, suture, and suture with occlusion.

Cases have been cured by compression, maintained by lint bound upon the opening. Compression of the entire parotis, made with the view of causing atrophy of the gland, has been practiced. As a single means of treatment, compression has given unsatisfactory results; if used, it should be employed in conjunction with cauterization or suture.

Cauterization by means of a finely pointed pencil of nitrate of silver, or a wire which has been heated to red heat, may be used. Or a caustic solution, either alkaline or acid, may be injected into the opening.

Suture has been used; for this purpose trim the edges of the opening, and close by means of catgut or fine metallic suture. The author has successfully employed the latter plan, combined with occlusion of the sutured wound by means of collodion, painted over the part. The operation was repeated three times before success was obtained. Besides occlusion with collodion, the work may be aided by compression on the parotis, by which secretion of saliva will be diminished. Meantime, movements of the mouth, tongue and lower jaw should be avoided, and nutrition should be maintained by means of liquid food.

Stenonian fistula may arise from wounds which open the duct; also from an abscess involving the duct. A rare cause observed is a calculus, forming in the duct, which enlarges until it perforates the walls of the canal.

The diagnosis of a Stenonian fistula is made without difficulty; in fact, it too easily announces and declares itself by the escape of saliva from the opening on the cheek. Though this salivary trickling may be constant, yet it is greatly augmented during the act of chewing food: and this fluid, trickling upon his person, renders the patient offensive to himself, and an object of nauseating disgust to those who are in his presence. The victim

early and urgently seeks relief, and is surprised when told that the repair of this insignificant breach in his face is one of the most difficult feats in operative surgery; yet the patient is undismayed by the troubles to which the proposed treatment will subject him; for if unrelieved he will be forced to use some device to catch his driveling saliva. Morand says that a patient of this trouble, whom he saw, was forced to use at his meals a barber's basin. From a patient of Duphœnix there flowed, from such a fistula, about four ounces in twenty minutes. The disuse of the buccal end of the canal causes it to become very narrow; and this impediment must sometimes be overcome in the treatment.

Inventive genius has been diligent in the search for means to accomplish the cure of Stenonian fistula; and many expedients devised seemed to have accomplished cures.

In a thesis on the subject of parotidean fistula, written, in 1868, by Mirza Abdal Vaherb de Gaffary the numerous means of treatment are reviewed; the following is a synopsis of the methods: cauterization; compression made between the gland and the fistula, or over the fistula, or on the gland itself; or exsection of the fistula may be done, and the wound closed by suture. The work can also be done by dilatation of the end of the canal; or a derivative canal may be made by means of a hot wire, a silken cord, a canula or a trocar and a seton. Or two canals may be formed by means of a leaden wire, or a common cord. Cures have been effected by cauterization of the fistula; likewise by injecting into it some stimulating fluid. The leading and trustworthy methods consist, in the main, in restoring the calibre of the anterior portion of the canal, in case that has been contracted, or of forming an opening from the fistula directly through the cheek into the mouth. The farther backwards the site of the fistula is, the more difficult is the cure. Tillaux says that if the fistula be in the masseteric portion, the cure is impossible, or nearly so; on the contrary, if seated in the anterior or buccal portion, it is curable. And, as an opening in the posterior portion might be mistaken for a fistula from the glandular structure, as distinction between the two, Tillaux finds that, in the glandular fistula, some saliva will still flow into the buccal cavity, while in case of the main duct being opened, the whole of the fluid escapes on the cheek, and none into the mouth.

We will proceed to individualize in detail the methods which have been successfully employed by different surgeons for the cure of this fistula.

Louis sought for the buccal end of the duct, and passed into this a fine, fenestrated probe which carried a thread; the probe and thread were carried through the anterior portion of the duct, and brought thus through the fistula. The thread, being detached from the probe, was left in the entire passage, and, to maintain it in place, the end within the mouth was tied to that on the cheek. In a day or two a larger thread was passed, and this was repeated until the canal and fistula had been much enlarged; this attained, the cord was cut off on the outside, and then the buccal portion was drawn inwards, and the canal allowed to close from the cheek inwards. This plan would be impossible should there be closure or much narrowness of the buccal portion of the duct. As aid, injections may be made through the anterior part of the canal.

A method superior to the one described is that invented by Deguise in 1811. This consisted in passing a small trocar through the fistula and forcing the instrument from before backwards; through the canula Deguise passed a leaden wire. Then, from the same external orifice, the trocar was caused to traverse the cheek from behind forwards, and the other end of the leaden wire was carried through into the mouth, when the ends were fastened inside. This method has served as the model of other plans in which the original is somewhat modified. Instead of leaden wire, that of silver or gold might be used, and, after the wire is fastened inside of the mouth, the edges of the fistula may be pared, and the external wound closed by suture. The looped wire should be tightened, from time to time, so that it may gradually cut through the included portion of the cheek. Silken cord might be used instead of wire, or a small canula might be passed in from the fistula and retained in the cheek, so as to permit the saliva to enter the mouth after the outer opening is sutured.

The treatment has been directed to the outer opening alone; the plans here used have been suture, cauterization and compression.

The edges of the fistula may be trimmed and then united by suture, and this will be aided if covered by a thick coating of collodion. A cure might thus be effected, provided the anterior portion of the canal is yet patent; and should this be contracted, it must be dilated by the use of appropriate sounds.

Closure has been attempted, yet rarely successfully, by cauterization of the fistula by means of a pencil of nitrate of silver, or the thermal cautery.

Compression has been tried, and this may be applied on the outer opening, so as to prevent the escape of saliva; or the pressure may be made on the gland, so as to check the secretion of saliva.

Claude Bernard has found in vivisective experiment that, if the salivary duct be tied and the secretion thus retained behind the ligature, atrophy of the gland will ensue. Some have counseled to utilize this fact in the cure of salivary fistula. The few reports of trials of this plan do not encourage its repetition.

Viborg, after severing the duct in animals, reunited the ends by suture; and as union occurred, he proposed direct suture as a plan of curing Stenonian fistula.

The ingenious Langenbeck proposed to dissect up the posterior end, and turn the same into the mouth through an opening made inwards through the tissues. The objection to this plan is that the end which has thus been shifted tends to retract, and the buccal orifice becomes narrowed or closed.

Desault proposed to dry up the fountain by compression maintained on the gland, so as to cause its atrophy. It is probable that the offspring of modern civilization would rebel against such a painful plan of treatment.

Bonafont reports that he cured a salivary fistula in 1841 by dissecting up the posterior part of the duct, and, having fastened the end in a small canula, the latter was passed through the cheek into the mouth, and retained there during the healing of the outer fistula, which was closed by suture. In 1851, Balassa reported a cure by a modification of the plan of Deguise, above mentioned. In 1861, Consolini cured a Stenonian fistula by passing a catgut thread through the anterior portion into the posterior one, and retaining the thread in place until the outer fistula healed. In 1882, Stokes, of Dublin, cured a case in a similar way, yet, instead of catgut thread, he used a wire.

In conclusion, it is clear that there is no dearth of methods from which the surgeon may make selection for the cure of parotidean or Stenonian fistula; and it is probable that by a diligent prosecution of any one of them, a cure of the patient will be attained.

CHAPTER XV.

MAXILLA SUPERIOR.

Fracture.—Reference has already been made to fracture of the upper jaw which existed coincidently with a lacerated wound of the cheek; mention was also made of subcutaneous fracture of the anterior wall, in which the latter is forced into the antrum; there yet remains to be considered certain fractures of the maxilla superior which involve the processes or the body of this bone.

The alveolar process may be broken, on a small scale, in the act of extracting teeth; yet the improved methods of dentistry, in which the forceps has replaced the lever and key, have rendered such fracture a more rare occurrence. The roots of the molar teeth are sometimes disposed in such divergent position, or these roots so embrace a portion of the process, that the teeth cannot be extracted without causing some fracture of the process. And this injury may consist merely of a small piece of bone broken from the inner or outer wall of the alveolus; or the rent may include a considerable portion of the alveolar process; or, finally, it may involve the body of the jaw.

When a minute fragment of the alveolus is broken off, the conditions are such that it usually dies, and, if not removed at the time, it will sooner or later become separated by suppuration. The condition is somewhat more grave and requires more attention when a portion of the process containing one or more teeth is broken off. An injury of this kind is to be treated by restoring the fragment to proper site, retaining it there, and maintaining it in rest. The replacement is easily done; retention in site is more difficult; this may sometimes be done by ligating the teeth of the fragment to those outside of it by means of wire or silken cord. Wire is more easily used, yet thread is less apt to injure the teeth. If retention in place is thus impracticable, as is the case in which a large portion of the process is broken, and by its weight separates from the body, then a mold of gutta percha should be applied to the part, and the lower jaw brought against

the upper one and held there by a bandage placed around the head. Meantime the patient must be fed on liquid food. This food may be introduced through a tube passed into the buccal cavity, around and behind the molar teeth; or, if there be a breach in the teeth of the lower jaw, the food may be introduced there. During this closure of the teeth, the cavity of the mouth must be rinsed out two or three times daily by injecting into it a weak solution of borax: thus parasitical multiplication is averted, and more rapid healing insured. Under this management speedy union of the fracture ensues in from three to four weeks.

In case a portion of the body of the jaw is detached with the alveolar process, then a similar plan of treatment is to be pursued; special care, however, is to be taken that the displaced fragment be accurately replaced and retained in normal site. After the healing of the fractured alveolar process, should there remain some inequality in the position of the teeth, this will commonly disappear through the work of mastication, in which pressure on the dependent part tends to force it into normal place.

The body of the maxilla superior is so situated that it is protected from the usual causes of violence which produce fracture elsewhere in the body; and, excepting projectiles which also wound the soft parts, the fracture of the upper jaw through indirect or direct impact of force, is rare.

Fracture resulting from indirect violence has been studied by Leheribel, who finds that this bone is protected by three sets of osseous columns, viz., the fronto-nasal in the median line, the malar and the zygomatic at the sides, and lastly the pterygoid processes, which support the bone behind. Violence is oftenest transmitted to the upper jaw through the maxilla inferior; for example: a blow on the chin may break the lower jaw; or, this part escaping, the violence may travel to and break the upper jaw. In a second way, when the lower jaw is fixed, violent force acting on the summit of the head has been known to fracture the maxilla superior. And in a third way, the bone may be broken by the patient falling some distance and striking on the chin. And, lastly, fracture has arisen from violence acting on the malar bone, and driving this bone downwards and inwards.

Guérin, in experiments on the cadaver, found that a blow on the face below the nose causes a horizontal fracture traversing the maxilla below the malar bones; and the pterygoid processes are likewise broken. In such case, if the finger be passed behind the molar teeth and pressure be made on the pterygoid plate,

the latter will be felt to move; or, if it is not moved, such pressure awakening pain is indicative of fracture; and the movement mentioned and the pain awakened are pronounced by Guérin to be trustworthy diagnostic signs of fracture of the upper jaw.

In the cases of fracture resulting from indirect violence, the diagnosis, as just seen, may be difficult to determine; on the contrary, cases occur in which the condition is clearly evident through the displacement of the bone. The two bones may be separated from each other, and one may be movable, and somewhat depressed below the other; or both of the maxillæ, without injury of their median synosteal suture, may be detached from their upper, lateral and posterior connections, and may hang loosely over the oral cavity. The writer has seen and treated a case of the latter kind, which resulted from a cable-car accident, and the violence was probably direct, as the cheeks were greatly contused. There was no open wound. The maxillæ, as a common mass, were movable, and rested on the lower jaw. There was serious encephalic injury, in which cerebral concussion was prominent.

In fracture caused by direct or indirect violence, vascular rupture must occur; and should the bones be displaced, this rupture will be so extensive as to cause swelling and visible ecchymosis. Such ecchymosis may be found in the roof of the mouth, or in the tissues investing the base of the alveolar process. Such swelling and blood marks aid in the determination of the fracture, when there is no mobility.

Fracture of the upper jaw may have as ill consequences obstruction or closure of the lachrymal canal, pressure on some of the branches of the superior maxillary portion of the trifacial nerve, and irregularity of the dental row through displacement of the alveolar process. To avoid these results, which may amount to grave annoyances, the surgeon in charge should accurately restore the fractured part, or parts, to their normal site, and afterwards retain them at rest until union has taken place. Restoration to place may be done with the fingers and a blunt instrument, such as a sound passed into the nostrils. That the lachrymal canal is open will be shown by the tears passing through their natural channel; but if the canal be obstructed, the tears will flow over the lower lid. Another rare accident is the emphysematous infiltration of the tissues, due to air being forced into them during strong expiratory effort through the nasal passages.

Fracture of the maxilla superior is remarkable for the short time required for healing, provided the parts be placed in proper position, and thus immobilized. After coaptation, if alveolar fracture demand it, let the teeth be encased in gutta percha, and then, by a bandage, fix the lower jaw against the upper one, so as to retain the latter in position. Meantime, during the four weeks, which time is demanded for healing, let the patient be fed in the manner already described. The appliance of retention may be a gypsum cast; or straps with buckles may be placed vertically, obliquely and horizontally, so as to maintain rest of the broken bone.

Fracture from gunshot wound has often been observed by the military surgeon; and in this era of social discord, in which the worst as well as the best elements are evenly paired in the turmoil of civilization, the civil surgeon is not an infrequent observer of gunshot injuries; such injury, self-inflicted, may be the gunshot wound in the mouth, which failing to kill, as was intended, the ball has shattered the upper jaw. Such projectile wound should be treated in the same manner as gunshot wounds in other parts of the body; especial care, however, should be taken to save fragments of the palatal process which are still adherent to the soft parts.

Resection of the Upper Jaw.—Resection of the maxilla superior may be partial or total in its extent; partial resection may concern either the processes or a portion of the body; but in total resection the entire bone or both maxillæ may be extirpated. In total resection the inferior turbinated bone is necessarily removed, inasmuch as it articulates only with the upper jaw. On the other hand, though resection is said to be total, yet, in most cases in which it is done, fragments of the articulating processes are left behind.

Resection is also done temporarily, in which a part of the bone is loosened and uplifted in connection with the soft parts, for the purpose of reaching growths situated in the antrum, the nasal cavities or the naso-pharyngeal region; and after this purpose is accomplished, the bone is replaced.

Resection is often done for the purpose of removing a malignant neoplasm which implicates a part or the whole of the bone; for the maxilla superior, like its close neighbor, the parotis, is the germinal site of the various malignant growths; and if these do not arise in it, they may reach it by extension. Exceptionally, resection is required for the removal of benign

tumors. These unfortunate prerogatives belong to both the upper and the lower jaw.

O. Weber has collected three hundred and seven cases of tumors of the upper jaw, which he classifies under the following heads: osteoma, thirty-two; vascular tumor, one; fibroma and vascular fibroma, seventeen; sarcoma, eighty-four; enchondroma, eight; cysts, twenty; mucous polypi, seven; carcinoma, one hundred and thirty-three, and melanoma, five. Weber thinks that some of the cases of carcinoma should have been placed under the head of sarcoma, since he believes that nearly half of maxillary tumors are sarcomatous in nature.

In case the disease requiring resection is limited to the palatal or alveolar process, or is situated in a portion of the maxilla superior, then partial resection is the proper operation to be done. In such partial resection, the guiding rule should be to excise enough of the bone so as to completely remove the disease; to spare the parent bone and permit the early reappearance of the disease would be ill economy. The excising knife or chisel should, in its girdling cut, reach into the sound structure, and, in fact, comprise a few lines of the latter inside of the line of excision; only thus operating can a satisfactory result be obtained.

The resection of a portion or of the entire alveolar process is done as follows: An incision is to be made between the cheek and the jaw, in the bottom of the fossa between the two parts, and the cheek is to be dissected from the jaw to a sufficient distance to expose the outside of the bone which is to be divided. This separation is best done, after the first cut is made with the scalpel, by means of a chisel, with which the periosteum is uplifted. A similar cut, and concentric with the first incision, is to be made on the palatal side of the alveolar process. The vertical cuts are now to be made through the bone, including the affected part. To make these cuts, it is often necessary to extract one or more teeth which stand in the line of the incision. Next a horizontal cut uniting the vertical ones is to be made. This third cut completes the separation of the diseased part. The division of the bone may be done with a resection saw, chisel and mallet, or with large, strong-bladed forceps. If forceps be used, there should be two pairs, one with straight blades for the vertical cutting, and another curved pair to divide horizontally. The chisel and mallet are favorite instruments of the French in maxillary resection; the division, thus done, leaves a more irregular surface than if the removal be done with the resection saw.

This instrument with its narrow blade can be used in any direction, and at any angle. The author has operated according to each of the methods mentioned, and gives his preference to the saw, especially, if along with it, there be used a small trephine, with which openings may be made at the point of union of the vertical and horizontal lines of section; for the narrow-bladed saw can be passed in such opening, and thence the sawing can be done in both directions.

This alveolar resection can be done through the mouth, and hence without external scar. Should the opening of the mouth be too narrow, then more room could be gotten by extending the angle of the mouth by means of a horizontal cut; and such a cut would leave an inconspicuous scar. To assist in doing the work through the mouth, the oral opening can be held open and dilated and shifted from its site by means of large retractors.

A growth seated on the anterior surface of the superior maxilla and limited to this face, may also be removed through the mouth. To do this, incise through the labio-maxillary fossa, and with a blunt dissector separate the structures of the cheek from the maxilla; and this detachment can be carried to the infra-orbital margin. To aid in this dissection, the mouth may be shifted upwards. In this wise the writer excised an osteomatous growth already referred to, involving the front face of the maxilla.

The total excision, or resection, as it is oftener named, of the upper jaw has been the matter of emulous effort among operative surgeons. Among those who have earned distinction in this field are the names of Gensoul, Lizars, Michaux, Dieffenbach, Heyfelder, Langenbeck and O. Weber. A diagrammatic representation of the lines of incision would present a face well traversed with sections. If these lines be studied as to their position and direction, one finds a frequent one to be a vertical median line from the lower part of the forehead (glabella), along the dorsum of the nose, through the upper lip into the mouth; or, instead of in the median line of the nose, the incision may be made vertically alongside of the nose to the mouth; in a third method, the incision is made from the angle of the mouth, or from some point of the border of the upper lip, upwards and obliquely outwards. This oblique cut has been given various positions on the cheek; and it may be straight or curved. And, lastly, a horizontal cut may be made from the nose outwards, close to the lower border of the orbit.

In the pioneer work done by Gensoul and Lizars, the maxilla was exposed by a quadrangular flap, which was made by two vertical cuts, viz., one which was made alongside of the nose, and another extended directly upwards from the angle of the mouth. The lateral or outer cut, in this method, divided many branches of the facial nerve as well as the duct of Stenson; and thus the unfortunate patient remained with a palsied cheek and a salivary fistula; conditions which, if not as fatal to life as the growth which is to be removed, certainly render existence scarcely tolerable. And to avoid these ill results, the outer vertical cut was abandoned.

The following review of resection of the superior maxilla, drawn from the published work of eminent authorities, will present in somewhat historic order the various methods which have been pursued.

The quadrangular flap of Gensoul being abandoned, for the reasons before given, Dieffenbach, in 1847, published thirty-two operations in which the removal was done through a vertical cut which passed from the inner angle of the eye to the mouth, and which was aided by a horizontal cut beneath the eye; thus done, the facial nerve was spared.

Michaux, in 1852, removed the superior maxilla to form a way by which he could enter the posterior nares and remove naso-pharyngeal growths; and, in his method, he discards the removal of the malar bone as done by Gensoul, and exposes the maxilla through a median incision which reaches from the lower part of the forehead along the dorsum of the nose downwards into the mouth; and this may be aided by a horizontal cut underneath the eye; and, if need be, a third cut may extend from the outer angle of the eye to a point beneath the zygoma. As far as the disease will permit, save the zygomatic, nasal and palatal processes of the maxilla. To do bilateral maxillary resection, Michaux counsels to use the long cut in the median line of the face. He uses the chisel and mallet as more manageable instruments than the Liston forceps, or the chain-saw. Michaux performed fifteen resections, of which seven died from purulent infection.

Oscar Heyfelder, son of J. F. Heyfelder, in 1857 wrote on maxillary resection: a work inspired by filial devotion, in which the methods pursued by the father were compared with those of other surgeons. The father, in 1852, was the first to perform resection of both maxillæ. This was done by two lateral cuts

extending on each side from the malar bone to the angle of the mouth. The large flap thus formed, including the nose, was dissected up and turned upwards. The malar bone, separated from the upper jaw by the chain-saw, was preserved. And the soft parts lining the palatal process were loosened and separated as the last act of the detachment. As cuts, which may be used, the Heyfelders employed a central median one and an oblique lateral one; the latter, commencing at the angle of the mouth, may run upwards and outwards, and terminate at the anterior, middle or posterior part of the malar bone. As a rule, the maxilla, with the tumor, can be removed through the oblique lateral cut; and the advantages resulting from it are that there remains but one scar; its disadvantages are that it must sever branches of the facial nerve, and might divide the duct of Stenson. The maxilla superior can also be exposed by an anterior lateral flap that lies along the side of the nose; and to this, two horizontal incisions may be added, one underneath the eye, and one continued outwards from the angle of the mouth; and thus a large quadrangular flap is so formed that the salivary duct and the facial nerve are spared. This quadrangular flap is the one preferred by Heyfelder for resection of the upper jaw.

In case partial resection is to be done, then Heyfelder advises the incision of Küchler, viz., a cut one and one-half inches long, passing from the mouth upwards alongside of the nose.

Should it be needed to remove the lower jaw along with the upper one, Heyfelder advises to do this through a cut made from the forehead to the point of the chin; and another cut which passes along the lower margin of the maxilla inferior, and upwards along the ramus.

In all these operations, Heyfelder advises to uplift and retain the periosteum, when this is possible. When necessary, separate the upper jaw through the median suture by which the two are connected. Large forceps may be used to separate the maxilla from the bones with which it is articulated; in many cases, however, Heyfelder prefers the chain-saw, which he carries around the part to be divided by the aid of a curved needle, which formed three-fourths of a circle, of which the diameter was from fourteen to sixteen lines. Such a needle attached to the chain can be carried through the lachrymal canal into the nose. Bellocq's canula may be used for passing the chain-saw. The posterior articulation of the jaw with the sphenoid bone must be carefully separated; and this may be done with a chisel. After the detach-

ment of the maxilla from the neighboring bones, as it is being removed, divide the infra-orbital nerve with scissors. Heyfelder did not dress the wound for several hours. The labial cuts were sutured, and no lint placed in the wounded cavity. Bleeding was slight and did not occur secondarily. For two days, cold dressings were used; then warm ones were applied. The patient was fed with food injected into the œsophagus. Recovery was most rapid, viz., in from two to three weeks.

Heyfelder published, in 1858, that, in a list of three hundred and fifteen maxillary resections, there had been secondary bleeding in only five cases; and this absence of hæmorrhage he refers to the fact that he did not plug up the wound.

Springer, in 1860, in a publication, offered some new suggestions, partly his own, and partly those of others, on maxillary resection; he advises to spare the palate and mucous membrane as much as possible; also, to perform partial, instead of total, resection in all cases where it is possible. The outer parts must be sutured to the mucous membrane where the latter remains.

An example in which the incision was as limited as possible was that of Butcher, in which the greater portion of the maxilla superior was resected through a cut made from the mouth into the nostril, and then, with one blade of a pair of strong forceps in the mouth and the other in the nostril, the bone was divided in the median line; and then, having extracted a tooth behind, a similar lateral division of the bone was made at the side; thus a portion of the jaw was removed.

In 1862, Lücke reported that B. Langenbeck had performed two bilateral resections of the upper jaw with no death; but of eighteen unilateral resections two died, and of twenty-eight partial resections one died. Death after removal of the jaw arose from pus passing down to the lungs and causing pneumonia; and to avert the swallowing of pus, Lücke advises to do the work, as far as practicable, sub-periosteally. After total maxillary resection, there occurred suppuration of the eye in a few cases, and this was referred to destruction of the trifacial nerve; and as a means to avoid such accident, Lücke directs to close the eye with adhesive plaster.

To remove the upper jaw Langenbeck makes two incisions; one of these commences on the glabella between the eyebrows, or beneath the internal palpebral ligament; thence the cut is carried down to the wing of the nose, and, from the lower end of this incision, another is carried upwards and outwards to the zygoma.

By means of these incisions the soft parts are uplifted, and the work can be done, to some extent, without entering the buccal cavity. Langenbeck uses a fine saw to separate the jaw from its surrounding osseous attachments, the saw being passed into small crevices or openings.

Weber operated similarly to Langenbeck, viz., by means of a vertical cut running from beneath the inner angle of the eye to the mouth; and this was aided by a horizontal cut under the eye, in case it were necessary to remove a part or the whole of the malar bone. If the periosteum be sound, it should be uplifted with the soft parts and retained. Weber prefers to divide the osseous attachments with the resection saw, which is used as follows: The saw is carried into the orbit under the uplifted periosteum, and the bone divided thence to the opening of the nose; or, the saw entering first, the nasal opening may be cut towards the inner part of the orbit. The parts being uplifted outwards until the saw can be passed into the inferior orbital fissure, the section, started in the inner or outer portion of this crevice, may include and remove a fractional portion or the entirety of the malar bone. The concluding act is to saw through the palatal bone, in which, if possible, the soft part with the periosteum should be preserved. In this sawing, the soft parts should be retracted from the cutting instrument with the fingers or retractors.

Lehmann, in 1864, proposed in maxillary resection, of the upper or lower jaw, to save the alveolar process and the teeth contained in them. His plan is to detach and reflect from the process the investing soft parts; next, saw through the base of the alveolar process, so as to preserve as great a portion as the conditions will permit. If the entire alveolar quadrant cannot be saved, preserve a section of it. The teeth, thus saved, can afterwards be used for mastication. New bone seemed to grow on the portion of process thus saved. The teeth retained their color and lustre. Kölliker teaches that the teeth depend for their nutrition on the pulpa dentis and the contiguous tissue of the alveolus, and Lehmann's observations confirmed this. Lehmann claims for his method that, by it, the teeth, which are commonly lost in the work of resection, may be saved.

As conclusion of the chapter on resection of the maxilla superior, it is appropriate to describe an operation akin to it, viz., temporary resection of the upper jaw. In 1861 B. Langenbeck wrote on osteoplasty, in which a bone is moved or shifted from its

site, and afterwards replaced again; such an operation Langenbeck performed on the maxilla superior, to make a route by which naso-pharyngeal growths could be reached and removed. Michaux advocated the same procedure, claiming that these growths could only be successfully extirpated through the removal of their periosteal attachments. Langenbeck was led to temporary resection of the maxilla superior, by the good results which followed temporary resection of the nasal bones to aid in the removal of polypus. And to reach growths in the spheno-palatine fossa, the sphenoidal sinus and the Eustachian tube, Langenbeck found that the work may be done by temporarily shifting the site of the body of the upper jaw. From a study of the facial skeleton, Langenbeck conceived the design of detaching the upper jaw from its place by sawing it through in certain directions, so that the body remained only connected by its nasal process to the nasal and frontal bones. The jaw was sawn through horizontally above the alveolar process, also vertically at the side. The vertical cut is placed so far laterally that it includes the malar bone, and, when the sawing is done, the part included is loosened and lifted upwards and inwards. After the tumor has been removed, the shifted bone is to be replaced, and if it does not remain in normal site, it should be retained there by metallic sutures.

Demarquay announced in 1862 that, since 1851, he had practiced resection of the anterior face of the antrum and the nasal process of the superior maxillary bone, for the purpose of reaching growths in the nose, throat or antrum. To expose the part to be resected, he makes a cut alongside of the nose down through the lip; and a second cut is to be made horizontally from the angle of the mouth to the masseter muscle; or the vertical cut may be shorter and only reach from the ala of the nose to the mouth, the horizontal one meanwhile being carried to the masseter muscle. After such operation, Demarquay thinks that the resected bone may be reproduced.

In concluding this chapter on resection of the maxilla superior, the writer will add that, from his operative experience, he has learned that partial excision may be done through the mouth, and that, for total unilateral removal, the work can also be done by widening the mouth horizontally, through incising the buccinator muscle. Such cut can afterwards be closed. Thus proceeding, facial palsy will be avoided, and facial scarring and deformity reduced to a minimum.

CHAPTER XVI.

MOUTH AND ORAL CAVITY.

Lips.—The lips, which constitute the entrance to the buccal cavity, may, within normal limits, vary much in shape and volume, and so the opening which the lips bound, commonly designated the mouth, may be small or large. The dimensions of this opening, when large, give the surgeon an advantage when he operates in the buccal cavity; on the contrary, the smallness of the opening may be such that it requires widening by incision, as a preliminary to intra-oral work.

The investing coverings of the internal and external surface of the body meet on the lips; here one sees a transition from mucous membrane to derm taking place so gradually that the boundaries between the two are indeterminable. The mucous as well as the dermo-mucous coat is normally of red color. This hue varies in different subjects, and it may do so in the same person at different times. In persons of the sanguine temperament, and in those addicted to spirituous potations, the lips are strikingly red. In those who have lost much blood, and in the leucæmic subject, the lips are pale. And the lips, which are normally red, in the act of swooning, become pale; a condition frequently supervening in those to whom an anæsthetic is being given; such paleness then, as a faithful sentinel, announces depressing nausea or commencing syncope. The fading color of the lips demands temporary suspension of the work, during a surgical operation, and momentary attention to the condition of the patient. Concealed hæmorrhage is indicated by the colorless lip: for example, when blood has escaped unseen down the throat into the stomach, or in work done on the rectum the blood has passed upwards into the bowel; and, lastly, such paleness has given warning of intra-abdominal hæmorrhage which had occurred unseen after a laparotomy. Therefore, attention to the color of the lips must be among those matters which demand care in the surgeon's work. Such paleness is the silent monitor

of present or impending danger; if unheeded, the case in question will probably afterwards stand in the fatal column of non-success, and the cause of death be placed under the convenient heading of shock.

Lying between the mucous and dermal coats of the lips, there exist a small amount of adipose tissue, a circular muscle, a glandular stratum, vessels, lymphatics and nerves.

The fatty tissue, different from what one sees elsewhere near the surface of the body, does not occur as a separate layer; the derm and mucous membrane are closely adherent to the orbicular muscle, and the adipose material is diffused through the muscle in small rounded masses: and it does not augment in amount; hence the lip, like the eyelid, does not increase in thickness through adipose development.

The openings of the eye, ear, nose and mouth contain muscular fibers; yet the openings of all except the mouth are maintained patent by a layer of cartilage in their walls; such stiffening material is absent from the lips, which are distinguished by their pliant mobility; and any surgical work, which lessens this suppleness through interjection of cicatricial tissue into the muscle, must trammel the functional activity of the lips.

The various facial muscles which converge towards the mouth aid in the formation of the orbicular muscle, those from above entering the lower segment, and those from below add fibres to the upper segment, while the buccinator contributes fibres to both segments; the arrangement being such that the mutually interlacing bands support each other in the closure of the mouth. The entrance and action of these component muscles at the labial commissure give transverse elongation to the oral opening, in opposition to the independent circular fibres, which form a considerable part of the orbicularis; and these fibres retracting cause a triangular gap when the lip is incised vertically. The orbicular muscle is closely and tightly bound to the skin by fibrous tissue. In unilateral palsy of the face, the mouth is drawn towards the unaffected side; and in bilateral palsy, as seen in the apoplectic patient, the lips in breathing are passively drawn in and out, as in the act of smoking the pipe. Also in the non-palsied face, if from some cause there be greater power on one side, the angle of the mouth will incline to that side, and give an unnatural expression. In unilateral palsy, the depression of the labial angle permits fluids, which are received in the buccal cavity, to escape there, much to the patient's inconvenience.

And a similar condition is induced when the muscular equipoise of the two sides of the face is disturbed by some accidental lesion, or, perhaps, by the surgeon's knife.

A no less important structure than the muscular is that of the glands, which lie between the mucous and muscular coats. These glands are in greater number in the upper than in the lower lip, yet they are more voluminous in the lower lip. They are surrounded by connective tissue, and the elements for suppurative action are here present.

These glands, hard in texture, can be distinguished when the lip is pressed between the thumb and finger; likewise, when a section is made through the lip, as in the excision of epithelioma, these glands crop out above the cut surface, and should not be mistaken for diseased tissue. Should the uplifted glands render the surfaces uneven which are to be united, they should be excised with scissors, or the point of the scalpel.

The arteries of the lip are derived from the facial; they are the superior and inferior coronaries and the inferior labial. These vessels from the two sides inosculate. Their situation in the lip is important to note: the superior and inferior coronaries lie in the glandular structure, between the mucous and muscular strata; and they are situated about midway between the attached and the free borders of the lips. At the labial commissure, a thumb and finger can grasp the edge of the mouth so as to include and compress these arteries; or flat-bladed, clasping forceps can do the same; such hæmostatic clasps were used by Langenbeck in his operations on the lip. These vessels seldom demand ligation, since the suture closing the wound can also include the vessel; but since the coronary vessels lie just underneath the mucous coat, the suture, to be effective, must transfix the entire thickness of the lip. The inferior labial artery lies behind the labio-mental sulcus; and it results that when a long vertical cut is made through the lower lip, there is bleeding from both the coronary and the inferior labial vessels. Likewise, where the upper lip joins the septum of the nose, there is an arterial branch. The labial veins may be disregarded in surgical work.

The lymphatic vessels pass to glands which lie above the hyoid bone in the space bounded by the inferior maxillary arch. The enlargement of these glands, in case of epithelioma of the lips, is of great prognostic significance, and nearly always means incurability.

The nerves are motor and sensory: the motor, derived from

the facial nerve, is distributed to the orbicular muscle; the sensory filaments of trigeminal source are numerous and are principally sent to the mucous and glandular strata of the lips.

If one examines the site of the mouth in the incipient embryo, the upper lip will be represented by three germinal buds or tubercles, while the lower lip is indicated by two; in each lip these germinal buds, developing, finally coalesce, and by their fusion they form the normal lip; such development and fusion nearly always occur in the lower lip. The embryologist Coste, who studied and described these rudimentary parts of the embryo, named the middle one of the upper lip the incisive bud, since it contains the germs of the incisor teeth; it likewise contains the primary elements of the premaxillary section of the maxilla superior. The origin of hare-lip has been referred to an arrest of the development of these primary components of the upper lip.

The mouth, or opening bounded by the lips, is an all-important part to the new-born child, since it is the entrance to the canal of nutrition; and if the form of the lips is in some way abnormal, the life of the infant is compromised. Such abnormality may be present in the form of atresia or entire closure, stenosis, wideness, deviation of the site of the mouth, adhesions, labial hypertrophy, labial atrophy and hare-lip.

Atresia, or complete closure of the mouth, is rarely seen in the new-born; while nature not unfrequently disregards her guiding model in fashioning the rectal end of the alimentary canal, as well as of the adjacent orifices, the openings of the mouth, nose, eyes and ears rarely appear closed. The history of such cases, as phenomenal rarities, is to be found in the annals of medicine, especially in the olden time, when myth and fabulous statement found place and credence along with truth. And, for this reason, such cases occur much oftener among the writers of the eighteenth than of the nineteenth century; the winnowing hand of criticism, the love of fact undebased with inaccuracy, and the restive intolerance of the unauthenticated and marvelous, which characterize the present century, have greatly lessened the number of statements which levy the tribute of credulity.

Yet eliminating the untrue and improbable, a small number of trustworthy observations of congenital oral atresia are found recorded; and when studied they present themselves in two classes: (1) Atresia, in which, not only the mouth, but the upper extremity of the alimentary canal is wholly closed. This closure coincides with other deformity; according to Craveilhier, it coin-

cides with the teratological type of the cyclopean monster. (2) In the second form, the atresia is confined to the labial orifice, the cavity of the mouth otherwise being perfect. Such closure may be a coalescence of the entire thickness of the lips, or the union may be through the medium of a web-like film similar to that seen in atresia ani. In the form in which oral closure is associated with absence of the buccal and pharyngeal cavities, the unfortunate infant is in a condition which defies legitimate surgery; concurrent conditions of ill form conspire to end its existence before it would perish from hunger. But where the atresia is of the web form just mentioned, then the operation is of a simple nature, and consists in division of the occluding film; to do this, let a tenaculum be fixed in the thin web, and the latter being lifted up, the little cone thus formed can be excised, and thus a circular opening is obtained, through which one blade of a pair of scissors can enter, and the oral orifice be reëstablished. The wound thus made is slight, yet, to maintain it fully patent, some instrument of dilatation should daily be introduced; as such, dressing forceps may be used, which, when withdrawn with open blades, will dilate.

Incomplete or partial atresia of the mouth may appear congenitally, or it may arise later as the result of some lesion or disease; and such occlusion may vary from a small orifice to one deviating but little from normal size. As a congenital condition, the lips may be soldered directly together on each side, or they may be united by means of a web-like film, there remaining a small, median opening. The mouth may be narrowed by gradual extension forwards of one or both commissures, through ulcerative action and subsequent union of the raw borders; and such ulcerative agency may arise from any cause which destroys the mucous coat of the lips: viz., a traumatic lesion, or one from fire, or an escharotic, as an acid or an alkali. And in cases in which such injury to the lip has occurred, precaution should be taken to prevent adherence of the parts; and this consists in daily separating the adherent surfaces and interposing some body which will maintain the parts asunder. This prophylactic task, though industriously pursued, is rarely satisfactorily accomplished; the oral opening remains narrower than it was originally.

Treatment of Partial or Complete Atresia of the Mouth.—In cases in which the atresia is partial, and there is an opening of small dimensions, the condition has sometimes been allowed to remain

unoperated on; and then the patient has been fed through a funnel and tube; or a beak-bearing cup has served the purpose; or the nutrient fluid has been injected into the mouth with a syringe. As a palliative procedure to maintain the small opening patent, occasional dilatation may be made by means of a sponge-tent, or other expanding agent. Such treatment would rarely be continued long; its inconveniences would erelong overcome the subject's reluctance to a more rational treatment, in which one of the following operative plans may be adopted:

The united structures were simply divided with a knife by Amussat, and separation maintained by means of lead foil; this plan was pursued by Boyer also; in spite of persistent effort, the cicatrizing force seems to have triumphed over that of the surgeon, and but slight improvement was thus obtained.

A better plan than the preceding was one which was suggested by the custom of piercing parts of the body and establishing a cicatrized foramen by means of a foreign body; an example of this is the introduction of a ring in the lobule of the ear. Savagism, from which such mutilation originated, still affords examples of a perforation of the cheek, similar to that which the surgeon may use to restore the narrow mouth to normal size. The Polynesian native, as well as the Indians in the valley of the Amazon, pierce their cheeks and lips with pieces of bamboo or wood, and retain the foreign body in site until scar tissue is formed around it, and thus a permanent opening is established. Such work may be imitated in the case of the narrow mouth; and after the formation of such opening at the site of the desired commissure, the part remaining between this and the small oral opening may be severed. Taking a lesson from the South Sea savage, the surgeon may use as perforator a piece of bone, which, having pierced the cheek, is allowed to remain in place until the opening is permanently established, when, unlike the savage who lets his remain in site as an ornament, the surgeon removes the body and divides the remaining bridge. This method, named by the French Botoc, from the Botocudos, a cheek-perforating tribe, partakes too much of savagism for a place in scientific surgery, and is better replaced by one of the following plans:—

Serre, of Montpellier, introduced an operation in which incisions are made laterally and horizontally from the existing opening, and then the mucous membrane and the derm are united by silken sutures so closely applied as to completely close the wounded parts. The work thus done is followed by healing, and

a proper oral opening is secured to the patient. The writer would suggest the use of the metallic instead of the silken suture for closure of the wound.

A second plan, which was originated by Dieffenbach, is the immediate formation of commissures which are invested with transposed mucous membrane, so that the constructed angle remains as it is formed. To do this work, from the existing oral opening incise laterally to the site of the desired commissure; and, having cut through the skin, excise a small portion of the thickness of the cheek, leaving only the mucous membrane intact at the bottom of the sulcus. Next, from the unsevered mucous membrane, so construct a flap that it can be folded outwards, and joined by suture to the skin. In case the mucous membrane is unsuited to form this commissural flap, then the adjacent derm may be employed for this purpose. When the commissure is thus formed, the skin and mucous membrane may be united over the remaining wound of the divided cheek, thus combining the methods of Serre and Dieffenbach.

In case the atresia has resulted from some cause which has produced other deforming scars, these should be removed, loosened or otherwise changed as the case demands; and among the means which can be used, that of subscision is one of the best; by means of a tenotome, introduced beneath the skin or mucous membrane, the contracted bands may be severed, and irregularity of surface lessened.

Macrostoma.—A condition, quite the opposite of the one described, is that of extreme wideness, named macrostoma; this is usually of congenital origin, though it can arise from accidental lesion, or even the surgeon's knife. Congenital wide mouth originates in an arrest, or standstill, in the work of commissural fusion of the two lips in the development of the embryo. Such defective form is often associated with other abnormal conditions of the infantile face. Or there may be cephalic deformity: and these concomitant defects are usually of so serious a nature as to destroy the subject's life. Should the infant have no other deformity, this one would entail from birth the troublesome condition of constant escape of saliva from the mouth; and at a later period, during dentition, the teeth, lacking their usual wall-like support, would tend to diverge outwards, and, cropping out through the abnormal gap, they would become useless, and, besides, add much to the unsightliness of the face. The abnormally exposed mucous surfaces readily ulcerate, and add a con-

tingent to the trouble. Besides this type of macrostoma there are seen less grades of it; these may be so near normal limits as to demand no surgical attention; but if it is a marked deformity, then surgical intervention is proper. Had the German princess, who was nicknamed *Taschenmaul, or pocket-mouth,* had her mouth reconstructed in infancy by the surgeon's hand, it is probable that she would have been spared this ignoble sobriquet.

The writer has seen a case of unilateral macrostoma which originated from mercurial ptyalism. This was not an infrequent cause of oral and buccal devastation in the early part of this century, when calomel, the "white eagle" of the old alchemists, soared triumphantly through the domain of therapeutics, and, not unfrequently, in its destructive swoops made prey of tooth, jaw, lip and cheek. Accumulated experience has trained the eagle, falcon-like, to abide in more purposive circlets. In the case mentioned, the young man when an infant was so severely ptyalized that a portion of his cheek, including the angle of the mouth, sloughed and left a great breach in the wall of the buccal cavity. The teeth which grew on that side diverged outwards and stood more nearly horizontal than vertical. The saliva constantly escaped. This breach, an inch and a half in height and two and a half inches long, was closed by an operation in which the protruding teeth were removed, the edges of the breach made raw by free trimming, and then a large inferior flap was constructed from the cutaneous and subcutaneous structures which lay beneath the opening. As the uplifting of this flap left a large gap on the upper part of the neck, to close this a pedicled flap was raised from the loose derm near the clavicle, and fixed in the place whence the first flap was taken. The open space, now remaining above the clavicle, was closed by means of subcutaneous detachment and lateral sliding of the adjacent derm. The flaps healed by primary union, and the patient's appearance was much improved.

Besides sloughing of the cheek from mercurial abuse, it may arise from noma, of which the writer once had the unfortunate privilege of seeing a number of cases; this was in a ward in an emigrant hospital which had been set aside for children affected with scarlatina and measles. The disease was of a virulent form, and the ward was not ventilated. The noma began as a small black point in the midst of the swollen and ashy pale cheek, and soon extended until it occupied the surface corresponding to the buccinator muscle. In nearly all these cases, death spared these

unfortunates from impending deformity, and the essays of reparative surgery.

Treatment.—The problem of lessening the mouth is an easier one than that of enlarging it. The task consists in shifting the commissure anteriorly. This can be accomplished by paring the opposite margins and uniting the raw surfaces by metallic suture, and then immobilizing the parts by an appropriate bandage. The work done in this way has the disadvantage that the commissure is an acute and not obtuse angle. To remedy this, a flap of mucous membrane may be uplifted from the border of the upper lip, behind the site of the desired commissure; this flap, a half inch long, and with attachment forwards at the proposed commissure, is to be folded forwards, and sutured to the raw surface below. Thus an obtuse angle is formed. The remainder of the wound is to be closed by sutures, and the parts rendered motionless by a proper appliance.

Deviation of the Oral Opening.—There may be deviation of a part of the wall of the mouth, or the entire oral opening may be displaced. Thus from a burn on the cheek, or any cause destroying the structures near the angle of the mouth, the work of cicatrization may attract, and displace the commissure towards the place of injury. In like manner, a single lip may be eccentrically displaced by an adjacent cicatrix. And, on a more extensive scale, a migrating lupus has, in its cicatrizing march, drawn along the mouth for a short distance.

Besides the causes enumerated, labial deviation, extensive or limited, may arise from osseous disease through which a portion of the upper or lower jaw is destroyed. The author has seen examples of each; in the greater number, however, the disease was in the maxilla inferior, and in children. The loss of a portion of the lower jaw through necrosis, and the dwarfed development of the jaw, cause the chin to retreat, and the teeth of the upper jaw to project forwards and slope outwards. And if the necrosis be unilateral, the mouth will sink, and its angle be deflected towards the affected side. In such cases the upper incisors, through their ill position, become a striking deformity. Such a mouth can be improved in form; and this improvement will be greater if the subject be a child whose face is not wholly developed. This work, commonly committed to the hands of the dentist, is done by removing a canine or a bicuspid tooth on each side, and then a compressive band including the incisor teeth is fastened to the teeth behind. Thus the projecting teeth can be

forced backwards into the space left by the extracted teeth. To be effective, this compression should be continued for a year, or even longer. In bad cases it may be necessary to extract two teeth on each side. If the backward pressure be made with too much force, in order to shorten the period of treatment, there is the risk of injuring the nerves which supply the shifted teeth; the latter, like other parts of the human body, will revolt against a rapidly encroaching violence, which would be easily tolerated if it approached gradually. Surgical art, as far as is possible, should here copy the methods of nature, who hastens not, and spurns all limitations of time in the accomplishment of her work.

In cases in which correction of the deformity cannot be satisfactorily effected in the manner above described, then, after the removal of lateral teeth, the jaw can be partially divided on each side, and the work of pressing backwards the protruded portion can be done, as before pointed out.

Labial Hypertrophy.—Hypertrophy of the lip, consisting in a thickening of the mucous membrane and of the submucous structure, occurs as a rare deformity of the mouth. The upper lip is more often the site of the enlargement; it does, however, occur in the lower lip. This condition is named double lip, and it has been given the more technical name of exstrophy. It consists in an augmentation of the components of the mucous membrane along the entire visible border of the lip. In the act of smiling, this red and transversely striated structure, moistened with the mucus, which its enlarged glands secrete, is rolled forwards, and gives the mouth a most disagreeable appearance. A condition present, and probably having some causal agency, is defective development of the derm which adjoins the lip. This is said to exist congenitally; and afterwards, in growth, the mucous structure outstrips the dermal. The infant, in protruding its tongue against the lip, aids in the development. Irritation in the form of slight abrasion, ulceration, or fissure, promotes the growth.

Treatment.—Attempts have been made to remove this condition therapeutically; astringents have been applied for this purpose, but with unsatisfactory result. The more rational treatment is excision, which may be done by grasping horizontally a fold of the redundant structure and excising this with scalpel or scissors. A transfixing tenaculum may serve to uplift the part to be removed. The writer once treated by thermal cauterization a

case in which the upper and lower lips were the site of hypertrophy, the enlargement being mainly in the lower lip. These greatly enlarged lips, with their gelatinous coating of inspissated mucus, presented a most repulsive appearance. The derm was not defective, as it usually is in the ordinary case of double lip. The form was corrected by the use of the blade point of the thermal cautery. The muciparous glands were much enlarged. The wound made was allowed to heal, by granulation, and the result was a reduction to something near normal form. In such cases, the work of excision might be done with the knife with less peril of exceeding the proper limit of retrenchment, and after the surplus structure was removed, the wound could be closed by sutures.

Labial Ectropion.—One or both lips may be everted through ulceration or some lesion destroying the dermal surface near the mouth. The most common cause is a burn arising from a flame, exploding powder, or an acid or alkaline escharotic. The cicatrizing surface shortens and draws the adjoining lip outwards and fixes it in that position. The resulting deformity is great; for example, in a case of a burn from flame which the writer saw, the upper lip was drawn upwards to the septum of the nose, and the lower lip was drawn down and fastened to the chin. And, in another case, along with such labial distortion, the chin was drawn down and held near the larynx. In such cases the teeth exposed to the air are disfigured by incrustations and inspissated secretions of the buccal cavity. The saliva trickles uncontrolled from the mouth, and adds to the patient's unfortunate condition. In eating, fluids escape, and the ingestion of food is embarrassed, since the mouth cannot be closed, as is necessary during ordinary deglutition. For relief from the wretched plight in which such a patient finds himself, the surgeon's hand is earnestly appealed to.

As means to correct labial eversion, one may resort to the undulating incisions of Dieffenbach, the V-cut of Weber, or to the incisions of Teale.

The undulating cut of Dieffenbach, best fitted for the upper lip, is made on each side of the nose, as follows: The incisions closely circumscribe the wings of the nose, and are continued downwards convergently on the lip, and meet a short distance above the margin of the lip; the incisions unite beneath the nasal septum in one line, which is continued downwards into the mouth; thus two flaps are formed which are drawn downwards and united by sutures.

The method of Weber, of which he acknowledges the suggestions from Wharton Jones, consisted in making a V-incision, open towards the mouth, and which includes the scar tissue that pulls the lip outwards; the adjacent parts are detached, brought into position, and retained so by sutures. Instead of opening towards the oral opening, the writer suggests that the V-incisions might converge towards the mouth, and then the lateral structures being loosened might be rectified in position, and fixed thus by sutures to the sustaining and retaining angle of the V-incision. In this work, should the mucous border be too prominent, a horizontal section, oval in form, may be removed from it.

A third method by which the lip, everted and shortened in height, can be improved in form, is that proposed by Teale, which is as follows: For the lower lip, when ectropic, let there be made two incisions downwards through its entire thickness; and these cuts are at such a distance from each other as to include one-half of the lip between them. Next, from the lower ends of each of these cuts, an incision is to be made upwards and obliquely outwards, and end one inch beyond the labial commissure. Now let the upper border of the intermediate portion be made raw by trimming; and, finally, the lateral, detached flaps are to be drawn inwards and fastened on and above the upright intermediate portion. In this way the lip is rectified in position.

Hare-lip, Cleft-lip, Labium Leporinum.—Cleft-lip, or hare-lip, as it is popularly named, is one of the most interesting subjects to the operative surgeon; he has an assured and undisputed position here, since surgical art has no envious rival in the means for the relief of this defect; and the surgeon's hand can never be superseded by that of the presumptuous charlatan. Nature, whose unseen work is often usurped or stolen by cunning ignorance, is helpless here, and pleads for intelligent aid; and the interesting myth invented to explain the incomplete model of the cathedral at Cologne is here repeated; the envious fiend of Ill-form seems to have snatched from the hand of nature the archetypal design of her purposed structure; and nothing short of a Saint Ursula typified in the wonder-doing hand of the trained surgeon, can restore the lost sketch and bring back again to normal form the marred face. To learn how nature may wander from her wonted well-beaten path in her work of modeling the human face, some light is gotten by a study of the metamorphic stages through which the embryonic face passes in its primeval development.

The changes of form which the embryo undergoes have been carefully studied by Coste, His, Reichert, Thompson and others. At the age of one month, the human embryo has the form of a semi-circle or letter C; and the cephalic end presents an enlargement corresponding to the future head. On the inner side of this enlargement, transverse arches, named branchial or gill-arches, are seen; and between these arches lie intermediate clefts, or openings, as exhibited in Figure 76. *A* shows the head at one

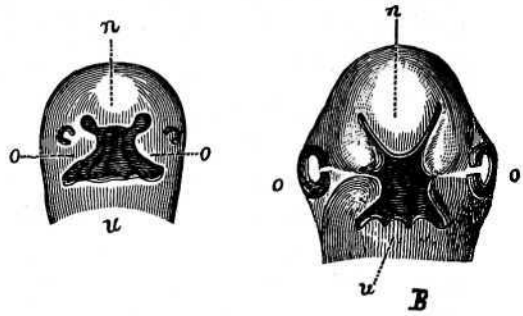

FIGURE 76. Plates from Von Ammon showing development of the fœtal head.

month, and *B* exhibits a later stage when the frontal plate *n*, the lower lip *u* and the eyes *oo* are appearing. The uppermost cleft is the one to which the most interest attaches, since it occupies the site of the future mouth; and if the surroundings of this fossa be observed, one finds that it has overhanging it a small structural plate, named from its position the frontal lamella; on the opposite side lies the part which corresponds to the inferior maxilla, or lower boundary of the mouth. At the upper part of the sides of the fossa are the germinal buds of the future upper jaw, which are some distance apart; and as development proceeds, beneath the frontal plate on each side exists a small depression, bounded internally and externally by the nasal buds. As growth continues, the lateral maxillary processes approach each other; and the intermediate naso-frontal plate grows downwards, and is named from its position the incisive plate. These parts, in the normal face, continue to enlarge by growth, until the incisive and lateral maxillary processes unite and close the irregular gap, which overhangs the embryonic oral opening; the fusion is so complete that in the normal adult all traces of the primitive fissures have vanished. Reverting to the rudimentary bars which cross the inner face of the forming head, it is seen that, at an early period, the upper one may be likened to a broken arch, which is constituted of a middle and two lateral segments,

so disposed that an upright cleft exists on each side. Normally, as said, these clefts vanish; abnormally, one of them continues, and then an opening remains, which, if limited to the lip, constitutes a single hare-lip; or if the fissure extends deeper and more posteriorly, then the case is one of labio-palatal cleft. The defective development seems to be more concerned in retarded growth of the intermediate plate; and if this part be followed in its growth, it is found that there originate from it the frontal bone, the nose, the vomer and the intermaxillary, named also the incisive bone; and the retarded growth is principally in the lateral faces of the intermaxillary bone and the lip in front of this bone.

It was reserved for the inventive fancy of the chief of German poets to catch the first glimpse of the doctrine that hare-lip is the result of arrested development. Goethe, whose mind created the imperishable imagery of Faust, revealed, as Virchow says, his nobility in that he sought mental invigoration in the observation and study of material objects and material phenomena, and found content in the "eternally true." Blumenbach, the contemporary of Goethe, whose museum of crania at Göttingen still rivals any European collection, taught the same doctrine. Meckel, Béclard and Geoffroy Saint Hilaire espoused the same doctrine. And the theory was elucidated and verified by the studies of Coste, who found that the early forms of the embryo are in accord with such theory. The conclusions arrived at from these studies are, according to Sappey, that hare-lip is caused by an arrest of development; that this arrest affects chiefly those parts of which the development is tardy; and that when the arrest is present in other parts of the body, the deformity of the mouth is usually the greatest; also the arrest appears simultaneously in both the soft and hard structures; and finally, that such arrest results from some natural cause, at present unknown.

Those who have been occupied in researches upon this subject concede that causes other than arrested development may be present, and coöperate or be the chief agent in the matter.

Among agencies which have been suggested as causes of hare-lip, the following may be mentioned: Heredity, in which something abnormal is impressed on the primordial germs, disease affecting the fœtus, maternal impressions acting on the fœtus, and mechanical causes, as adhesions of the fœtus to its cord or membranes.

That heredity has a bearing is shown by the fact, that in

certain families hare-lip has been transmitted through successive generations; the anomaly in the first instance being due to the law of variation, which is observed to particularize the form of members of the same species.

Observation of the new-born has shown that intra-uterine life has its diseases; and if some affection were to implicate the region of the branchial arches and clefts, these parts might cease their growth, and deformity result. The origin of hare-lip has been referred to mechanical causation, in which some agent, as the hand, cord, or other member or appendage of the embryo, may rest against the oral region and interfere with its proper growth.

Popular opinion assigns to the mother's mind an important agency in the causation of hare-lip. Dionis, Roux and Langenbeck have given credence to such agency. After an apologetic prologue for the avowal of his belief, Roux says: "Since some time, I admit the empire of the mother's mind upon her fœtus; and this power seems to be greater in proportion as the fœtus is more removed from its complete term of development; I believe that great mental shocks, and vivid impressions acting on the pregnant woman, can probably cause nævi, and, especially, striking deformities and freaks of nature; and such agency might cause disturbance of nutrition, and change the order of evolution, and development of the organs." In a clinical lecture of B. Langenbeck, heard by the writer, the learned professor in a manner half reluctant and apologetic, avowed his credence in the influence of maternal impressions in producing deformity in offspring; his remarks were a preface to an operation in a patient of hare-lip; and a few cases within his own experience were cited in proof of such agency. As counter evidence against such agency, the author would state that, in an extended experience, he has met many women who, from some ill adventure, had had ample reason to anticipate such "mark" in their offspring, but the latter, at birth, were free from any deformity; and, hence, such agency lies within the domain of chance where "millions miss for one that hits."

If such agency ever obtains, the impression could only be made during the first few weeks of gestation; that is, during the inceptive stage of development, while the miniature embryo lies in contact with the uterine wall, and may be conceived to be in contact with the ending of the uterine nerves; but, at a later period, the separation of the embryo from the wall of the womb,

and the intervention of the nerveless funis, preclude any communication between the mother and fœtus through the medium of nerve roots. This fact may be offered as solace to expectant mothers, who can be assured that after three months there exists an impassable breach athwart which their imaginations cannot wander to the detriment of their offspring, which is yet in plastic state.

The causal agency of retardation of development has been referred by some to the nerves of the fœtus, yet most authorities find the proximate agency in insufficient vascular supply of the affected parts; with our present knowledge the more rational theory is defective supply of blood. New development is naturally the sequent of vascular growth; since the blood is the pioneer agent of all organization. And in inadequate vascularity may likewise be found the probable reason of the usual occurrence of the hare-lip on the left side, instead of on the right; and the defect finds its reciprocal correlate in right-handedness, of which the most satisfactory explanation is that of Hyrtl, viz., that there is more blood sent to the right side than the left.

The supply of blood to the parts that become the site of hare-lip is through the facial, transverse facial, the internal maxillary branches of the external carotid artery and the infra-orbital branch of the internal carotid artery. These branches are like the ribs along which constructive material is carried to the border of the leaf; and if the arteries are obstructed, the parts supplied become dwarfed in the same way as the border of the leaf is imperfect when its nutrient channels are obstructed. In what way the vessels of supply may be obstructed has not yet been determined; the author will suggest that it may be explained conjecturally by flexion and position of the developing embryo, for example: Abnormal flexion of the arterial channels may lessen the blood supply, and restrain growth. Also, from obliquity of direction, in either the cephalic or podalic presentation the blood-pressure may be unequally distributed, and the scales of nutrition becoming unbalanced, there is an uneven or one-sided distribution of constructive material.

Children occasionally present at birth, lips and roof of the mouth marked as if they had recently recovered from an operation for the cure of cleft lip and palate; and such vestiges of cicatrization are explained by the supposition that there has been retarded closure of the fœtal clefts. Max Bartels, in 1873,

published observations on the subject of closure of the hare-lip in the uterus. In one case there was a scar of a cleft which had healed on one side of the lip; and, in a second child, there was a scar on both the right and left sides of the lip, which seemed to be remnants of healed clefts. Rennes, Dieudonné, Marjolin and Desormeaux believe that such intra-uterine closure may occur. Bruns thinks such labial scar is the mark remaining of a cleft which extended through the palatal vault, upper jaw and lip. The author has a case under observation, in which there is the plain mark of a lately healed median cleft on the upper lip of an infant, in which the burden of deformity is widespread, having been laid in the arms, hands, fingers, legs and feet of the unfortunate child. Probability is lent to this theory of late closure by the fact that cases have been observed in which the closure occurred after the birth of the child. The so-called intra-uterine cicatrization is hereditary in certain families. It is reported to have been seen in children, the offspring of parents who were the subjects of hare-lip. Instead of closure having occurred as here indicated, may not the appearance have arisen from the parts having fused in an unnatural manner, in which the supra-oral tripartite components of the face met and fused irregularly, nature here doing her work in the thoughtless way of a surgeon who closes unevenly the lips of an incised wound, or badly coaptates in the repair of a labial cleft?

A nearly forgotten theory of hare-lip is that, after the parts have been normally formed, they, afterwards, through atrophy, separate, and leave clefts; such a theory is irrational, and in discord with the rules and method to which nature conforms in the work of organization.

Hare-lip presents itself in several forms, which may be classified as follows:—

1. Simple lateral hare-lip.
2. Simple lateral hare-lip with complications.
3. Uncomplicated double hare-lip.
4. Complicated double hare-lip.
5. Median hare-lip of the upper lip.
6. Median hare-lip of the lower lip.

1. Simple uncomplicated hare-lip is usually situated on the left side: it consists of a cleft with separation of the borders, having the form of an inverted V The borders have the red lining of the normal lip; when the infant cries, the borders separate, and the gap becomes larger; and closure of the mouth

brings the borders towards each other. This cleft in different subjects varies in degree, from a minute gap in the border of the lip to a breach which reaches from the border of the lip to the lower border of the left nostril.

2. The simple cleft may present various complications, of which the following may be mentioned: The opposite borders of the cleft may be of unequal thickness; and in that case, the left side is commonly thinner than the right one. In cases in which there is claimed to have been retarded union, the united portion is often thinner than the adjacent structure of the lip. In the so-named retarded union, the closure may be yet more imperfect, viz., there may be an angular opening at the nostril and at the border of the lip, the apices of which are directed towards each other, and are separated by a longer or shorter bridge of attenuated structure. Likewise, in the maxilla just behind, there may be a depression denoting late union; or perhaps there is irregular closure of the lateral premaxillary suture. The labial hare-lip may be coincident with palatal fissure, which may be minute or of vast dimensions. A frequent complication of labial cleft is its extension into the left nostril; and then the nostril is much too wide, and the left wing of the nose is inclined obliquely, and adds to the deformity.

3. In the double uncomplicated harelip, there exist two clefts of inverted V-shape, separated by a triangular portion of the lip, which lies over the incisor teeth. These two fissures, with the intermediate angular portion of the lip, when viewed together present the appearance of an inverted M. The median remnant may be regular or irregular in outline, and thinner or thicker than the lateral boundaries of the defect. Palatal cleft is often associated with the double cleft; and in great variety of form, this concurrent defect may complicate and increase the labial deformity. When palatal cleft exists, the premaxillary bone may be lessened in volume, and occupy an abnormal position: viz., the palatal gap on one side, or those on both sides, are formed at the expense of the side or sides of the bone; in fact, the open breach may quite occupy the premaxillary space; more often, however, there exists a fragment of the bone; and then, as a continuation of the vomer, in smaller or greater volume it hangs promontory-like, over the oral cavity; and if the subject has reached adult age without being operated on, the protruded bone, armed with teeth, becomes a revolting and most intolerable deformity. No surgical ailment makes stronger appeals for operative

aid; and in scarcely any deformity of the body can intelligent skill make greater improvement than in this one.

Besides the usual forms of hare-lip before mentioned, there remain to be referred to, certain unusual forms, placed in our classification under heads three and four.

Bidalot, in 1867, wrote on rare and unusual forms of hare-lip; he makes four groups of these rare cases: (1) Cleft of the upper lip extending upwards to the lower eyelid. (2) Median cleft of the upper lip. (3) Median cleft of the lower lip. (4) Horizontal hare-lip. Michel saw an example of the first kind. In 1855, Parise of Lille saw an infant in which there was a median cleft in the lower lip; the sides of the opening were lined with mucous membrane and stood asunder as in normal hare-lip. The tongue was bifid; also the lower jaw was cleft anteriorly, and the halves united by fibrous tissue. The child lived but one month; yet its remarkable deformities assure it a lasting paragraph in the annals of surgery.

In 1870, Trélat reported a case of median cleft in the lower lip, seen by one Ribell; this fissure extended down to the chin. In 1879, Lannelongue reported two cases of congenital cleft of the lower lip; in one case the fissure extended into the lower jaw, so that the two halves were movable, one on the other. The child, two and a half years old, had been operated on with but partial closure of the cleft; the saliva escaped through the unclosed portion. And, in another case, in a girl fourteen years old who had club-foot, and hare-lip in the upper lip, there existed a transverse fissure in the lower lip, a half inch long and two-fifths of an inch deep; this fissure was beneath, and parallel with the border of the lower lip; and was closed by an operation.

Morian, in 1886, writing on the irregularities which hare-lip or facial clefts may present, finds three varieties: (1) The cleft commencing as a hare-lip, ascends between the nose and the cheek to the inner angle of the eye, and thence passes out through the outer canthus, and extends upwards on the forehead. (2) The cleft may commence more externally than the preceding species, and ascending outside of the wing of the nose to the inner canthus, it pursues the same course as the preceding one. (3) The slit commences at the angle of the mouth and, ascending, enters the palpebral slit. Other writers, as Blandin, Bitot and Nicati, have written on median cleft of the upper lip. And if the records of teratology were searched by some tireless compiler or statistician, other examples of irregularity in labial cleft might be found.

Among the numerous agencies which are inimical to infantile life, hare-lip deserves a prominent place; and this danger is greater in proportion as the disease is more complicated. The imperfect lip prevents the child from grasping the nipple; and swallowing is rendered difficult, since this function, to be easily done, requires that the mouth be closed. Where the breach is great, the infant breathes through its mouth; and the air, not warmed, as it normally is by passing through the nose, becomes the causal agent of catarrhal and pulmonary trouble; thus, between hampered nutrition and pulmonary affection, the chances of life are materially lessened. Hence surgical relief of such cases is early and urgently sought for by the infant's parents. By the mother who has just escaped through the throes of labor, no question is more earnestly asked than whether her child is perfect in form, and no more appalling words can fall on her ear than the answer that it is deformed. No persuasion is required to induce parents in such emergency to commit the unfortunate one to the surgeon's hands; and the first question to determine is: What is the proper period to operate on the child? and this question has been answered differently by authorities who have written on hare-lip.

In a review of this matter published in 1842, the mass of authority favored operating in the early months of infancy, viz., about the end of the third month; this was the time preferred by Dupuytren, Houston and others; Godefroy operated at birth, yet Dupuytren opposed operating at this time, since he thought the parts are then too soft, and are more easily cut by the retaining pins, than they are at a later period. Dubois the accoucheur, in 1845, in a communication to the Academy of Medicine, recommended early operations in strong and healthy infants.

Roux advocated doing the operation at birth; the reasons he offered were the following: "The new-born infant is patient, tractable, and without knowledge of what one is going to do, or does do, on him; and he is without will or power to resist or withdraw himself from what gives him pain; he has no knowledge of pain, nor does he fear it; and hence he is not agitated; nor does he make any movements which will interfere with the operation and its results. The muscles at that time, including those of the face, have but little power; those of the mouth have no force beyond the function of suction; hence one need not fear brisk and violent movements of the lips and cheeks, nor efforts of retraction which can cause tearing and separation of the

united parts. Besides, the tissues which are operated on have great vitality, and hence great plasticity, and a tendency to heal: and this tendency is greater probably than at any other period of life." These opinions of Dubois and Roux, for a time, had a great following; but in 1856 a number of unfortunate operations were reported, and tended to alter opinion on this subject.

Periat, in 1857, in a thesis sought to settle the matter by collecting a series of cases which had been operated on at different ages, and weighing the results in the scales of statistics. The first series comprised fifty cases, consisting of thirteen of simple form and thirty-seven of double hare-lip with complications; there were three deaths, five failures and forty-two successes. The operation was done at periods varying from the first to the thirtieth day after birth. In a second series consisting of forty-four cases, of which fourteen were simple and thirty complicated hare-lip, there was one death, four failures and two secondary reunions; consequently thirty-seven successes. These infants were operated on at periods varying from two to twenty-four months. A third series consisted of twenty-six cases, operated on at ages varying from two to five years; of these one died, two were failures, and two were secondary unions. Of these twenty-six cases seven were simple and nineteen were complicated. In a fourth series done at a late period, comprising forty-nine cases, of which seventeen were simple and thirty-two complicated, there was no death, and all the operations were successful.

The operations here enumerated amounted in all to one hundred and sixty-nine, of which one hundred and forty-nine ended successfully, five died, ten were failures and five were but partially successful. The operations were done by leading surgeons of France; it is possible that these figures do not represent the whole of their operations. In statistical logic, fallacies often lurk which are difficult to eliminate; that such fallacy does here exist is evident when these figures are compared with others which have been reported. In reflexions appended to a report of ninety-eight operations for the case of hare-lip done by himself, Eigenbrodt, in 1885, alludes ominously to the mortality which attends the operation. Fritsch found that it was fifty per cent in Zurich, and Herrmann reported that it was the same in Breslau. And where hare-lip is double and complicated with palatal cleft, a still greater number die, viz., of sixty-eight cases, sixty-five per cent died. Volkmann takes a yet more gloomy view of the results of operation for the cure of hare-lip with

palatal complication; he finds that such cases, if they do not die at the time of the operation, generally do so within a year afterwards.

These figures, which are probably correctly reported, differ so greatly from those of Periat, that one must conclude that the figures used by him did not fully represent the number of the unfortunate cases which occurred. The writer, who has had an extensive experience in the operation for hare-lip, thinks that the figures of recovery of Periat, though too small, more nearly represent facts as observed in private practice, than do those of Eigenbrodt, whose figures represent fatality in dispensary or hospital practice. That so great a fatality as fifty per cent should have attended the work of the skilled hand of the painstaking German surgeon, can only be accounted for by the supposition that the cases after being operated on passed out of sight of the operator into the hands of ignorant parents, who, too often, do not find unalloyed evil in the death of such child. It has been the writer's observation that the operation for hare-lip is very rarely followed by death, if the surgeon carefully watches the case. And if the author were to formulate a rule which should be religiously observed, it is that the surgeon's attention should, by no means, cease with the operative act, but that he should carefully watch his patient afterwards; his obligations to surgical art and science demand this; and his duties to a human being, which has intrusted its life to him, with a solemn and impressive emphasis command this.

The question is usually put to the surgeon, whether he can restore the cleft lip to normal form; in case of the simple uncomplicated cleft, this may be answered affirmatively; and, likewise, that the danger to the child's lip will be very slight. If it be a case of double hare-lip complicated with other deformity, the result will be less perfect, and there will be some risk of the child dying from the operation. The defects, which may be left after the operations, have been studied by Neudörfer in 1858, and are classified by him as follows: (1) The edge of the lip may remain lower on one side than on the other. (2) On the outside, though union has been obtained, a vertical furrow may remain. (3) A V-shaped defect may remain at the site of union, and this defect constitutes ninety per cent of all the defects resulting from hare-lip operations.

In the writer's opinion, the defects mentioned may be referred rather to the operator than the operation; since by careful work

and dexterity acquired through experience, the defects mentioned may be avoided, or greatly lessened. From the author's observation, the most glaring and striking defect is that which remains after operations on hare-lip, in which the cleft extends into one or both nostrils, and the wings of the nose rest obliquely on the face. This flaring nostril is oftener on the left side; and besides the obliquity, the two sides of the nose are not symmetrical. To correct such asymmetry and obliquity, and to erase the V from the lower margin, are problems susceptible of fairly satisfactory solution. The guiding rule or general principle involved in the operation is to remove the margins of the cleft, and then unite the opposite raw surfaces so that similar textures will be conjoined; special pains being taken that the outer surface be level, and hence free from irregularities.

Operation.—As instruments needed in the operation are the following: scalpel, scissors, hæmostatic clasps or forceps, a flat piece of wood to be placed under the lip as it is incised, materials for suture and adhesive strips to immobilize the wounded parts.

In the early history of the operation, closure of the wounded parts was effected by means of adhesive plaster and a variety of cumbersome appliances; these have properly been consigned to disuse, and the work of union is now universally accomplished by suture of either the knotted or twisted species. As to the choice between these, authority is about equally divided. The simple knotted suture is advised by the following surgeons: Mirault, Guersant, Woakes, Boeckel, Giraldés and Hamilton. The twisted suture, or that done by means of pins and thread, is advised by Thierry, Ancelon, Langenbeck, Bruns and Tricot. Thierry, to avoid the cutting of the skin which often occurs when the twisted suture is used, closes the parts by means of a small nut which is screwed on the transfixing pin; his plan is not followed. To avoid this cutting, Tricot used an elastic thread which he passed around the inserted pins.

A reserve or tension-relieving suture was used by Woakes, Boeckel and others. And this suture placed at some distance from the border of the wound, was used by some surgeons along with thin plates of metal, hard rubber, bone or ivory; the sutures passed through apertures in these plates, so that, when tied or closed, the sutures pressed on the plates, and not on the included labial structures. Such protective supports were used by Denonviliers in 1856; he used two, one on the inside and one on the outside, made of India rubber. After the threads traverse these

plates, they are to be tied over a roller; and after twenty-four hours, Denonviliers finds that union has taken place.

The ingenuity of surgery has been exerted to avoid the V-shaped defect in the labial border at the site of closure. The ways devised to accomplish this may be grouped in four classes: (1) By introducing the pins in a direction tending to lengthen the vertical span of the lips. (2) Marginal suture. (3) By a special shape of the vertical wounds. (4) Flaps double or single cut from the sides or side of the cleft; or a loop-form incision may be used.

1. To depress the site of closure, the transfixing pin has been caused to enter straight, and then to have its point rise, and then afterwards to descend again; the effect intended is to force the structure downward, and the action is similar to that of the acupressure needle, which is so passed as to compress the subjacent vessel. This plan is no longer used.

2. An attempt to depress the border has been tried by means of a horizontal suture beneath the wound; this plan has acted as ineffectually as the preceding one.

3. Better results have been attained by giving the vertical wound such a form that the border or borders become elongated when juxtaposed. For example, if one side of the cleft be longer than the other, Dieffenbach trimmed the longer one by a straight incision, while the shorter side was so trimmed as to present a concave outline. The result would be, when the wound was closed, to straighten, and hence to lengthen the concavely wounded side. Tricot, in his dissertation on hare-lip, advises this mode of avoiding defect. And in case both borders of the cleft be short, then each border may be trimmed with concavities facing each other, as shown in Figure 77; the effect of this would

FIGURE 77. Showing Graefe's plan of elongating the borders by trimming them concavely.

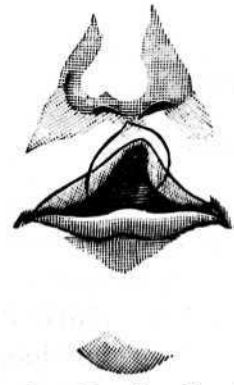

FIGURE 78. Showing Graefe's plan as modified by Bruns. (From Weber.)

be to lengthen each border when the sides are exposed; thus Graefe advised the work to be done, in order to shun the V-defect. In Figure 78 there is exhibited a modification of Græfe's plan as practiced by Bruns.

4. In plastic work done to remedy defects, it should be an inviolate rule to sacrifice no structural material if this can be utilized; and nowhere is this more imperatively necessary than in the repair and reconstruction of labial and palatal cleft. This rule applies preëminently in the solution of the problem to avoid the V-defect. For it is possible, through ingeniously devised incisions, to retain the marginal structure of the cleft, and to make it do the service of closing up the gap which otherwise would remain on the edge of the lip. In case the cleft be single and does not extend up into the nostril, Sédillot, Nélaton and Clémot make an incision which is so directed as to circumscribe the summit and sides of the cleft in such a manner that the uplifted edge is attached below on each side, and resembles a loop or swinging bridge. When this is closed, instead of an underlying V-gap, there will remain a slight prominence, as shown in Figure 80.

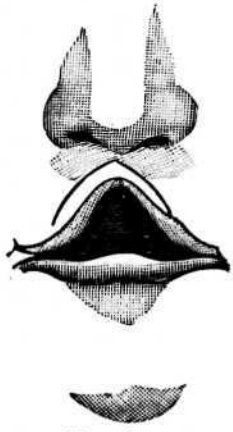

FIGURE 79. Showing form of flap shaped like a swinging bridge, practiced by Sédillot.

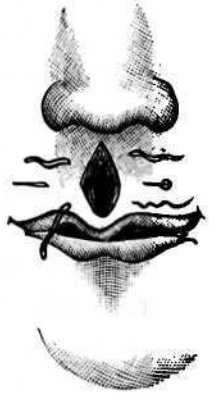

FIGURE 80. Result after partial closure.

The same closure may be done by means of a flap formed on each side, and which hangs at the base of the breach, as shown in Figure 81. A correct idea of this is obtained by conceiving a loop formed as above described, and then cutting out the middle third of the loop. This method, or a modification of it, was first suggested and practiced by Mirault of France; and soon afterwards employed by Henri, Malgaigne, Langen-

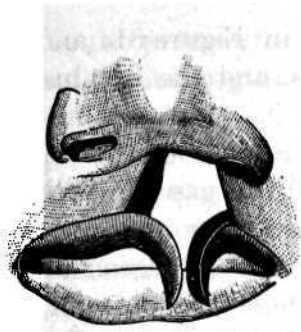

FIGURE 81. Showing lateral pendent flaps which were employed by Mirault, Henri and Malgaigne.

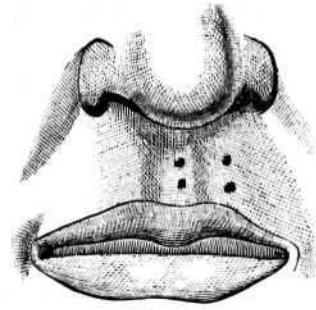

FIGURE 82. Showing result when flaps have been united, and surplus material has been excised.

beck and others. The author early in his professional career practiced a modification of this method, and believed at the time that he had originated it; he learned later that his work had, like that of many another inventor, been antedated by someone else; for, as history shows, many a loud-heralded invention or discovery is but the repetition of something which has gone before. A wider range of knowledge would have muffled the herald's voice. Such prophylactic knowledge abounds in the writings of Hippocrates.

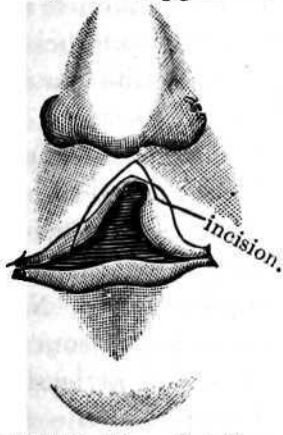

FIGURE 83. Showing Mirault's method. Hanging flap on the left side.

FIGURE 84. Result of work done as shown in Figure 83 when closed.

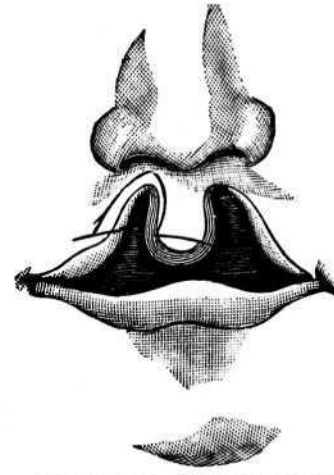

FIGURE X. Showing the incisions to be made for closure of double hare-lip.

Mirault, in his method as shown in Figure 83, formed lateral flaps which were attached to the base of the cleft. The mucous membrane is trimmed off from one of these flaps, and retained on the other. The breach is next closed by sutures, and the flaps so disposed that the one which retains its mucous membrane will lie outermost. The pendent flaps being sutured in horizontal position completely close the cleft below. Malgaigne and Henri

formed lateral hanging flaps, as shown in Figure 81; and these flaps were united by their raw surfaces, and the surplus tissue afterwards excised.

Whichever of these modifications is chosen, the operator will surely have enough material to fill the gap on the border; in fact, there is more material than is needed, so that afterwards a part must be trimmed off. And should the surgeon desire to change his plan, when he has formed these flaps, he can easily modify it so as to conform to the plan next to be described, viz., that of the single flap.

The method of doing the work by means of a single flap to avoid the V-gap is sometimes erroneously referred to Mirault; still, to him surgery is indebted for the idea of swinging flaps, dependent below with lateral attachment, for closure of the labial cleft, and his idea suggested the modifications employed by subsequent operators. Langenbeck used the single flap in some cases; yet his plan is defective in this respect that he formed this flap from the right side in the case of cleft on the left side. For over a quarter of a century the writer has used the single flap in closure of the simpler as well as of the complicated forms of hare-lip. To do this in the best manner, if it be a cleft of the left side, first remove the border on the right side by a vertical incision, and, when this cut is near the lower border, let the knife continue its work for at least two lines horizontally towards the right, and finish by cutting the flap off. Thus a raw surface in L-shape is formed. And the horizontal part of the L should not terminate acutely, but should have a blunt ending. In making this incision the section must be as perpendicular as possible to the surface of the lip, and at its end below, it leaves a rectangular notch. Next, from the left side, let a flap be formed which will hang from the left border of the cleft by a pedicle which is a line, at least, in thickness. This flap should commence at the apex of the cleft, and be a continuation of the right incision, and, like the right one, the left section must be perpendicular to the labial surface. The hanging flap should now be brought across the base of the cleft, and the raw sides of the same apposed; then it will commonly occur that the flap which has been formed will be too long, and, if so, a part of the free end may be excised, but in this excision care must be used not to shorten too much; also the flap must end bluntly, so that it will fit and fill the notch on the border.

After these preliminary statements, the writer will proceed to

describe the proeedures to be pursued in the closure of hare-lip of different grades, beginning with the most simple form, in which the cleft does not reach to the nostril. The operator should first examine whether the sides of the cleft are adherent to the upper jaw, and, in most cases, such adherence will be found only on one side. The child being anæsthetized for the operation, such adhesion must be severed, and this may be done with scissors, knife, or the blade of a thermal cautery. When the child is feeble, or where extensive division must be made, the thermal blade is preferable, since in this way blood is spared. Sometimes no abnormal adhesion exists, and still the operation will be rendered much easier if the upper lip adjacent to the cleft be freely separated from the upper jaw. If this be done with the scalpel, as is commonly the case, less blood will be lost if the labio-alveolar cul-de-sac of mucous membrane be divided close to the jaw, and then the detachment be continued sub-periosteally, with a blunt dissector.

The right side of the cleft should first be removed in the manner above described, the incision beginning above and on the left side of the summit of the cleft. Care must be taken that this incision fully include the border at the vertex, and that no dermal fragment be left which would interfere with union. And this will best be done if the flap removed from the child's right side pass over the vertex of the cleft and extend the distance of two lines on the child's left side. This cutting is best done with a scalpel of short blade and sharp point, and the cutting should be done on a surface of wood which may be formed from a shingle, and this wood should be three inches long and two inches broad. The work could not be done so well with scissors, since the initial part of each section should commence at the vertex by transfixion. Besides, incision with scissors tends to leave inversion of the inner and outer surfaces of the divided structure. While this cutting is being done, bleeding is to be controlled by compression made at the labial angles by forceps or the fingers of an assistant.

The wounded parts, as thus prepared, are next to be closed by suture, and this is best done by the interrupted species in which no transfixing pins are used. The best material for suture is fine copper wire which has been well gilded, that is, covered with gold. Such copper wire is stronger than that of silver of the same thickness; it is so pliant that the ends can easily be united by twisting or tying. Thread might be used, yet it irritates

more than metallic suture. In most of the work done, this fine wire should be doubled, and if much tension is to be overcome, it may be used triple or even quadruple.

For the sutural closure of a simple hare-lip, the author uses four sutures; two of these are deep, in which the double wire is used, and in two, single wire is used. The first deep suture should be carried through the entire thickness of the lip, at the lower part of the cleft, after the sides have been thoughtfully coaptated. The wire is carried through by means of a moderately curved needle, which is so long that, when it has passed through the two sides, its head will remain projecting beyond the entrance point, and the point of the needle will project a half inch at least after its emergence on the right side of the cleft. Such a needle is much more easily used than a shorter one. Since the coronary artery lies near the mucous membrane, the needle must pierce the entire thickness of the lip, so that the wire, when closed, will circumscribe the vessel and prevent bleeding, which must occur if the wound be left open on the side of the mucous membrane. Neglect of this has permitted the blood to flow unseen after the operation has been completed; and to this cause may be referred much of the mortality after this operation. The second deep suture, likewise transfixing the entire thickness, is next to be passed below the vertex of the cleft. These deep sutures should enter and emerge at a distance of not less than a quarter of an inch from the edge of the cleft. In case the labial material is scant and there is much tension, it is well to let at least one of the deep sutures enter and emerge a half inch from the edge of the cleft.

A third suture is next to be introduced between the deep ones and much more superficially; this suture, consisting of a single wire, is to reduce the included surface to a level, and to maintain it so during the subsequent swelling of the parts. The fourth suture, likewise of single wire, is to be introduced through the middle of the base of the swinging flap and then to pass through the lower part of the right side of the cleft, and to emerge beyond the angular notch in which the flap's end is to fit. If this suture be properly passed, it will hold the entirety of this flap in its destined horizontal site, and the flap will completely fill the gap which was wont to remain after the former methods of closure. Should the flap be found to be too long, and by its pouting downwards form too large a tuberculum, then enough should be cut from the end to leave material which will form a normal

eminence at the middle of the lip. After the introduction of the four sutures, should the wound gap or present an uneven surface at some point, then another fine suture should be used.

The writer closes the wire, not by tying, but by twisting the ends together; and his custom is to cut short one end and leave the other an inch or more in length. The wire should be closed at one side of the wound, and never over it. It should not be closed too tightly: merely enough to unite the sides of the wound; more pressure will pinch and pain the child, and cause the wire to cut. The long ends of the wire of the three upper sutures should be laid horizontally, while the end of the one which fixes the flap should be turned obliquely upwards. After the sutures are in place, the line of the wound should be coated with the compound tincture of benzoin, which forms a varnish-like covering which is impervious to the fluids of the mouth. The ends of the wires are now to be covered with strips of adhesive plaster, which, commencing below the lobule of the ear on one side, are carried across the wound upwards on the cheek, to end above the other ear. These strips may be three or four in number; and when properly placed, they alternately cross each other on the wound. And, lastly, to maintain these crucially disposed strips, one or more strips must be placed vertically, forming a loop under the chin. In placing the first series of retaining strips, the ends of the wires must be covered completely; and especially the one that pierces the flap.

The adhesive strips have a tendency to slip down over the edge of the lip; and to avoid this, they should be narrow and placed well up towards the nose. These retaining and immobilizing strips should consist of rubber plaster, which is insoluble in, and impermeable to, saliva, milk or other fluid which may come in contact with it. These strips applied in the manner described, draw the adjacent parts towards the wound, and hence they diminish the tension of the sutures.

After forty-eight hours the upper one of the deep sutures should be removed; and this is done by dividing the crucial strips on one side, so that the portion of them covering the sutures may be uplifted, and then the long end of the upper suture is to be seized and drawn on so that the wire can be cut on the opposite side, close to the skin. The wire should be so drawn on that, when it is severed, the cut end will sink back into its orifice; now by pulling on the long free end, and at the same time supporting the parts on each side, the suture is easily

drawn out. By thus dividing the suture through a portion which was buried, the end which is drawn on will have no dried excreta on it, and will easily forsake its canal. As soon as the suture is removed, its track is re-covered with the adhesive strips supported by a new strip on each side. At the end of three days, if union seems complete and firm, the lower deep suture may be removed; and also the intermediate suture; the work being done as in the removal of the preceding suture. There now remains but one suture, viz., the marginal one, which may be removed on the fifth or sixth day, according as the union seems solid. The supporting adhesive strips should remain in place for at least one week after the operation has been done.

Instead of the deep suture of wire here described, one may use the twisted suture, in which the so-called hare-lip pin is used. The author has frequently employed this plan, and obtained satisfactory results. It is used as follows: The cleft having been trimmed and a swinging flap prepared as described, two pins are to be introduced, occupying the sites directed for the deep wire sutures. These pins should pass quite through the thickness of the lip, so as to prevent hemorrhage. The next step is to twist the silk thread around the inserted pins. The points of the pins are finally to be cut off by means of a special instrument known among mechanics as pliers; such an instrument cuts without displacing the pin. And to prevent the heads and points of the pins from cutting the surface beneath them, short strips of adhesive plaster should be inserted between them and the skin. The next step is to fix the swinging flap in its place by means of a single wire suture. The long end of this suture is to be turned upwards, and the whole to be covered by the rubber adhesive strips before described. Should there be but little tension of the parts, short strips placed horizontally will sufficiently immobilize them.

In regard to the time when the pins should be removed, opinion and practice vary; Langenbeck, for example, removed them on the second day, but to prevent the closed parts from rupturing, the thread which surrounded the pins was allowed to remain in place, having previously been fixed there by a coat of collodion, applied at the time when the operation was done. Other operators, again, remove one in forty-eight hours, and the other at the end of the third day; or even a day or two later, in cases in which separation of the wound is feared. And here, as

in the case of the knotted suture, the unhealed wound should be supported by protective strips of adhesive plaster. The act of removing the pins requires care; the sides adjacent should be supported by the hands of an assistant, and he should be instructed to support the parts gently, and not to press violently, lest the tenderly united wound be caused to open. And similar precaution should be used in the removal of the interrupted or knotted suture. And should it happen that the wound is opened in the extraction of the first pin or suture, then the remaining one should be allowed to continue in place two or three days longer, and the reopened wound closed by adhesive strips; thus proceeding, the wound will re-heal in a day or two.

Operation on Uncomplicated Double Hare-lip.—The operative work of closing the double hare-lip of simple form is quite similar to that, already described, which is done for the closure of simple labial cleft; yet the operation is a more extended one, and is more difficult.

In case the cleft is a broad one, the work should begin with the formation of a flap on each side which will depend from the border below, similar to the flaps which are made in Malgaigne's operation before mentioned.* Next, the intervening V-shaped part of the cleft is to be pared; and then the raw surfaces are to be closed by two wire sutures which include the thickness of the lip; or, instead of the interrupted suture, pins may be used for closure. The closure of the lateral wounded border with the median angular part is seldom satisfactorily done; the angular part usually remains higher, and sits like a promontory between the sides which are united to it. And where this has threatened to remain a permanent deformity, and disfigure the lip, the writer in operating has preferred to wholly sacrifice the angular part rather than to attempt to adjust the discordant promontory to its surroundings. But if it be thought better to retain the median part, then in closure the suture should pass through the apex of the V-portion, after the latter has been prepared and drawn well downwards. If one partially separates this angular median part from the upper jaw, and finds that it is so thick as to rise above the lateral parts, it may be pared slightly underneath, so as to be on a level with the contiguous parts. The two hanging flaps, which have been formed from the sides of the breach, are next to be united by their raw surfaces, and surplus material may then be cut from the end of these united flaps, so that enough material will remain to fill the V-shaped gap

*Seen in Fig. x on page 569.

which otherwise would remain. In this closure, the author uses and recommends the metallic suture before described. Though pins might be employed, the former plan has been found to act more satisfactorily. In case of much tension, the wire cuts less, and can be allowed to remain in place longer than pins. The parts should be supported by adhesive strips, and the sutures should be extracted, successively, on the third, fourth and fifth days; but the adhesive strips should remain a few days longer.

The double hare-lip may be complicated with fissure extending through the alveolar process and the palatal vault of the roof of the mouth; and such alveolar and palatal fissure may be single, or it may be bilateral.

As previously explained, the osseous complication here mentioned arises from defective development of the primitive frontal and maxillary processes of the embryo; and the part which eminently figures in the present deformity is the median portion into which the frontal plates are transformed. The anterior and inferior end of this develops into the bone, variously named the incisive, intermaxillary or premaxillary bone; and in the form of hare-lip under consideration the premaxillary bone may present every grade of growth between entire absence and almost completed form. It may stand almost in row with the broken alveolar arch on each side; or, it may be protruded forwards to such an extent that, instead of standing vertical, it lies horizontal. Also, the median V-shaped fragment of the lip may be of considerable size, or reduced to a mere vestige; and in these particulars it resembles the premaxillary bone on which it rests. The adjacent interrupted alveolar arch often presents irregularities in this respect, that one portion of it stands higher than the other; and something analogous to this sometimes appears in uncomplicated double hare-lip, and even in simple hare-lip; for frequently there appear traces of retarded closure of the bones; and one side, oftener the right one, is protruded beyond the other, so as to render the alveolar arch irregular.

Besides the extraordinary deformity with which complicated double hare-lip stamps the child, the latter is menaced by a peril yet more grave in the interference with its nutrition; the function of suction and swallowing becomes difficult, and sometimes impossible in such an infant; and hence an operation here has a double object, viz., to restore normal form and to aid alimentation. The work to be done is a severe attack on the infant's vital resources; and the question has been much discussed at what

time should the operation be done. The mass of authority opposes early interference, and favors delay, until the child has acquired greater strength, and has greater powers of resistance; and this time is fixed at from three to six months, by some; others would postpone operating until the child is four or five years old. The majority of operators do the work of entire closure at one time; others claim that the danger to life is lessened if half of the double cleft be closed at one time, and that closure be completed at a later time.

The author's experience justifies him in advising an early operation; for the new-born appears commonly in the threshold of existence with an ample supply of reserve force to meet the new conditions of life for the first few days; and as a consequence the lungs and the alimentary canal, which must hereafter replace the placenta, commence their functions leisurely. Through the unclosed intercommunication between the right and left hearts, venous blood, for a time, reaches the arteries, and, as a result, general sensation is lessened and there is a tolerance of traumatism in any form. Also, the exposure to cold air through the labial breach, if closure be deferred, may induce bronchial and pulmonary affection. Such are reasons which plead strongly for an operation soon after birth, and have induced the writer occasionally to operate during the first day of the child's life.

The child's life is imperiled by the large quantity of blood which is usually lost at the time of the operation; also, by bleeding which may continue after the work is done; and another danger is the interference with respiration, which arises from the closure of the nostrils, which is often temporarily done by the operation; and such interference arises also through the closure of the child's mouth which occurs during the inspiratory act. The operation greatly lessens the oral opening, so that when the child draws in its breath the lips fall together, valve-like, and entirely close the opening. The hæmorrhage arises from the extensive surface which is wounded; also from the work which is done in the disposal of the premaxillary bone. The writer has found that some blood can be saved by using the thermal cautery to detach the sides and summit of the cleft from the upper jaw. And other hæmostatic precautions will be mentioned when the treatment of the premaxillary bone is considered. The breathing must be watched by a nurse who will vigilantly discharge the task of drawing down the chin or lower lip whenever the mouth is closed. If this be neglected the automatic movements

of inspiration and expiration will be repeated without the admission of air until the infant becomes cyanosed through want of oxygen.

In hare-lip with premaxillary complication, the best mode of disposing of the premaxillary bone is a question which has greatly occupied the attention of surgeons; and as it is the first act in the operative work, it will here be considered.

In the early or developing period of the operation on this complicated form of hare-lip, the older surgeons summarily disposed of the difficulty by excising the premaxillary bone, and then closed the labial breach in the same way as double hare-lip without complication. And even in later periods this practice was pursued. Volkmann, for example, was accustomed to sacrifice the bone. Yet this plan is obnoxious to the grave charge that it lessens the arc of the upper jaw, and diminishes the number of the teeth; and in the end, the future face is thus given a disagreeable shape. The nose sinks downwards and backwards, and the middle portion of the maxilla superior has the appearance as if it had been driven backwards; the normal rotundity of this portion of the countenance is exchanged for flatness. The shortened and broken dental arch presents an unsightly, if not repulsive, appearance when the mouth is opened. The shortened antero-posterior diameter of the buccal cavity deteriorates the voice. These are valid reasons for preserving the premaxillary bone; if, however, the labial defect cannot otherwise be closed, the bone should be removed. This may be done in the infant with a pair of scissors; yet, if the operation be done after ossification, bone forceps will be needed for the division of the nasal septum to which the bone is attached. Should much bleeding follow the removal, this may be arrested by cauterizing with the thermal cautery.

For retention and preservation of the premaxillary bone one of the following methods may be chosen: (1) From the nasal septum close to the bone, Blandin excised a V-shaped portion, whereby the septum could be shortened; the bone is then crowded backwards into the gap between the superior maxillary bones. Bruns treats the premaxillary bone in a manner similar to Blandin's method. As aid in this work, and to control hæmorrhage, a strong thread passed through the partition before and behind the excision may be tied, so as to aid in the closure and also to prevent bleeding from the vessels opened in the excision. For this purpose strong silver wire can be used more conveniently

than silken thread, since the former can easily be twisted to any degree of tightness, and the twisting can be repeated at a later period if required. (2) Desault pushed the premaxillary bone backwards into the opening between the maxillary bones. (3) Butcher of Dublin first fractured the supporting septum, and then he forced the bone backwards. In the announcement of his method of operating, Butcher claims originality for what Hueter pronounces not new, but old work (and on this point the writer would add that in such assumption Butcher held place among a vast number of so-called discoverers and inventors). (4) The mucous coating may be separated on each side from the unossified or ossified septum, and then, a section having been excised from the latter, the bone is thrust back into the room thus made for it, and a suture may be thrown around the wound in the septum, if there be excessive bleeding. (5) Esmarch trims the sides of the premaxillary bone, and then forces it into the gap behind; he thus hopes to favor subsequent union of the raw surface to the maxilla superior, for it has frequently been observed that, although the bone be forced back into the gap, it does not become adherent, but remains movable afterwards; and in such case, the teeth would be functionally nearly valueless. The objection to trimming the sides of the premaxillary bone is that one or more dental germs might be injured. Of the plans mentioned, the author advises that in which the mucous coating is uplifted, and the intermediate structure cut out as far as required, and then the bone is to be forced backwards.

Another complication of this form of hare-lip is the ill position of the nasal wings, and the flaring, funnel-like form of the nostrils, which results from such alar malposition. As means to correct this, Blasius used a quill or brace suture, which is placed on each side of the nose and included in sutures, which maintain compression. Bruns uses a loop of thread, which, suture-like, including the alæ and septum, corrects the obliquity of the former. Again, the writer has found that this work may be done by making raw the portion of the ala at its attachment to the lip, also the adjacent side of the pedicle of the sub-septum; and then uniting the raw surfaces by sutures, the form of the nostril can be rectified or much improved.

The order in which this work should be done, after the child has been anæsthetized, is first to place backwards the premaxillary bone by one of the methods previously described, and then to trim the margins of the cleft in the manner before given for

the treatment of uncomplicated double hare-lip. Two lateral flaps should be formed, which are to be united, as they hang pendent. The intermediate, angular, labial islet should be trimmed and saved, if it can be utilized in the closure. The lip should be detached from the jaw on each side, so as to facilitate lateral sliding. If the material be scant, there will be much difficulty in approximating and uniting the sides; and to lessen tension, Roux applied a bandage so as to include the united parts and lessen their tightness; and to accomplish the same, Heurteloup and Boeckel include the parts in a deep suture, which lessens the tension. Along with such suture, supporting adhesive strips may be used, applied in the manner before described. The nostrils are next to be rectified by means of lateral compresses, or the looped transfixing suture before referred to. The work of closing the wounded parts is now to be completed by the use of as many sutures as will effect coaptation. Metallic suture should be employed in all this work, since it irritates less than silk, and by twisting the wire, in place of tying it, any degree of tension can be obtained which is desired.

The time when the sutures should be removed should be longer after this operation than in any other case of hare-lip, since there is danger of the parts tearing asunder, the reason of this depending on two causes, viz., the thinness of the parts, and the pressure of the premaxillary bone. In many cases of complicated double hare-lip the parts are atrophied and are not thick enough to bear the strain of the sutures or the pressure of the premaxillary bone, against which the lips rest after the closure. This tension, or rather distension, continues after the sutures have been removed, and although union of the two sides may have been obtained, the pressure against them from behind continuing to act, they may finally separate completely or only partially. Partial union is much better than complete solution; in the latter case the condition is worse than prior to the operation; but when some union has been obtained it gives much aid in the work afterwards undertaken to obtain complete union.

The question sometimes arises whether in case there has been failure to get union, it is better to reoperate at once, or to delay until the parts have healed and the infant has become stronger. The experience of the writer is highly unfavorable to reoperating at once, in case there has been failure to get union at the first operation; though he has attempted this in a few cases in which such failure had occurred, in but one instance did the second

operation end successfully. Hence, the writer would differ from Sédillot, who advises to reoperate as soon as failure to obtain union has occurred. According to the writer's experience, the tissues which have recently been operated on and torn asunder are abnormally fragile and are very apt to separate again should they be reclosed; it is better to wait until the parts have become solidified, as they will do if time be allowed for them to heal. Not less than three months (and even six months is better) should elapse before the next operation. If this course be pursued, the chances of success after the second operation will be much increased.

The writer would warn against the error sometimes committed of prolonging the work by too much attention to the minute details of the operation; leading operators, as Stokes and Hueter, counsel expedition in the work. In hastening through the work, and by obeying the second term of *tuto, cito et jucunde*, the operator will comply with and emphasize the first and third; that is, celerity will contribute to safety and success.

After successful closure has been thus obtained, some additional work is commonly required to overcome certain defects which remain; and here, as in case of failure of the primary operation, the temptation is great to do this immediately; but as delay was needed in the former case, so it is equally necessary in this one; one should wait for three months at least, before using the knife again. And should the defects be slight, it will often occur that after a short period, they will become less conspicuous; in fact, the appearance will become so much better that the parents may decline any further operative amendment.

Surgical services are sometimes demanded in cases in which an operation has been done some years before for the relief of hare-lip, and in which the result obtained was unsatisfactory; and another operation is solicited. The remaining defect may be a V-gap, uneven opposition of the two sides or the exposure of too large a surface of mucous membrane; or an unsightly scar records the imperfect work which has been done. Again, without the scar being very conspicuous, it may contract lengthwise, and thus uplift and evert the border of the lip. Besides these labial irregularities, there may remain, after the operation, a flaring obliquity of one nostril, which, if unrelieved, will remain as an unsightly feature. In each of these conditions, a carefully studied piece of surgical work will be required to efface or improve the condition. And, despite the most careful and intelligent

attempt, the result obtained is often far from being a joy to the patient; on the contrary, it is often a disappointment; for correction of the errors and missteps made by nature in her work of molding the embryo, is far more easily done at the first operation, than in cases in which nature's errors have been intensified by the blunders of unskilled art. Hence it is prudent to abridge hope and limit promise in this secondary reparative work.

The most usual defect of those mentioned, requiring repair, is that in which the V-gap is combined with an unsightly vertical scar; the latter, by its paleness, contrasting with the adjacent normal skin. To correct this an operation may be done, consisting, in the main, of three acts. By means of a horizontal cut, a hanging loop-like bridge of tissue can be formed, from the border of the lip, at the site of the V-gap. This incision must be made in the horizontal plane and include enough tissue to retain its vitality. Next the scar is to be excised by two vertical cuts which closely include it; and these incisions should be continued upwards on each side of the nose, at first, close to the ala; and then each must diverge from the naso-labial sulcus laterally. The upper portion of these incisions will be in the form of a Y, of which the two upper branches should rapidly diverge as they ascend; and, if need be, the lateral portions are to be dissected from their subjacent attachment, while the median upper portion is to remain fixed in its site. Closure of the wounds is to begin from above, and in doing this, the sides must be drawn down and fixed to the intermediate portion by sutures, in such a manner as to lengthen the sides and, consequently, the height of the lip. To aid in this fixation, a transfixing pin should be used, which will pass through the depressed sides and the intermediate portion. Besides this twisted suture, one or more knotted metallic ones should be used to complete the closure of the vertical wound. The horizontal swinging bridge is next to be folded on itself, and closed by a suture which will fasten it, so folded, to the parts above. If these several cuts be properly done, the lip will be vertically lengthened, and the V-defect replaced by the normal tubercle.

In case the median gap is the only defect requiring removal, then the filling up of this defect may be done by an incision of V-form through the entire thickness of the lip, and stopping, on each side, at least one line above the labial border; and this may be done in opposite ways. In one way the cut is shapen as an inverted V thus Λ; this incision allows the forcing downwards

of the angular portion included between the lateral cuts, and the retention there of this part by proper sutures; thus done, there is effacement of the gap; or it can be done in a manner quite opposite to this, viz., with a cut of V form, in which the inferior angle will reach nearly to the labial margin. Such a cut will allow of the forcing downwards of the V against the border, and its maintenance there by means of proper sutures. By one of these ways, preferably by that of the Λ-form, the gap may be filled.

The exposure of too broad a stripe of mucous membrane may arise from the ill placing of the bridge which is used to fill the median gap. And a defect, almost as striking, is where dermal tissue occupies the normal site of mucous membrane. These defects are difficult of correction; their avoidance at the primary operation is an easier matter; here, as elsewhere, the preventive ounce far outweighs the corrective pound. As each case under this head has its special characteristics, the procedures for correction are so diverse that it is impossible to lay down special rules for the work; the ingenuity of the surgeon, if he be fertile in expedients, will devise a plan suited to the individual case. And the writer would say that the essays which he has made in this field, though contenting the patient, have not been satisfactory to himself; indeed, the operation accomplished rather a change than an effacement of the deformity; old lines of ugliness were superseded by new ones possibly less ugly.

A defect, sometimes arising from an operation on hare-lip, is an eversion of the middle portion of the lip, and continued exposure of the front teeth. To prevent such eversive retractile action and consequent shortening, Soupart of Ghent, in 1859, advised to cross the incision made by a second one, at right angles to the first one. This plan is in conformity with a principle which Soupart has verified, that a straight linear wound will contract less if it be intersected by other cuts. In fact, Soupart asserts that he lengthened the short side of a labial cleft by such intersecting incisions. The crossing cut need not pass through the entire thickness of the lip.

In case, however, such vertical shortening with eversion of the border is not corrected by a cross incision made horizontally or obliquely, then, in the gaping space thus made by incision, a pedicled flap, uplifted from the adjacent surface, may be turned around and inserted in the opening made. The cut, into which the insertion is made, should be deep, yet not pass through the entire thickness of the lip.

The last defect, for which corrective work may be demanded, is that of wide nostril, oblique flaring wing, and sinking of the end of the nose. The corrective work, here to be done, is to uplift the ala nasi and bring it nearer to the septum. To accomplish this, an excision of the tegumentary surface of the inferior outer angle of the nostril is to be made, and then the ala is to be forced inwards towards the septum, and retained there by metallic suture. This work of rectification is seldom required on more than one side, and this is commonly the left side. After the operations for hare-lip, if the child can nurse it should be permitted to do so; for if it be withdrawn from the breast until the wounds heal, it sometimes forgets the act of seizing and holding the nipple. It can readily nurse after the operation, provided the nostrils are patent; but if these be closed, as sometimes occurs, then the child must be nourished from a spoon, or other means used in the nursery. And, as a severe assault is made on the child by the operation, it is a matter of the utmost importance that its nutrition should be well maintained.

CHAPTER XVII.

LABIAL GROWTHS.

THE neoplastic developments which have location in the lips will next be considered; and as the labial structure is a composite of many elementary tissues, it is a favorable site for almost all varieties of new growth; and such neoplasm, according to histologic origin, may be named *vascular*, *follicular*, *epithelial* or of *connective tissue* type.

The statistician, who has collected long series of tumors, finds that vascular growths occur oftenest in the head; Porta found, in a series of one hundred and fifty-one vascular tumors, that one hundred and seven were seated on the head, eighty-nine of these were situated on the face, and, of these, ten belonged to the labial region. In a series of fifty-six, collected by Lebert, twenty-six were on the head; and seven of these were on the lips. The upper and lower lips have equal share in furnishing site for the vascular neoplasm. From the writer's observation, the growth occurs much oftener in the female than in the male. Bouisson reports the operation of ten cases, all of which were in females. It may occur at the angle of the mouth, and then both lips are implicated.

The labial angioma, analogous to that seen elsewhere, may be superficial and confined to the surface; or the entire thickness of the lip may be occupied by the growth, and between these many gradations occur. Arterioles and venules concur in the development of these growths; and, where the tumor involves the deeper labial structure, it has the property of swelling. This form is known as the erectile vascular growth; and, from the fact that in this form dilated spaces are found which are filled with blood, this species is sometimes denominated the cavernous tumor.

The cavernous or erectile tumor is more frequent in the lip than the superficial forms; it begins as a small point, as a rule, and this may remain stationary, and afterwards rapidly grow,

extending into and involving the adjacent structure of the cheek. It presents a livid bluish aspect, and enlarges during any expiratory effort of the patient. The epiderm conceals the color on the side of the skin; and the livid hue is more apparent on the internal side.

During infancy and youth the erectile angioma may continue to grow until it reaches considerable dimensions; but in adult life and in the aged, such growth is absent, or, at least, very slow. And in a few cases the tumor has receded, and spontaneously disappeared. Such fortunate event is so rare that it is prudent to eliminate it from the problem of the prognosis of this growth.

This tumor is absolutely painless so long as the bounding skin or mucous membrane remains intact; it is, however, not an unfrequent occurrence that the external surface, through accident or otherwise, becomes the site of abrasion or fissure; and such opening permits the escape of blood from the breach; and thus hæmorrhage may recur and debilitate the subject. Such hæmorrhage can also originate from death and sloughing of the surface of the growth, the condition, here, being similar to that seen in ulceration arising from a varicosed condition of the lower extremities. This ulcerated condition of the angiomatous lip being a source of continued irritation, there may result malignant disease, similar to what occurs in the leg. And, in such a case, there is a commingling of the elements of cancer and vascular growth. Such disease, which has been observed by Bouisson, it is needless to say, is far graver than normal angioma; the treatment of the latter must vary from the former.

Another form of labial angioma is one which is limited in volume, and situated on the mucous border. This is non-erectile, constant in form, and is remarkable for its dark livid or purplish hue, resembling in color an undried prune. In appearance it is analogous to melanotic cancer; yet it is wholly benign. This growth occurs oftenest in the female's lip, and is a source of trouble from its unsightliness.

As the form and appearance of the lip may, according to their character, render the face attractive or repulsive, hence the angiomatous development here becomes of far more importance than it would if situated in other parts of the body; therefore the removal of such deformity in the adult is urgently solicited: and if in an infant, the diligence of affection is yet more importunate in its demands for surgical aid.

Treatment.—Many means may be resorted to for the cure of

labial angioma; a cardinal principle, which should guide in the work, is to leave as small a scar as possible; were it done otherwise, the patient would only exchange one ill for another. The treatment, also, should vary according to the grade of the vascular growth.

In case the growth is of the most superficial species, in which the affected structure, consisting of intercommunicating capillaries, has been named telangiectasis, the most appropriate treatment is cauterization by the actual or potential method. The simple thermal cautery will accomplish the work; but care must be used not to destroy the surface too deeply; the metallic cautery should be passed once or twice over the affected surface, and this should be repeated after the destroyed surface is detached. The work can also be done by means of fuming nitric acid, care being used that the acid does not enter the mouth.

Should the vascular growth reach deeper, then attacking it superficially will be insufficient. The most conservative plan which then can be pursued is that of simple compression. Boyer reports that he thus cured a labial vascular growth. To do this, a strip of India rubber should intervene between the lip and the teeth, and, on the outside, compression may then be maintained by an elastic bandage; or, to a head-dress, a compressive appliance might be attached anteriorly. As the intent of such appliance is to lessen the blood supply to the lips, the work would be materially aided by continued pressure maintained on the facial arteries, where they lie on the maxilla inferior.

The labial angioma might be removed in the infant by inoculation with vaccine virus; a serious objection to this method is that it entails the permanent marks which characterize the vaccine scar. Another grave objection is the long period of suppuration which it compels the patient to pass through.

Pustulation with tartar emetic will accomplish the same regressive change in the vascular structure; and an ointment of ipecacuanha acts similarly.

The tumor may be brought to a permanent standstill by injecting into it some coagulating fluid, as a solution of a salt of iron, or some vegetable astringent, as the tincture of nut-galls. In this way the blood content may be coagulated and remain, as it were, fossilized, an unchanging component of the labial structure. Besides the peril that such fluid might overleap the boundaries of the growth and enter the circulation, it is unsatisfactory in another way, viz., that the mucous surface may remain uneven

and discolored. Hence other methods are preferable to that of coagulation.

A method which might be used is thermal cauterization, done by means of needles, which, heated to red heat, are thrust into the angioma and retained there until they destroy a thin stratum of structure contiguous to them. This plan should be proceeded with slowly and repeated several times until the work is completed. If the operator has had some experience in this method, he will be able to thus satisfactorily remove or reduce the vascular growth; but in his first essays he usually exceeds or falls short of the proper measure.

Reduction may be done by transfixing the vascular structure by pins, and then including the pins in constricting ligature, the constriction to be maintained until the circulation is arrested.

By any of the methods mentioned, the angioma may be reduced in volume and often cured; still, it not unfrequently occurs that small sections of the growth remain, whence regrowth may originate, and the angioma subsequently reappear. Hence some certain and trustworthy plan is desirable; and this is found in excision. By excision, the writer has frequently removed the labial angioma, in which the growth occupied the whole, or the greater part, of the thickness of the lip. The scalpel makes few mistakes when wielded by the trained hand. Excision may be done by sections, or the entire growth may be removed by a circumscribing incision.

In partial excision, cuneiform sections of the structure are to be removed, and the intermediate wedge-shaped sections of structure which remain are to be united by sutures. One, who has not performed such cuneiform excision, should be warned not to form gaps too near each other, else he will find difficulty in effecting complete closure of the surface, for it is apparent that the remaining triangular portions of structure cannot simultaneously be displaced in two directions; and to avoid error in the closure, it is better to close each gap as soon as it is formed. The experience of the writer in such excision and closure has taught him that, if the work is done otherwise, it is difficult to estimate correctly the amount which should be excised; but, done as here indicated, besides satisfactory closure of the opened surfaces, the loss of blood will also be reduced to the smallest amount.

Inasmuch as any portion of the remaining tumor may continue to grow, a more certain method is to completely excise the vascular structure. In this work the entire thickness of the

lip should be excised; and this is practicable in cases in which the growth is not of large volume; but if the greater portion of the lip be involved, the treatment should be in accordance with some one of the conservative plans which have hitherto been explained. The question may be asked whether it would not be more proper to spare the dermal side of the lip, provided the angioma occupies chiefly the opposite side; the objection is that, thus done, there will be left a wound opening into the mouth. Or, if an attempt be made to close the wound by a suture in the inner side, the result would be a pouting process on the outside, which would continue as a lasting deformity. These are valid reasons for sacrificing the entire thickness of the lip, and they are further fortified by the facility which is given for accurate closure of the wound when the work is thus done.

Total excision is best done when the scalpel follows the line which separates the vascular from the normal structures. A little observation and study will enable the operator to do this, and excision, thus done, will cause but slight bleeding, for the growth receives and returns its supply of blood through but few arteries and veins. If, however, the incisions enter or traverse the angiomatous structure, then there will be profuse bleeding from the wound. It is rare that ligatures are required to check the bleeding. The hæmorrhage can be reduced to a minimum by torsion and careful apposition by sutures.

In case the growth is so extensive as to compel the operator to enter the buccal wall, then the dermal side, if possible, should not be opened, the removal being done wholly on the inside; and in this work, should an extended recess or pocket be formed between the mucous membrane and the outer wall, then the cavity formed should be slit to its bottom, so that excreta or other material may not find lodgment there.

Small, isolated angioma seated on the border of the lip, such as the prune-colored species early mentioned, is best disposed of by cuneiform excision done with scissors; and then, if a considerable notch be formed, it may be closed by suture.

Labial Cystoma.—Cystic growth, commonly of small dimensions, sometimes develops beneath the mucous surface of the lips. Such growth is somewhat flattened in form, and rarely exceeds the size of a pea in volume. The content resembles inspissated mucus, and is viscid and gelatinous in character. The covering wall is transparent and so thin that the character of the content is distinguishable through it. If this wall be opened, the con-

tent escapes, and the cyst temporarily disappears; yet it soon reforms and presents the same appearance as before. Besides the small cysts here described, those of much larger volume have been observed. And as these were multilocular in structure, they probably arose from the fusion of two or more simple cysts.

Whether simple or compound, the labial cyst doubtless arises from closure of one or more mucous follicles, and the retention and accumulation of the secreted content.

Such cyst is painless, yet its presence is disagreeable, inasmuch as the tip of the tongue falls into the habit of often visiting the part, a fact which the writer can testify to from subjective knowledge. And this becomes especially annoying if the cyst is large, as in the cases cited above; in fact, such development would visibly deform the lip.

This follicular cyst is innocent in character, and free from any malignant tendency; yet, as the lip is so often the site of epithelial cancer, any growth in it awakens suspicion, is a source of anxiety, and soon leads the possessor to seek medical counsel. The physician or surgeon can quickly allay the patient's fears by assurance of the harmlessness of the growth; if, however, the patient has the misfortune to fall into the clutches of the cancer quack, after a period of torture with caustic applications, he finds himself cured, and his case is heralded among the laity as a case of cancer cured without the use of the knife.

The proper treatment for this cystic growth is to insert a fine tenaculum beneath it, and, having uplifted the cyst, excise with curved scissors. Or the lip may be so compressed as to push the growth outwards, when its removal with scissors alone is easily done; in fact, in this way the writer, standing before a mirror, removed such a cyst from his lower lip, and his report on the work is that it was less difficult than painful; and the lesson derived from his experience was what, no doubt, many a reader can bear witness to, that the most accurate knowledge of a disease is derived from being its subject; for while books furnish the changing doctrines of disease, and clinical observation often illustrates the same enigmatically, yet personal experience of suffering stereotypes the same on the page of memory as knowledge unembarrassed with doubtful theory.

Labial Cancer.—The pathologist who divides the chapter of cancer into four or five sections, may find representatives of these different species in the labial region; but the infrequency of

encephaloid, cicatrizing, colloid and melanoid cancer on the lips, renders a consideration of the latter unnecessary here. The form commonly occurring in the lip is that which has received several names, viz., local cancer, cancroid epithelial cancer or epithelioma. The name of epithelioma was given it by Hannover, in 1852, and this name is derived from the circumstance that the main constituent of the growth is the epithelial element which forms the outer investment of the lip; and so well is the name affixed to the page of nomenclature, that the word is beginning to have a place in the language of the learned layman. The name *Cancroid* had its defender in Lebert, and after flourishing transiently, seems to have run through youth and maturity and is now verging into obsolete age, whence, if it follows the usual fate of words, it must soon find its humble place in the glossary which is appended to works on nomenclature.

Commencement and Course.—The labial epithelioma commences by an augmentation of the epithelial investment of the lip, and this, as a rule, is the lower lip; the superposed strata are increased in number, and the component cells are augmented in volume. And this cellular development occurs initially on the border of the lip where dermal and mucous epithelium meet. This augmentation, at first slight, is plainly apparent later; and this may be limited to a small space, or it may be spread along the border until it attains an inch or more in extent, and then the middle portion of the affected border is the most elevated, unless it has been lowered through ulcerative action. The affected part has a whitish or grayish appearance. This altered condition may remain with but slight change for a long period; the outer epithelial stratum becoming desiccated and of dark color, is occasionally detached, either by accident or the patient's finger, and then it is soon replaced by a thicker stratum.

Cases somewhat akin to those mentioned are those in which the morbid growth is limited to a small surface; the epithelial strata, forming a mold of two or more papillæ, continues to grow without limit, and thus a horn-like growth is produced, which may attain dimensions of from a half inch to an inch in length. Such a growth is formed of concentric strata, in the center of the base of which is contained a process of the mucous structure which is sensitive and vascular. The presence of sulphur, in which the growth is rich, and the peculiar odor arising when it is burned, show the identity of this growth with horny material, as hair, nails, etc. Such growth may exist simultaneously with

adjacent epithelioma, and finally assume the malignant nature of the contiguous epitheliomatous structure.

Instead of the epithelial development of the flattened or of the horn-like species mentioned, an equally common if not more frequent form, in which it makes its advent, is that of a wart, or of a crack or fissure in the border of the lip. This form is commonly in the middle third of the lip, and near or in the median line of this portion. Whether in the form of a raw tubercle, or a cleft in the border, there is a hardness of the affected site, and this induration, along with increasing thickness of the lip, slowly enlarges its sphere until it occupies a greater or less portion of the lip. If the initial point be a fissure, sooner or later the sides of this break down by ulceration; since the strata of cells most remote from their nutrient source, through inanition, perish, break down and are detached, there remains a raw surface. And about the tuberculated site of origin, from analogous excessive cell growth, disintegration ensues. The advancing malady in either case is like a cruel victor who both occupies and destroys, and without rest pursues its march of devastation. The cell product insinuates itself, by a species of substitution, into the normal tissues, and ends by replacing the latter; a replacement so complete that abnormal is substituted for normal tissue, and the former, after a transient existence, dies, and there remains an ulcerated breach. The morbid growth may extend along the border of the lip horizontally; yet the infiltration proceeds rather towards the base of the lip. This infiltration is not uniform, the substitution being more complete at some points than at others; hence sections of undestroyed structure may remain standing alongside of the adjacent sections which have broken down; thus, in time, there arises a very irregular surface; islets of but slightly affected tissue border on ulcerated excavations.

If the epitheliomatous process be studied, it will be seen that it consists in the development within normal tissue of a structure of which the marked characteristics are rapid growth and short life; after originating in some unexplained manner, it passes through brief periods of youth, maturity, age and dissolution. If it be examined by incision in its mature state, it will be found much harder in structure than the normal labial tissue; the incised surface is marked by yellowish or greenish spots, and if it be compressed, there will be forced out a paste-like fluid and yellowish bodies. If the material thus extracted from the morbid tissue be microscopically examined, it will be seen to be composed

of epithelial cells, isolated or in groups, and those in groups may have a concentric arrangement which they have retained from their primitive molding around the papillæ of the mucous membrane. Elementary analysis discovers that the active agent in this destructive transformation is the epithelial cell, and, along with these cells, coëxist bacterial microphytes, of which the agency, whether causal or passively contingent, has not been determined.

After the labial epithelioma has continued its work of ulcerative destruction to the expiration of its lease of life, an examination will discover that the glands in the space within the inferior maxillary arch become enlarged. When small, these glands are easily movable; but later, they become adherent to the contiguous structures, and finally the covering derm opens, and an ill-formed pus is discharged. This pus is somewhat similar to the material before mentioned, which can be squeezed from the stroma of the mature epithelioma. In character the discharge is similar to that which is yielded by a broken-down gummy growth. The location of such enlarged glands is near the submaxillary gland, and, as a rule, it is directly underneath the affected portion of the lip; by some abnormal error, the affected glands are exceptionally found on the opposite side; such aberrant metastasis the author has now under his observation. If the lymphatic glands, lying on the submaxillary salivary gland, indurate, swell and open, the salivary gland becomes infected, and likewise ulcerates. The adjacent maxilla, when reached by the advancing infiltration, becomes affected; the erosion may be superficial, or so deep as to nearly divide the jaw and make its fracture an easy matter. Or the ulcerative devastation may be chiefly intra-buccal, and then the disease may burrow into the wall of the cheek, or pass into the floor of the mouth, and dissect up the tongue from its front connection to the floor of the mouth. In its destructive migration, the epithelioma may cross the roots of vessels, and, opening them, cause bleeding. From compression or ulceration of the gustatory and hypoglossal nerves, there may be loss of sensory and motor function of one side of the tongue. The ulcerated breach in the lip permits the saliva to escape, and, trickling down on the chin and falling on the dress, it renders the patient intensely repulsive to others, and quite as much so to himself. The ulcerated gap in the mouth interferes with respiration and the taking of food.

Thus, as seen, the epithelioma, at first a microscopically small

lesion, may widen its domain of destruction until it ends the life of its victim; in its career it is akin to a spark of fire on a dress, which a touch of a finger may extinguish, but if once awakened into a flame, a hundred hands can hardly rescue the unfortunate one.

A remarkable circumstance in connection with labial epithelioma is that, during its incipient period of development, the slight lesion rarely awakens attention on the part of the patient. The trivial breach in his lip arouses no suspicion of its real nature; and, as a rule, the subject is only awakened to his true condition when the disease has well entrenched itself in the lip, and has produced some destruction of tissue.

Causes.—The epithelial element of the lip is launched on its aberrant course by some irritant which is continued in action for a long period; such irritation may be caused by the irritating action of the smoker's cigar or pipe-stem; or the nail, tack or other object which, the mechanic daily placing in his mouth, presses on and bruises the lip; or the foul content of an uncleansed mouth constantly coming in contact with an eroded surface of the lip; or a crack or cleft in the border of the lip that is maintained in a raw state by the action of the muscles which are constantly moving the lips; or, finally, any occupation in which the mouth is exposed to injury; of which a rare example is the blowing of food into the beaks of fowls which are subjected to forced feeding to hasten their fattening, or rather fatty degeneration. An erosion from any of the causes enumerated, often finds an efficient ally in the irritant remedies which the patient applies to it; and a further efficient ally is the lingual manipulation with which the eroded surface is continuously tormented.

To what extent smoking is a causal agency has been and remains a subject of contest among surgical writers. As usual, those who smoke are partisans for their favorite pleasure, and offer numerous plans in defense of its harmlessness; and an argument which they urge is that, while there are thousands of smokers, there are but scattered units of those who become the subjects of labial cancer. To this their opponents, among whom the writer is included, reply that labial cancer occurs oftenest among men who smoke. And that units only of the thousands of smokers become affected is in accord with the deportment of many other diseases; though many are exposed to attack, yet but a few become the subjects. There are doubtless constitutional conditions, as yet undetermined, which dispose to the develop-

ment of malignant disease, whether in the form of epithelioma, sarcoma or carcinoma; in those with such predisponent endowment, the continued irritation of the stump of the cigar which often remains on the ground after its trunk has been consumed, becomes the final causal excitant of epithelioma. The rough stem of the clay pipe does the work more surely, since it has, as co-workers, unclean mouth, unclean teeth and unclean lips. The heat of the cigar and pipe overheats their point of contact, and the drying saliva leaves its solid content on the lip; some irritation must thus be caused. The tobacco, as is known, contains nicotine, a most active principle, whose toxic virulence is well known to the pharmacologist. In the methods which are used to prepare the tobacco for smoking or chewing, ingredients are compounded with it which are said to set free ammonia as well as the alkaloid nicotine, and thus the material is rendered more acrid than it is in its natural state. Hence, in the act of smoking, the lip is irritated by heat at a degree which almost burns the surface; and this is combined with the action of nicotine, which evidently impairs and lowers the vitality of the part which it penetrates. If a few drops of nicotine, introduced into the throat of a bird, causes death, as has been found to be the case, it certainly must have a depressing effect on the mucous surface of the mouth. As this action may be exerted within the buccal cavity, the smoker's cancer is not limited to his lip, it develops quite as often at the sides of the base of the tongue, and on the pharyngeal arch, at a point which receives the impulse of the indrawn smoke. And finally, it may be stated that women, rarely smokers, seldom have labial cancer.

Another point, strongly in favor of the causal agency of tobacco, is the greater frequency of labial epithelioma since the use of tobacco has become more prevalent; this disease is one which now presents itself to the practicing surgeon oftener than any other form of malignant disease; such frequency did not exist a century ago, if one judge of the matter by the surgical works published at that time: labial cancer was not spoken of as a frequent occurrence by Boyer, Bell, Heister, Delpech, Richter and Richerand; but the present prevalence of the disease is in direct ratio to the popular use of tobacco; which has been advanced by fashion from an occasional luxury to that of a necessity; and thus promoted, tobacco will baffle the best efforts of the hygienist who seeks to lessen or abolish its use. The "Counterblast against Tobacco" written by a royal hand,* had as little effect in checking the use

* King James of England.

of the plant as does the knowledge well diffused among people that cancer may thus arise; and the principle here obtains that man would rather add to the sum of his pleasures, even if the added material must be taken from his life. In fact, the altruistic virtue which is so unselfishly illustrated in hygienic medicine, and which sacrifices itself for the sake of others, has slight extrinsic recompense.

Diagnosis.—The labial cancer during the initial period of its evolution has strong analogy with the primary or secondary lesion of syphilis. Chancre on the lip must originate from contact with a syphilitic subject; it is seen oftener in the female, and quite as frequently on the upper as on the lower lip. It may be multiple, and it commences often on the outer edge of the border, and, in its growth, it extends towards and on the derm, rather than towards the mucous membrane. The secondary syphilitic manifestation on the lips is oftenest on the lower lip, or at the labial commissure; and in the latter site, it involves both the upper and lower lip. This eruption is commonly in the form of the mucous patch, which is pearl-colored, or it may be a slight ulceration; and this is near the angle of the mouth. Labial cancer, in any of its forms, differs in appearance from the primary or secondary manifestations of syphilis above mentioned: namely, the flat form is slower in its march than the chancre or mucous patch; it is surrounded by a dark crust, and a horn-like growth may spring from it; manifestations unlike anything seen in the course of syphilis. The papillary epithelioma is drier than syphilitic condyloma, and has more contiguous induration. The nodular branches which the epithelioma projects into the neighboring structures are multiple, while the gummy development is usually single. The manifestations of syphilis are painless, or nearly so: the labial cancer, when it reaches the period of ulceration, is painful. Epithelioma confines its devastations to the structures of the face, chin and front of the neck; syphilis has no tendency to local isolation; it is ubiquitous in its secondary site; derm, muscle, mucous structure, bone, brain, abdominal viscus, indiscriminately share in the unenvied privilege of giving the constitutional manifestations of syphilis a transient if not a permanent abiding place. Syphilis is capable of elimination, and cure by the use of mercury and iodine; these remedies will retard epithelioma, as the author has verified in his practice; they will, however, not extinguish and cure epithelial cancer. The microscope may be used as a diagnostic aid; a small section placed in the

objective field will discover the epithelial constitution of the epithelioma; the cellular elements of the latter will sometimes be found in the interior of the growth, where they arise, according to Otto Weber, from the nuclear elements of the muscular components of the lip; such a cellular structure will not be found in tissue which has arisen from syphilitic action.

Tubercular disease may produce induration, swelling and ulceration similar to that which arises from labial cancer. Such tubercular disease appears as often in the upper as in the lower lip. Tuberculosis, similar to syphilis, does not confine its morbid action to so limited a portion of the organism as the lip; if found there it will be found elsewhere; probably in a gland, in the skin, in a joint, or a bone; but the localized site of epithelioma distinguishes it from the multifarious site of syphilis. The subject of labial cancer, as a rule, has general good health; except his lip, he is sound in body; the reverse usually obtains in secondary syphilis, or in tuberculosis.

Prognosis.—The inevitable tendency and undeviating course of labial epithelioma is to ever enlarge its sphere of destructive action; to spread from the lip to parts near by; and by continued ulceration and ichorous suppuration to undermine the patient's vital forces, and finally destroy his life. In the early stage, the disease is easily curable by proper treatment; if allowed to reach the adjacent glands, it is incurable. The poor and penniless are oftener cured than the rich; since the former are forced to depend on surgical aid which is furnished him by the city or State; while the rich, having exhausted their intelligence in the acquisition and maintenance of their fortunes, seem to have none left for their guidance in medical matters. At least, this has been the personal experience of the writer. Dives is careful to choose a skilled engineer to construct an irrigating canal, or pioneer the route for a proposed railroad; he would scout the overtures of one who, with no knowledge of painting, would offer to paint his portrait: he would look into and investigate the qualifications of a surgeon for his domestic animals; and yet such a one often submits his own disordered body for treatment to one who is ignorant of both Anatomy and Pathology. Often the author has been consulted by a patient whose face had been laid waste by cancerous disease, which, at first of minimum form, had been cultivated to its great dimensions by the industrious hand of the ignorant charlatan; and through ignorance or misguidance, such patient, once easily curable, was doomed to a cruel death.

Statistics of Labial Cancer.—In 1887 Maiweg published observations made at the surgical clinic of Bonn on labial cancer. These observations embraced four hundred cases, of which three hundred and sixty-six were men, and thirty-four women; that is, there were eight and five-tenths per cent of females. In the entire number there were twenty-two in which the disease was on the upper lip, and one-half of these were females. In respect to age, the most of the patients were between fifty-six and sixty-five years. After seventy-five years, the disease is rarely observed. The average time which the disease had existed when medical aid was sought was two years. Of one hundred and eighty-two persons operated on, one hundred and twenty-five remained free from the disease; that is, the disease was cured in two-thirds of the cases.

Wörner of Tübingen has observed three hundred and five cases of cancer of the lip. Of these cases ten per cent were women; and three were seen who were under thirty years of age. The subjects were nearly all of the laboring class. In sixteen of the three hundred and five cases, the upper lip was the site of the disease. Of two hundred and seventy-seven persons operated on, one hundred and six remained well during a period of three years in which they were observed. The mortality was five and seventy-seven-hundredths per cent, and was from secondary complication of the lungs. Melzer, in 1850, in a report of patients received at the hospital of Laibach, states that every sixtieth one was a case of labial cancer; he attributes the frequency of the disease to the use of a pipe which was covered with copper.

From all the publications accessible to Wörner, there were collected eight hundred and sixty-six cases of labial cancer, of which ninety and four-tenths per cent were in males. The upper lip was the site in five and six-tenths per cent of the cases. Of those having the disease in the upper lip, the greater number were females. The average mortality from the operation was seven per cent; and the recoveries obtained by operating were twenty-eight per cent.

The percentage of recoveries as here reported is strikingly small, and can only be accounted for on the ground that the cases were well advanced when the operation was done; or else the work was imperfectly done; probably both of these agencies shared in the causation; since, from the writer's experience, which has not been limited in this section of operative surgery, it is a rare event that the patient is not cured, if extirpation be

thoroughly done at an early period. The patient, if seen and operated on early, can be assured of permanent relief from his affliction.

Treatment.—The patient requires two things from his surgeon: viz., that the diseased portion of his lip be removed, and that the continuity of the lip be so preserved, that it will, in some measure, act the part of a retaining wall, which is an important function of the normal lip. As a considerable portion of the lip is sometimes sacrificed, a third operative act is often required, viz., restoration of this retaining wall, by the procedure of cheiloplasty.

Inasmuch as labial cancer is especially a disease of the lower lip, the latter will usually be the site of the operative work. The removal may be done by cauterization, potential or actual, or by section made with knife or scissors.

The proximate relation of the lip to the buccal cavity, renders it difficult, if not hazardous, to apply a destructive escharotic to the lip; and should cauterization be resorted to, the thermal method would be the preferable one; but the open breach which must then remain, even though this be temporary, is a strong objection against this mode of treatment. Excision, then, becomes the method which is almost universally adopted, since the scissors or scalpel do their work instantaneously; and the incision made enables one to inspect the divided tissue; and if all the affected structure has not been removed, one can remove another segment. The incisions may be so made as to assist in the concluding operative act, viz., that of closing the breach made.

Excision, as stated, may be done with scissors or scalpel; as a rule, strong scissors, with curved blades, and sharp at the points, do the work most easily. An anæsthetic should be used, if the patient desires it; the writer, in many cases, has done the work, in æsthesia, the patient choosing to show his powers of endurance without further aid than his innate courage. Instead of a general anæsthetic, sensation might be suspended locally by injecting into the lip a few drops of a four-per-cent solution of muriate of cocaine. By this local anæsthesia, vomiting will be avoided, and this risk of disturbing the work will be shunned; but from the writer's observation it is rare that the injected cocaine wholly annuls sensation; the division of the cocainized structure causes pain.

Only a small operation is required where there is a slight erosion of the mucous border of the lip, and the removal can

here be done by means of a superficial wedge-shaped excision, in which the cutting is done antero-posteriorly or laterally, as may be best suited to remove the affected part. The gap made must be closed by one or more sutures, and the surface then covered with a coating of the tincture of benzoin.

If the disease involves a larger portion of the border of the lip, and has perforated to some depth: for example, if the erosion be a half inch or more on the labial edge, then a larger excision must be done; and this should be of a triangular or quadrangular form; the more usual one is the triangular one, in which a wedge-shaped portion of structure is removed. Whether knife or scissors be used, the incision should be at least a half inch beyond the affected tissue, within the sound structure. And to be sure that this has been done, the excised portion should be carefully examined; and then, if it be suspected that enough has not been excised, more structure should be removed. This cuneiform mode of excision is a favorite with the operating surgeon, since it can be rapidly done, and the gap made can be closed by direct apposition; if the gap is not great, the sides can be brought together and retained so by suture. There is, however, the serious objection that structure is unnecessarily sacrificed in the lower part of the triangle; and further, the narrowing of the excision as it passes from the labial border involves the risk of leaving behind germinal elements of the epithelioma; and this will be greater the shorter the wedge is. A preferable cut, then, is one of quadrangular form, of which the vertical sides, commencing a half inch outside of the affected part, shall extend from one to two inches beyond the labial border; these vertical incisions are to be united by a horizontal one. To restrain the bleeding, which follows either the triangular or quadrangular excision, compression of the coronary arteries should be made, either with clasp forceps or with the fingers of an assistant; the former are less in the way; the latter are more apt to be at hand.

The quadrangular breach thus made in the lip may be closed by one of several cheiloplastic procedures. Since the object of these operations is to prevent deformity, the replacing material should be selected where its removal will cause the least possible scarring; and to accomplish this, the attempt has been made to restore the removed structure by material taken from the arm. Brachial restoring material was used by Graefe, Berg, Schuh, Wutzer, and others; the result has only been partially satisfac-

tory; in Wutzer's case alone the attempt was in some degree satisfactory. Such work is unsatisfactory in the color of the derm which is transplanted, and in the shriveled or folded form which the transplanted structure assumes. In Schuh's case the brachial flap rolled up into an ill-shaped mass; in Wutzer's operation the material was taken from the outside of the forearm above the wrist; and this had the fault of not being of the same color as that of the adjoining face. For these reasons, the operator should select material for restoration from the chin or the side of the face, and as that from the chin leaves a less conspicuous mark, one should choose there, if possible, material for restoration.

In case cuneiform excision be done in the lower lip, if the portion removed does not exceed an inch in breadth, then direct closure can be done; the oral opening will then be rendered smaller; yet, in time, this condition is lessened through the normal extensibility of the labial structure; nevertheless, the narrowed mouth is a source of inconvenience, and where the mouth will be rendered very small it is well to enlarge it. This widening can be done by a horizontal incision carried laterally from the labial commissure that is nearest the excision; and if the excision occupy the median portion of the lip, then a horizontal incision should be made at each angle of the mouth. To prevent these lateral cuts from closing, on the lower margin of each the mucous membrane and derm should be united by sutures. To obtain this muco-dermal union, in making the horizontal incision, a small mucous flap can be constructed on the inside, which can afterwards be folded outwards over the raw border; or a horizontal cuneiform excision from the cut border would permit of a similar muco-dermal closure. It suffices to make this closure in either the upper or the lower margin. Where commissural elongation is made, the extension should equal the breadth of the excised portion.

In directly closing the wound in the lower lip, either with or without commissural elongation, there will be formed a fold on the upper lip; also the margin of the upper lip will project beyond that of the lower lip; or, if the exceptional case occur that the excision is done from the upper lip, then an analogous folding or puckering will be formed in the lower lip. To correct this, the plan of Burow may be followed, by which the surplus fold is sacrificed by the excision of a triangle. Instead of losing this tissue, the author would endeavor to save it by forming a

pedicled flap from the surplus fold, and then, having incised the opposite border, whether this be the upper or lower lip, circumduct the flap, and insert and fix this by suture in the gap formed for it. Another plan, advised by Weber, is to elongate the commissure by an incision curving downwards towards the margin of the lower jaw, if the disease be on the inferior lip. When this incision is made, the lower portion of it may be sutured in such a way as to remove much of the fold; and this is done by drawing downwards the outer border, and sliding upwards the inner border of the excision.

The cheiloplastic restoration is often done by means of pedicled flaps taken from the adjacent surface. If the breach to be filled be a quadrangular one in the lower lip, then the plan of Sédillot may be resorted to, viz.: lateral flaps with upward base near the angles of the mouth are uplifted and made to fill the breach. This plan is shown in Figures 85 and 86. Or a plan

FIGURE 85. Showing Sédillot's plan of forming flaps for closure of quadrangular breach in the lower lip.

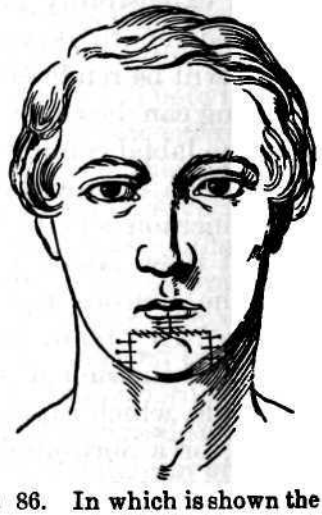

FIGURE 86. In which is shown the result of closure by Sédillot's method. (From Emmert.)

the reverse of this has been resorted to by Bruns; here the flaps have pedicles below, and their free sides are formed from the cheeks. The plan of Sédillot is the preferable one, since the scars formed will be on the lower part of the face, where they are more readily concealed.

The replacing flap, when it is brought into place by circumduction, can be given a form which will correspond to that of the breach made in the excision of the epithelioma; thus, it may have a quadrangular, triangular, trapezoidal, ovoidal, or even

some nameless shape, provided it will thus fill the breach. And in this work the operator must bear in mind the retractility of the uplifted flap; an allowance should be made for a diminution of its surface; and this, when the material is abandoned, should be equal to one-third of the replacing material.

The Celsian procedure is, sometimes, conveniently used to close a quadrangular breach made in the lip; this consists in elongating horizontally the basial cut, or that nearest the attachment of the lip; thus lateral flaps are formed which can be juxtaposed by lateral sliding.

Should the disease involve the angle of the mouth, then there arises the problem of canthoplasty, which is a difficult one to solve; one solution of it is the method pursued by Mackenzie, in 1851. This consists in forming a flap with a curved border on the side of the chin; then split this horizontally, so that one portion can form the lower, and the other the upper border of the commissure. To prevent this angle from closing, a portion of mucous membrane should be dissected up, wherever it is most accessible, and sutured in the angular gap.

Instead of the plan described, an angle-bearing flap might be uplifted from the side of the face, and so turned into the breach that the angle contained in it would occupy the site of the intended commissure. In this way a flap taken from the forearm might be modeled and utilized, if material adjacent were wanting.

In case the entire lower lip is removed by a crescentic incision, Weber advises to close the breach by means of two semicrescentic flaps formed below the breaches. One of these flaps is to be uplifted and drawn across, so as to form the upper part of a new-formed lip; next, the remaining flap is to be elevated and so fixed as to support the upper flap. These flaps are to be retained in position by metallic sutures. After closure has been done in this manner, there will remain an open space on the chin.

In case there exist alternate sections of sound and diseased tissue, Weber removes the affected portion by triangular excisions, the bases of which open towards the mouth. By this plan of compound triangular excisions, a destroyed commissure can in some measure be restored; and it has another advantage, that it shuns the needless sacrifice of unaffected structure.

The patient may present himself for treatment after the disease has extended beyond the labial region; and by such extension

the disease may implicate the adjacent buccal wall, and even the osseous structure of the lower or upper jaw; and simultaneously with this, the lymphatic glands in the inferior maxillary arch, and the upper part of the neck may be affected. According to the writer's observation, if the epithelioma has attacked the maxilla and appeared in the glands, an operation will be followed by recurrence at no distant period.

If the disease involves the cheek, the affected part should be excised by a circumscribing cut, and the opening plastically closed. Special care should be taken to avoid a salivary fistula, should the Stenonian duct be involved; and this may be done by dissecting up the posterior portion of the severed duct and turning this directly into the buccal cavity. In this wise, the author has successfully operated in a case in which the terminal part of the duct was diseased.

If the lower jaw is involved, and the malignant disease has penetrated to its central canal, then a portion of the body of the jaw should be exsected; and this is best done by a small saw by which the opposite sawn faces can be so shaped and inclined that they can be apposed and united by metallic suture. In case the bone be slightly affected on its surface, the entire thickness need not be removed; still, the disease may have penetrated beyond the surface, so that superficial removal of surface will soon be followed by reappearance of the disease; in all such cases the exsection should reach well into the bone: at least through one-half its thickness.

At some period, early or remote, the disease passes beyond its primary marginal site and commences a migration into structures contiguous; that is, the neoplastic invader makes provision for a successor in a new quarter, after it has consumed the structures which it first attacked; and this secondary site is the structure within the inferior maxillary arch and the anterior structures of the neck; and the first points of metastatic appearance there are the lymphatic glands which lie near the submaxillary gland. The lymphatic vessels which convey the germinal elements of the epithelioma seem to remain exempt from infection. The infected glands are commonly on the same side as the affected point of the lip, and they are the ones which become secondarily attacked when the epithelioma appears at the root of the tongue or in the arch of the pharynx. An exception to this rule of reappearance was seen by the author in one case in which the glandular infection occurred on the opposite side of the neck.

The proximate relation of the lymphatic glands to the submaxillary gland exposes the latter to implication, so that finally the submaxillary gland becomes also infected; and without much swelling, the submaxillary gland finally ulcerates and a portion of its structure is destroyed.

When labial epithelioma has advanced to the stage of glandular infection, in no instance has the writer seen the case permanently cured, even though the affected lip be radically excised, and the glands carefully removed; recurrence of the malady has been the invariable fate of the victim. However, in such cases, the operation is advisable, since the wound made will recover, and the patient is cheered with the illusive hope that he is really cured; an illusion which is sometimes unwisely broken by the surgeon revealing to the patient his own fears. The kindness of the physician is nobly and laudably exerted when he promotes the expectation of relief; he who would do otherwise is a stranger to those sentiments of humanity which belong to the morality of medicine.

In case the epithelioma has infiltrated the structures on the chin and the upper part of the neck, and the infected glands have suppurated, the affected field of nodulated surface presents a number of crateriform openings through which flocculent, caseous, fetid detritus is discharged; then a radical removal of the disease is impossible, and any operative procedure must be limited to an essay to remove the diseased structure, and thus diminish the foul discharge. This work is best done by the use of the curette, care being taken to avoid the blood-vessels. And for dressing a disinfectant may be applied; for example, a chlorinated solution, or one prepared from the permanganate of potash, may be used. Such a one is Condy's solution containing two drachms of the permanganate of potassium to two ounces of water, which may be used in this strength, or diluted with an equal quantity of water.

In the advanced stage of the disease in which the use of the knife would be a fruitless adventure, the writer has endeavored to retard the progress of the disease by the parenchymatous use of remedies; and agents, which his experience sanctions the employment of, are Fowler's solution of arsenic, the tincture of iodine, the fluid extract of ergot, and the solution of the muriate of lime. Of the agents here enumerated, the arsenical solution seems to have acted the best. Should further opportunity offer for this work, he would try the spirit of turpentine, which is one

of the most efficient germicides known. These remedies are introduced by means of the common hypodermic syringe. To do this work begin with the tincture of iodine, of which two or three drops may be injected at six or eight points; some of these points may be in the diseased structure, while others may be in the parts which bound the growth. The amount injected should not be enough to cause death and sloughing of tissue. In this procedure the tissues acquire tolerance to the agent injected, so that after a day or two, the injection may be done at a greater number of points. After the iodine has been used for a week, the solution of muriated lime may be used similarly, and in the same amount as the tincture of iodine was used. In the third week, the arsenal solution may be similarly injected; and in the fourth week the spirit of turpentine may be employed. And should a fifth agent be tried, the writer would advise the trial of stramonium, which as a topical application has retarded the progress of malignant growths. For interstitial injection the tincture of stramonium may be used. As here delineated, five agents are to be injected successively, each one week, and then the cycle to be resumed and repeated in the same order.

The writer anticipates more than mere retardation of the epithelioma by this plan; it is very probable that the trial of a large number of medicinal agents would end in the discovery of one which would act curatively. And the writer is pleased to note that essays in this work are just now being made with agents very remote from those hitherto known to the pharmacist, viz., with antitoxin lymphs; and among those the germ of erysipelas, as if to atone for the many lives it has destroyed, is now lending its virus for the cure of the malignant neoplasm. Such experimental work carried out in the cautious manner here indicated, has a promising and inviting future. As Kepler charted out the heavens with tentative diagrams with untiring patience before he hit on those which proved his three immortal laws, so the physician must patiently work who would find the agent to vanquish and eliminate malignant disease; but once discovered, the blessing will be as enduring as the laws of Kepler.

CHAPTER XVIII.

TONGUE.

Surgical Anatomy.—The tongue completely fills the buccal cavity when the lower jaw is fully uplifted, and the mouth is closed; this assertion made by a noted anatomist is not verified by the inspection of the buccal cavity of one whose absent teeth permit of its exploration; and this extensive occupation of the cavity when the mouth is shut, contrasts with the open space which is present when the mouth is widely opened.

The striking characteristic of the tongue is its great mobility; even the hyoid bone and the portion of the floor of the mouth to which the tongue is fastened, are mobile and permit the tongue in its movements to shift its points of attachment; this occurs when the tongue is well protruded, or drawn forwards. This lack of fixation permits the tongue to recede backwards, and so occupy and occlude the pharynx as to obstruct the entrance of air into the larynx. Beneath the anterior portion of the tongue is a fold of mucous membrane named the frænum linguæ, which, rising from the floor of the mouth, is attached to the free portion of the tongue in the median line. This bridle-like fold limits the forward movement of the tongue.

The marvelous mobility of the tongue arises from the disposition of the muscles; these are disposed in vertical, longitudinal and transverse direction; the genio-hyo-glossi and the hyoglossi act in a vertical plane; the linguales act in the antero-posterior direction, and the transversus linguæ muscle acts transversely.

The lingual structure similar to that of the heart, contains but little fibrous tissue; such tissue is found principally in a central septum which, placed antero-posteriorly, vertically separates the muscularity of the tongue into two lateral portions; and from this fibrous portion arises the transverse lingual muscle. This septum becomes much thinner as it proceeds forwards, and finally vanishes in the anterior part of the tongue. There exists

a small amount of interstitial adipose tissue in the posterior half of the tongue.

The tongue is the special organ of the gustatory sense; and this is seated in the superior surface, in papillæ of conical, filiform, fungiform and calyciform or circumvallated form. The filiform and conical papillæ are most numerous on the middle portion of the dorsum; the fungiform are most numerous at the point and on the dorsum.

The most important to the surgeon of the lingual papillæ are the circumvallated species, which lie on the base of the tongue in two lines, which converging, meet behind, and form an angle which opens forwards. The papilla at the point of this angle lies in a depression which is named the foramen cœcum. The circumvallated papillæ are hidden from view so that their possessor rarely sees them, unless he makes some exploratory search into his throat; and on seeing them he is frequently alarmed, and, thinking that he has some growth appearing, he presents his throat and fears to his physician; and from the latter he should learn that these eminences are the most important instruments of taste, and are potent factors in the pleasures of the table.

The non-papillary portion is the site of numerous small glands which empty their excretion into small follicle-like depressions. Glandules, deemed cognate to the sublingual gland, lie along the border of the tongue. On each side, within the structure of the stylo-glossi muscles, lie glandular masses, discovered by E. H. Weber; and on the inferior surface near the point, lie two glands, described by Blandin, and of which the excretory ducts open on the frænum. The posterior fourth of the tongue, which lies between the calyciform papillæ and the epiglottis, has been found by Billroth and Kölliker to be the site of a lymphoid tissue. In this tissue glands and follicles are found.

The lingual arteries anastomose in the anterior portion of the tongue; hence the oozing of blood, which occurs in section or removal of one side of the tongue, though the corresponding artery has been ligated. Besides the lingual, the sublingual, a derivative of the facial artery, furnishes blood to the tongue; thence some bleeding arises in removal of the tongue, though both linguals have been previously tied. This bleeding, as the writer has witnessed, is slight, and is readily controlled.

The lymph-vessels have been studied by Teichmann, who finds them numerous and disposed in close net-form, in front of the circumvallated glands, and these lymphatics are more super-

ficial than the veins. As one passes backwards, the meshes become wider, and the vessels of greater size. The lymphatics situated in the posterior portion of the tongue and on its sides converge to glands which lie in front of the internal jugular vein; those from the dorsal face of the tongue pass to glands near the submaxillary gland. And, thirdly, the lymphatics from the anterior part of the tongue pass to glands lying on the thyroid gland. Cancer seated in the posterior part, the dorsal or superior face, or in the anterior part of the tongue, will reappear in one of the corresponding glandular sites here mentioned.

According to Cruveilheir, the tongue of the embryo begins to appear in the median line of the floor of the mouth, in the seventh week, as a minute bud or tubercle.

Deformities.—The tongue is the subject of numerous deviations from normal form, which may be congenital or acquired; they are commonly congenital, in which, from some error in development, the part wanders from its typical conformation; for example, in the new-born, the tongue may be wanting; it may be bifid or it may be too large; and when too large it may be so voluminous as to be protruded from the mouth. The mobility of the tongue may be hampered by adhesions which may be above, below or lateral.

Complete absence of the tongue has not been seen; such absence has been merely partial, that is, there existed a stump adherent to the floor of the mouth, and this may consist of two or more parts. Loss of the greater part of the tongue has arisen from accident; also, from the surgeon's knife. Such rudimentary tongue, contrary to rational supposition, serves fairly well as the instrument of speech; this ceases to be surprising when an analysis is made of the mechanism of articulate speech: since such examination discovers that, of the elementary sounds which are formed by the vocal organs, there are but four which demand the action of the front portion of the tongue for their formation, and these are *d, t, th,* and *l;* it has been found that after the removal of the tongue, all the other primary sounds may be formed. In absence of the tongue, attempts have been made to replace the organ; such an essay was made by Ambrose Paré, though in a ruder way than has been done by the subsequent instrument maker. Such artificial tongue has proved a failure.

The bifid tongue, which is a normal conformation in the reptile, dromedary and certain birds, has occurred as a congenital phenomenon in the human subject; the tongue is sometimes given a bifid form in the removal of growths from the part. The

treatment of congenital bifid tongue consists in paring the median edges and uniting by suture; inasmuch as many of the cases of bifid tongue are in the infant in which many other deformities coëxist, the gravity of the latter is often such that the lingual imperfections may be neglected: for the prudent surgeon should decline to become an ally of fatal teratology.

Lingual Prolapsus with Hypertrophy.—The tongue may be enlarged beyond its typical proportions, and this may be coincident with birth, or appear subsequently. The abnormal development concerns particularly the anterior free portion of the tongue, and along with excessive volume, there is the disagreeable accompaniment that the tongue is protruded from the mouth, and in this position, besides the repulsive appearance which it gives to the infant, the tongue usually becomes painful through ulceration.

Prolapsus of the tongue was mentioned by Galen, and occasional mention of it occurs among modern surgical writers; Delpech, Maisonneuve, Clarke, Syme and Beauregard have described it; nevertheless, the affection is a rare one; the writer has seen but one case of it. It is seldom that it has been seen at birth; still, the conditions are believed to exist then, which afterwards lead to its development. As predisposing and causal conditions are too great elevation of the larynx, abnormal length of the tongue, pertussis, sucking the tongue, catching and compressing it between the gums, and exaggerated suction of the nipple. Symptoms which denote the development of lingual prolapsus are, that the infant has its mouth constantly open, the saliva is continually escaping, and the tongue is usually thick.

The writer had under observation, for a year, an infant which was the subject of lingual prolapsus. At an early age, this infant was in the habit of thrusting out its tongue and catching and compressing it, at its middle portion, between the alveolar arches. The result of such compression was gradual enlargement of the tongue, and it was manifest that this development was promoted by the turgid condition in which the tongue was maintained. The child seemed to have pleasure in the act of thrusting out and compressing the tongue. The escape of saliva, which was continual, occurred because of the open mouth and the chewing movements of the lower jaw. The author was convinced from what he saw in this case, that the affection was the result of the habit mentioned, into which the infant fell when a few weeks old; since at that early age, the infant's tongue was of normal volume and was retained in its mouth.

The lingual prolapsus, commencing in the manner above mentioned, advances until the enlarged part remains protruded and the jaws cannot be closed. The exposed part of the tongue has a violet color, and it is sometimes soft in consistence; at others, it is indurated. The secretions of the mouth desiccate and form crusts on the surface of the tongue. The deformed lingual mass projecting from the mouth gives the subject's face a most repulsive aspect.

The continual gaping of the mouth, and the dental alveoli wanting the support of the labial structures, the teeth gradually lose their position and incline towards a horizontal position. The projected tongue also pulls on the pharyngeal arches and displaces them, as well as the tonsils, forwards. The non-protruded portion of the tongue remains nearly normal in volume.

The affection interferes with breathing, the taking of food, and the cleansing of the mouth; hence emaciation and fetid breath.

As may be inferred from what has preceded, the primary stage of prolapsus is soon followed by macroglossa or hypertrophy of the tongue. The enlargement of the tongue is analogous to elephantiasis; there is found a cavernous network of connective tissue filled with lymphoid fluid, and in this structure the normal muscular fibres may be atrophied, normal or magnified in form. And the subjacent lymphatic glands may be enlarged. In 1853 reports appeared upon the pathology of hypertrophied tongue; the opinion, hitherto held, that the enlargement depends on enlargement of the muscular fibres was rejected by Virchow and others, who found only an augmented vascular development; the arteries are much dilated, and the fibrous or connective tissue is hypertrophied. Cystoid spaces are found, thought to be connected with the lymph-vessels.

Treatment.—The course to be pursued will depend on the stage of the disease when the case first comes under observation. If seen early, when the first signs of the affection are appearing in the infant, then it is proper to make trial of means which may prevent growth, and reduce that which has already occurred.

In the infant mentioned seen by the writer, the treatment consisted in strewing the surface of the tongue with tannin, and having forced the part into the mouth, it was retained so by means of a properly applied bandage, and this was occasionally aided by the nurse's hand. This child, which was a foundling, finally passed out of sight. The observation made of this case

was especially instructive, since it was evident that the prolapsus and growth had origin in habit; for when the child was not guarded, it thrust out its tongue and compressed it between the jaws, and in the act it seemed to have extreme delight; such satisfaction as accompanies every act which in the child has grown into a habit, especially a forbidden habit. The treatment pursued in this child produced but little effect.

Galen recommended the local use of the juice of lettuce, and Louis claims to have cured a girl by this means.

Treatment by compression was employed by Le Blanc and Van der Haar by means of a small linen sack or pocket into which the tongue was thrust; eight cases were said thus to have been cured. Fairlie Clarke, who has collected a series of cases of this affection, reports cures by compression. Syme, in 1857, is more favorable to compression than to operative means, and only after the failure of compression would he operate.

Lingual prolapsus with hypertrophy has been treated operatively in several ways, viz., by ligature, galvano-cautery and excision.

The ligature is advised by Maisonneuve, and others; it is, however, extremely objectionable, since the ichor escaping from the gangrenous portion may pass to the lungs, and cause gangrenous pneumonia. Besides, the removal by strangulation leaves an irregular surface, and has sometimes been followed by recurrence of the hypertrophy.

The method by thermal cautery is preferable to that by ligature, since the remaining surface will be more regular in outline; yet the cicatricial surface which will remain is not as good as that which can be gotten by excision.

Excision has been practiced in three ways: in one the tongue has been cut off transversely; in a second method, a single cuneiform exsection has been done; and in a third, a horizontal as well as vertical wedge-form excision has been done.

The method of simply excising the prolapsing tongue by a transverse cut is defective, since it leaves a broad, misshapen surface of scar tissue uncovered by normal mucous membrane.

The plan by a single cuneiform excision is preferable to that just mentioned, yet is not equal to the third method, in which a vertical and horizontal wedge-shaped section is removed: a plan of operating introduced by Boyer. The result of Boyer's operation is to restore the tongue to normal volume, and to leave the part which remains invested with its normal epithelial coating.

To render the tongue accessible to the surgeon's knife in this double excision, a strong thread should be passed through the base of the tongue, posterior to the line of exsection, and tied so as to form a loop, which an aid holding and making traction on, the tongue can be drawn well out of the mouth. While the tongue is thus held, the knife, with length sufficient to more than traverse the breadth of the tongue, is inserted as far back as possible, and by two incisions a wedge-shaped portion is horizontally excised; then a vertical portion of like form is to be excised. In this work enough must be removed to so reduce the tongue in volume that it can be returned and retained in the mouth; and to do this, it may be necessary to remove a large mass of structure. In such an operation reported by Wutzer, he excised a mass of structure which weighed over eight ounces. The hæmorrhage which follows the excision has been reported as very considerable in some cases, and was with difficulty controlled; to do so, Wutzer was compelled to resort to circular circumscription, by which a portion of lingual structure was also included with the vessel.

This double cuneiform excision has resulted well in nearly all cases; Syme, however, lost a case, in which so much swelling followed it that the patient died from asphyxia; against this death, there are twenty-two recoveries reported. In some cases the operation was not permanently successful; the hypertrophy reappeared, and another operation became necessary. After such recurrence, Humphry cured the patient by compression.

In 1853, Humphry wrote elaborately on macroglossa; he collected twenty-seven cases in literature, of which seven were cured by compression, seven by ligature and thirteen by excision. In the early stages, Humphry recommends a trial of compression.

Ankyloglossa, or Tongue-tie.—The orator Cicero, in his work on Divination, refers to tongue-tie when he asks: "Where tongues are so adherent that they cannot talk, may they not be liberated by being cut with a scalpel?"

The tongue may be fastened to an adjacent wall on any of its sides: thus it may be bound below, at its sides, or above. Lateral and superior tongue-tie are phenomenally rare affections; sublingual adhesion is a common occurrence, and often requires surgical aid. This subjacent fixation of the tongue is commonly due to anterior extension of the normally present frænum. Ordinarily the frænum is only about a line in its attachment; but if it be much more than this, and especially if this band be short in its vertical length, then the tongue will be hampered in its move-

ments. There is a popular notion that this restriction of the tongue's movements will interfere with the child learning to talk; such interference, however, is very slight. To discover the amount of the sublingual attachment, let the child's mouth be well opened, when the end of the tongue can be uplifted with the finger, or the handle of a spoon; commonly, the unusual manipulation frightens the infant so that it screams, and, doing this, it fully exposes the condition of the tongue. A little experience, however, will enable the physician to determine the state of the tongue by merely inserting two fingers under the tongue so as to include between them the frænum. The treatment consists in dividing the extended frænum with a pair of blunt scissors; and this is most readily done by watching an opportunity when the part is well displayed during the infant's crying; thus the author has frequently divided the frænum. The division is sometimes done by means of a spatula with a fissure at one side, or a grooved dissector, which has a furcated end. If such instrument be used, let the frænum be caught between its branches, and divided between the floor of the mouth and the instrument. Instead of this plan, two fingers may be used for uplifting and fixing the tongue. The bleeding is slight, unless by careless work the floor of the mouth or the lower surface of the tongue is wounded; and through such wounding, hæmorrhage can occur, which may demand control by compression, or applications of a styptic.

The child affected with congenital syphilis, and being also the subject of tongue-tie, should not be operated on. From unfortunate experience in such a case, the writer desires to emphasize this advice. In an infant several weeks old, in which there were secondary lesions in the anal and genital region, the frænum was divided to liberate the tongue, which was bound down on the floor of the mouth. A chancroid phagedenic ulceration was developed, which extended to the adjacent mucous membrane of the tongue and mouth, and this ulceration was only controlled after months of anti-syphilitic treatment.

Instead of a thin fold of mucous membrane, the frænum may be a thickened mass, in fact, a species of ranula, of solid instead of cystic structure. Such a development seriously interferes with the function of the tongue. The treatment practiced in such cases has been to scarify or incise the enlarged structure.

The tongue may be adherent to the floor of the mouth by its entire inferior surface; a condition which renders the organ unable to accomplish any of its functions; and in the new-born,

if unrelieved, it would cause death by starvation, since swallowing of food would be nearly impossible; lastly, in the act of deglutition the tongue could not recede and prevent the entrance of food into the air passages. Such adherent tongue must be detached from the floor of the mouth and reunion prevented by frequent separation of the parts.

Lateral or gingival adherence of the tongue, in which the part is attached to the surrounding maxillary wall, may arise from noma, mercurial sloughing, or from destruction of the mucous surface from any cause. It has been seen, though rarely, in the new born. The treatment in such case would be to divide the adherent parts, and maintain the liberation by sundering the adhesions as often as they reformed, a task more easily advised than accomplished in a case of extensive adhesion.

Lapie describes the rare condition of adherence of the tongue to the palatal vault, in which the child was unable to nurse. The treatment in such condition would be to separate the tongue from the palatal roof by means of a spatula or blunt dissector, and separation afterwards maintained by detaching points of re-adherence.

Glossitis, or Inflammation of the Tongue.—The tongue may be inflamed merely superficially, or the entire structure of the organ may be affected.

Demme, who has made special study of the inflamed tongue, gives the following classification of the superficial form: (1) Catarrhal, which may be caused by a local irritation, or by some catarrhal affection of the alimentary canal; it is indicated by hyperæmia, thickening of the mucous membrane, and cell-proliferation. (2) Exanthematous, an accompaniment of an exanthema, and is papular or vesicular in nature. (3) Toxæmic glossitis, which attends typhoid fever and pyæmia. (4) Croupal, which is seen in croupous disease of the throat and air-passages. (5) Dissecting glossitis, in which irregular ulcers appear on the surface of the tongue.

Deep or profound glossitis is rarer than the forms just enumerated; there are two varieties of it, the phlegmonous and the muscular; the phlegmonous commences in the sub-mucous and inter-muscular tissue; but in the other variety, the muscular fibres are the site of the disease. The deep form may end in suppuration and death of tissue, or the event may be cell-growth and the development of fibrous tissue.

Glossitis may be unilateral, or both sides may be affected; it

may also be diffused or circumscribed. It appears in acute or chronic form. The epithelium may remain adherent, or it may be detached, and in the latter case there is usually much pain.

If glossitis be studied in reference to its incipient symptoms, four types of it may be distinguished: (1) It begins without any general symptoms; (2) it may be preceded and accompanied by rigor and fever; (3) it may be accompanied by affection of the mucous coat of the stomach and bowels; (4) it may be attended by concurrent pain in the jaws, teeth and throat.

In all cases of deep inflammation of the tongue, there are pain and swelling, the swelling soon reaching a large volume; the inflamed structure is red, tense and increased in heat, yet if the tongue remains protruded, it becomes cool. If the tongue is compressed within the mouth, its sensibility is lessened. In exceptional cases the tongue has been seen unusually white.

When pus forms, the tongue is altered in its form; it becomes rounder, unless the pus is deep seated. Sometimes the pus travels from the upper anterior part to the lower posterior part of the tongue. The function of the tongue is impaired in its office; the acts of chewing, talking and swallowing are trammeled. There is a feeling of tension and discomfort in the masseter and temporal muscles, and in the joint of the lower jaw, especially if one forcibly open the mouth.

From swelling, especially if this be in the back part of the tongue, respiration may be so impeded that cyanosis results from defective admission of air to the lungs.

From obstructed circulation, there may occur œdema in the floor of the mouth, in the upper part of the neck, and in the palate, throat and epiglottis. From the œdema and swelling cerebral congestion and apoplexy may result.

In the acute form there is high temperature, yet this is nearly absent in the chronic form.

To epitomize the phenomena, then, of a case of glossitis of the acute form which is fully developed, the face is congested, with œdema of the floor of the mouth, palate and throat; the skin is cyanosed the expression of the face is that of extreme anxiety; the tongue, as a swollen mass of violet hue, is protruded from the mouth, and is dry; there is cerebral congestion and mental stupor; the temperature is 104° or 105°; the pulse is strong and rapid, the breathing difficult and anxious, and the skin is hot and dry; speaking is trammeled, and there is little saliva in the mouth; and signs of suppuration soon appear,

unless a proper treatment early intervenes. The predominance of the muscular structure in the tongue, almost to the exclusion of other tissues, which elsewhere are so intimately associated with the suppurative process, renders suppuration a rare event in glossitis.

In 1856, Arnold saw a number of cases of glossitis in Wurtemberg, which seemed to arise from some epidemic influence, and, in other districts, a similar epidemic influence prevailed. In those cases the disease appeared to commence with a swollen point, whence it extended and involved the entire tongue. The submaxillary gland was involved in some of the patients, and suppuration occurred in the floor of the mouth.

The writer has observed two cases of glossitis of an extremely malignant type. In one, the disease was preceded by erysipelas, which traveled into the mouth, and attacked the tongue, which became so swollen that breathing was interfered with; and the laryngeal and tracheal regions were so involved or swollen that the patient perished through asphyxia. In a second case, the inflammation involved the tongue, the floor of the mouth and the upper anterior cervical region, and pus formed in these parts; though tracheotomy was done, death soon occurred from gangrenous pneumonia.

Treatment.—From the observation of nineteen cases, Demme claims that, nearly always, glossitis can be brought to a termination by resolution, that is, dispersion of the neoplastic elements; and even where pus has formed, he claims that its absorption can often be effected.

In the early stage of the disease, the alimentary canal should be emptied of its contents by saline cathartics, and astringent washes should be used in the mouth; for this purpose a solution of tannin, decoction of oak bark, or a solution of alum may be used. Ice should be allowed to dissolve in the mouth, and thus the oral cavity be maintained at a low temperature. Ice may be applied around the neck and throat. Should the disease still persist, local bleeding should be resorted to; for this, leeches have been used, yet a better plan is to scarify the surface of the tongue. These incisions should be antero-posterior in direction, and should penetrate so deeply as to cause free bleeding. As such incisions quickly contract through lessening of the volume of the tongue, it will be necessary to again repeat the incisions after a few hours. A third remedy, of which the efficacy has been lauded by Demme, is the local use of the tincture of iodine. This becomes more efficacious in the following combination :—

℞. Tr. Iodinii Compos..... .....ʒi
Tr. Gallæ. ....ʒi
Misce.

Let the tongue be painted with this every four hours.

In a case of glossitis which is developing rapidly, the disease may be attacked simultaneously from several sides by the means here detailed, viz.: by purging, cold, astringent gargles, scarification, and tincture of galls and iodine; and by such vigorous management, the writer has seen the disease promptly controlled, and within a short time the tongue was reduced to its normal volume. The incisions made soon heal and scarcely leave a scar.

Abscess of the Tongue.—A few cases of abscess within the body of the tongue have been seen by the writer; and the pain which had preceded the suppuration was so slight that it scarcely attracted the patient's attention. In the cases seen, there had slowly appeard a swelling of the tongue, principally in the central part of the organ, rendering this portion elevated and rotund in form. The treatment, in such case, is to open the abscess by a longitudinal incision, made as nearly as possible in the median line of the tongue; such an incision will shun the blood-vessels, or those which might be opened would not bleed much; for each side of the tongue has its own system of circulation, and the intercommunication between the two is only of a capillary character, except near the apex of the tongue. Through the opening made, the purulent content can be forced out by digital compression made at the sides and beneath the tongue; and since, in the cases seen by the writer, the site of the pus was unilocular, such compression, after reopening the cavity once or twice, sufficed to cure the patients.

Ulceration of the Tongue.—The tongue may be the site of ulceration; and viewed in reference to causation, the following forms present themselves: mercurial, syphilitic, lupoid, scrofulous or tubercular, aphthous and traumatic.

Since the era began of the more judicious administration of mercury, dating from about the middle of the nineteenth century, mercurial ulceration of the tongue is a rare event; the aquila alba (calomel) of the old alchemists has been so domesticated that its talons make fewer ravages in the oral cavity, than was its wont in olden time; still, such cases are sometimes met with, especially in the mercurial treatment of syphilis. This condition is announced by a swollen, inflamed state of the alveolar tissue, and redness of the borders of the tongue; soon the

mucous membrane of these parts breaks down, and a raw surface is left. Meantime, a peculiar fetor, termed mercurial or metallic, proceeds from the affected parts; and there is a profuse flow of a fluid consisting of saliva mingled with albuminous and epithelial excreta. These phenomena, in a subject who is using mercury in some form, are proofs that the remedy has exceeded its intended action; in brief, that the patient is *salivated*. The experienced eye will usually descry the coming ptyalism at a period so early that it may be arrested before the affected structures have suffered much injury: viz., the mercury must be discontinued, the patient purged, a solution of borax be used for cleansing and disinfecting the mouth, and a solution of alum, viz., ten grains to the ounce, be applied to the gums, borders of the tongue and the ulcerated portions of the cheeks. An excellent gargle for the mouth is one composed of nine parts of water to one of alcohol, or spirit of camphor. These detersive gargles have done better service for the writer than the chlorinated solutions which are often used; for it has seemed probable that the chlorine element in these compounds has increased the activity of the causal factor, mercury. In case the borders of the tongue and other affected surfaces are the site of ulceration which is tardy in healing, then these parts should be lightly touched with a finely pointed pencil of nitrate of silver; or a crystal of alum may be used in the same manner.

Among the many secondary manifestations of syphilis, lingual ulceration is of frequent occurrence; in its wandering vagaries this destroyer does not omit the mucous membrane of the tongue; the mucous patch, the characteristic ulcer, and the gummy growth reveal a history which the tongue itself would fain deny. The ulcer, here referred to, occurs on the margins of the tongue, and most commonly on the middle portion of the sides. This ulcer is superficial in its character; and as proof of its true nature, there will coëxist ulceration of a similar character in other parts of the buccal cavity; also, an examination will reveal the existence of cutaneous syphilitic rashes. And this ubiquitous manifestation of mucous and dermal eruptions distinguishes clearly this form of lingual ulcer from those of a different nature. According to Paget's publication of 1858, the syphilitic ulcer is more clearly bounded than the scrofulous, and is not preceded by suppuration; it appears on the end or sides of the tongue; and is in the form of oblique or star-like fissures; or it has the appearance of an erosion, of which the central part is the deepest.

Further proof of its syphilitic nature is that it rapidly heals under the use of iodide of potassium.

Treatment.—The lingual syphilitic ulcer can only be cured by prolonged constitutional treatment: mercury and iodine, singly or combined; and, cotemporaneously with this, some mild astringent, as a decoction of oak bark, may be applied, and this may be alternated with a mineral astringent. During this course, the patient, if he uses tobacco, must wholly drop its use: if he does not do so, the tobacco will greatly retard the cure of the syphilitic eruptions in the oral cavity, of whatever form these may be.

Ulcer of the tongue of a lupoid nature is sometimes seen; it occurs oftenest on the edges of the tongue near the epiglottis Lupus never appears on the tongue without already existing or having previously existed on the face. It commences on the tongue as small tubercles which soon break down and present a soft granulating base, which, healing, leaves star-like scars. The proper treatment is energetic cauterization, which is best done by means of the ferrum candens, or the thermal cautery. Along with this topical treatment, the patient should be given cod liver oil and Fowler's solution.

The tongue is not unfrequently the site of tubercular disease. Weber, who saw and studied the tubercular ulcer of the tongue, found that it occurs on the border of the latter, and is bounded by irritable, irregular edges; and from the bottom of the ulcer, granular, caseous, tubercle-like matter can be expressed. Cotemporaneous with the lingual trouble, tubercular affection of the lymphatic glands, apices of the lungs, epididymis or rectum may exist. In cases of tubercular lingual ulceration, the writer has seen similar affection in the anal and rectal region. In one patient, besides the anal ulcers, the peri-rectal structures were cribriform with fistulæ.

The tubercular ulceration of the tongue has sometimes been mistaken for cancer; and to avoid such error, experience and discriminating judgment are requisite. The antecedent or cotemporaneous existence of tubercular disease elsewhere, will give proof of the true nature of the disease.

Trélat, in 1870, described what he named phthisical ulcer of the tongue as a forerunner of pulmonary tuberculosis. He finds this disease of the tongue to begin from tubercle-like bodies in the surface of the organ; from these develop ulcers with red surface and ragged edges; before opening, however, these tubercular eminences have a whitish aspect. Such eminences may be

agminated or isolated. In the subject of such tubercular eminences or ulcers, other manifestations of tuberculosis may often be found.

Treatment.—Such ulcer will heal under the mildest treatment, provided the nutrition of the patient be uplifted; along with a rich, generous diet, the only local treatment needed is to maintain cleanliness of the mouth by frequent abstersion with an aromatic water, as mint, or cinnamon water, or chamomile tea; and if a local remedy be used, let this be a weak solution of the sulphate or chloride of zinc. As a gargle which will disinfect and facilitate healing, one composed of five grains of borax to an ounce of water, may be used. By such management, tongues have been saved to their owners which had been condemned to excision.

An aphthous ulceration of the tongue is not unfrequently seen; this consists of a slightly hollow breach of surface, which is coated with a thin layer of whitish gelatinous material, which is closely adherent to the subjacent surface. This diphtheroid structure requires a raw or wounded surface as a ground on which it takes root; and it is doubtless associated with some microphyte as cause or ally.

The treatment of this form of lingual ulcer consists in frequent washing of the mouth with some antiseptic fluid; for this purpose one may use aqua picis liquidæ, a decoction of the leaves of Eucalyptus globulus, or the bark of the white oak. And should there be seen collateral gastric or intestinal derangement, this also must have appropriate attention.

Traumatic ulcer may arise from any agency which causes a breach of surface; though there are many causes which fall under this head, the one of most usual occurrence is an irregular face or edge of a sound or decayed tooth. Such cause, though unsuspected by the patient, is often revealed by a careful exploration of the posterior teeth of the lower jaw. Such ulcer has irregular outline, uneven surface, is often coated with an aphthous formation, is extremely painful; and this pain is maintained by the frequent movements of the tongue. As treatment for this, the buccal cavity should be frequently cleansed by an antiseptic solution selected from the list above given. And to the ulcer itself let nitrate of silver be applied, sparingly, by a rapid touch.

The various forms of lingual ulcer enumerated are accompanied by pain, which is continually awakened and intensified by the movements of the tongue; and the normal action of the

tongue in taking food is so painful that the patient abstains from food. To lessen this difficulty, the food used should be fluid, or so liquified that it can be swallowed without any preliminary preparation in the mouth. An excellent diet for such patients may consist of rice, milk, eggs and broth; and with this some wine may be taken; and after using food, the buccal cavity, and teeth should be carefully cleansed; an act, indeed, which should be done in every healthy mouth after the reception of food; for thus doing the mouth would be purified, breath deodorized, teeth preserved, and life probably prolonged.

The several forms of ulcers which have been treated of, though they occur oftener in the tongue, yet they frequently are seen in other parts of the wall of the buccal cavity; and, in these different sites, such ulceration demands the same treatment as that before explained for similar ulcer on the tongue.

Growths of the Tongue.—Besides the aberration from normal form and disease of the parenchyma of the tongue already described, the organ is the occasional site of neoplastic growths, both benign and malignant. The benign class contains the following species: vascular, cystic, lipomatous, fibromatous and papillomatous.

The vascular species consist of two varieties, similar to those found elsewhere: the superficial form, or telangiectasis, and that which involves the deeper structure, or the entire thickness of the tongue.

Telangiectasis of the tongue is usually congenital and is often so slight that it may remain unseen. It may be associated with the deeper species, and then the whole thickness of the tongue can be implicated. Pure telangiectasis tends to lateral rather than to deeper growth. Expiratory efforts tend to swell it and increase its red color; compression or cold renders the surface pale, and if it be pricked, it bleeds easily, and perhaps profusely. It may remain stationary for a long time and then suddenly grow to much larger dimensions. Maisonneuve, who names this form of vascular growth erectile arterial tumor, has observed that it tends to cancerous degeneration.

The deeper form of vascular tumor, named by Maisonneuve the erectile venous tumor, is sometimes congenital. In structure it resembles the cavernous body of the penis. Compression easily effaces it temporarily, and the blood returns more tardily than when the growth is arterial in structure. The writer has seen two examples; in one the growth was at the border of the tongue;

in the other it was situated in the median part of the dorsum of the tongue.

It is seldom that the vascular growth of the tongue, whether it be of the superficial or deep form, is a source of much inconvenience; in many cases it has existed without the subject of it suspecting its existence; and where it is thus free from trouble, the guiding rule must be abstention from surgical interference, especially since the growth may spontaneously disappear, as was observed by the accoucheur Dubois; and only in cases in which it is annoying through its large size, or where from exposure of the tongue to lesion, the subject is in danger of hæmorrhage, should relief be sought by some operative procedure.

Treatment.—As modes of treatment which have been employed are cauterization, ligation, écrasement and excision. Cauterization may be done with the hot iron or heated portion of the thermal cautery; the latter is the more convenient, since its action can be more exactly gauged. Since extensive cauterization may produce sloughs which might be followed by bleeding when they are detached, hence the safer plan is to burn superficially and to repeat the work as soon as the burnt surface has fallen off.

If the growth be of the erectile or cavernous type, cauterization may be done interstitially, as Lallemand did in a case with successful result; this is done by needles, which, being heated to red heat, are thrust into the tumor at different points.

The tumor may be circumscribed by constricting ligature, which introduced by means of a transfixing needle, is tightly tied. This plan, though effectual in result, has the inconvenience that from the gangrenous tissue, ichorous material continually escapes and is swallowed, to the detriment of general nutrition. Frequent ablution of the buccal cavity will, however, partially counteract the ill results from such sloughing.

If the vascular structure is so situated that it can be isolated by circumscriptive constriction, the linear écraseur may be passed around it and the removal be effected without peril of bleeding.

And a fourth method is excision of the affected part by means of the thermal cautery, knife or scissors; the method by scissors the writer has employed in a case in which a venous vascular growth was situated on the border of the tongue; after excising a cuneiform section the breach was closed by a deep suture, which remained in place for a number of days.

Should the vascular growth occupy one-half of the tongue, the proper procedure would be ligation of the corresponding

lingual artery; and if the vascular development occupy, on a large scale, both sides of the tongue, then the only procedure promising a successful result would be to tie both lingual arteries.

The tongue may be the site of aneurism, of the circumscribed or diffused form. The strong pulsation perceptible in such tumor, its compressibility and partial effacement by pressure, and rebound when committed to itself; especially, if there be a history of some injury of the tongue, would clearly indicate the true nature of the affection. The pliant and yielding character of the lingual tissues, conjoined to the mobility of the tongue, favors the continued enlargement of such aneurismal tumor; and hence the growth soon interferes with the function of the tongue. The treatment which has been proposed is direct compression; also, arterial ligation; compression of the tongue is, at best, an ill-manageable procedure, and hence the better treatment would be ligation of one or both of the lingual arteries.

Cystic Growths.—Four varieties of cysts have been observed on the tongue: the serous, mucous, hydatid, dermoid and atheromatous.

The serous cyst appears in all portions of the tongue; yet it occurs oftenest in the base and the inferior face of the organ. It would appear to commence from preëxisting follicles, which closing, their content continues to be formed. This fluid is clear and water-like. When the interior wall of such cyst is examined, it will be found to be invested with an epithelium, whence is excreted the serous content. This cyst appears as a prominence uplifting the mucous membrane; and it rarely becomes so large as to annoy the subject of it. When it occurs underneath the tongue of the infant, it may interfere with seizing the nurse's nipple.

The mucous cyst originates in the glands with which the tongue is provided; its walls are thicker than those of the serous species, and its content is also thicker; it may resemble liquified gelatine.

The serous and mucous cysts have a resemblance to the ranula; the former belong especially to the tongue, while the ranula has sublingual site in the floor of the mouth.

The tongue, as an exceptional event, has been the site of a hydatid cyst; the echinococcus has been seen here; such cyst is distinguishable from the serous species only through puncture and examination of the content, in which the hooklets of the parasite will be discovered.

The treatment of these several species of cystic tumor is much the same: the entire wall should be uplifted with a tenaculum, or toothed forceps, and excised so as to fully empty the contents; and then the remaining cavity should be cauterized with nitrate of silver; or what is yet more effective, the work may be done with the thermal cautery; thus the remainder of the wall will be destroyed, and any secreting property it may possess, can be destroyed.

The dermoid cyst, situated wholly within the structure of the tongue, has rarely been seen; but such cyst has been met with under the front of the tongue; thus Ozenne, in 1858, saw and operated on a dermoid cyst, situated here, and which contained hair and dermal cells. He collected twenty similar cases. The operation should consist in opening freely the containing wall, evacuating the dermoid content, and then, to hasten healing, the wall of the cyst should be carefully dissected out. The atheromatous cyst may have its site in the sublingual region, and in its development, encroach on, and become buried in, the structure of the tongue. The author has seen and successfully removed such a cyst, which was as large as a hen's egg, and forced the tongue upwards and backwards. After removal, drainage was made through the floor of the mouth.

Lipoma has been observed in the tongue. In 1863, Mason of London saw a case; also Maisonneuve saw and dissected such a tumor; he states that its most usual site is in the posterior and inferior part of the tongue; a situation that might be inferred from the presence of fatty matter in this portion of the tongue. This lipomatous growth may be pedunculated, sessile, or interstitial in site. Cauchois, who saw a case in 1883, finds that its site may be submucous, or inter-muscular. This fatty tumor is soft, and it may yield a fluctuation similar to that of a cyst of fluid content. It may attain considerable dimensions, and may ulcerate at points, so as to embarrass the diagnosis. It has no action on the lymphatic vessels which are contiguous.

The lingual lipoma will never disappear spontaneously; the proper treatment is extirpation; this is readily done where the growth is pedunculated; but if it be sessile, or inter-muscular, then an opening must be made to it from the side at which it is most accessible; and such incision should be longitudinal, and should be as near the median line as possible; thus vessels are less exposed to injury. If the incision be deep, then it is well to close with suture. Laugier in 1855 reported the removal of a

lipoma from the tongue, which was done by making an incision through the structures in which it was encapsulated, and then simply enucleating the growth. There was no bleeding demanding ligature. Laugier remarks that lipomatous growths are not unusual in submucous tissue; and he thinks they are similar to polypi in their origin.

Fibroma of the Tongue.—Growths consisting of connective or fibrous tissue have been seen in the tongue; and they occur there oftener than the lipoma. They seem to occur oftenest in the border of the tongue, though Erichsen saw one on the inferior face of the organ. As to relation with the tongue, they have been seen pedunculated, sessile, or situated within the lingual structure. Fairlie Clarke, of Charing Cross Hospital, mentions such fibroma as polypoid in character, and so situated as to embarrass or obstruct swallowing. It is oftener single than multiple in its appearance. The fibroma might be confounded with the lipoma; but since the treatment of the two is similar, such error in diagnosis would have no ill consequence; a more unfortunate mistake, however, would be to excise a gummatous product under the suspicion that it were a fibroma. Should there be a suspicion that the growth is syphilitic, the true nature might be determined by subjecting the patient to an iodo-mercurial treatment. As the fibroma continues to grow without limit, it finally reaches dimensions which disturb the patient, so that surgical relief is solicited; and for this, extirpation is the only satisfactory procedure. If pedicled, it may be removed after ligation of the footstalk; if sessile or interstitial, remove the growth by a circumscribing cut, and close the wound by suture.

Malignant Growths of the Tongue.—If the literature of the lingual neoplasm be studied, one finds that the chapter devoted to the malignant genus has been gradually undergoing change; formerly one found that writers recognized the existence here of four species, scirrhous, encephaloid, melanotic and cancroid or epitheliomatous; to-day the generic tree, by most writers, is stripped of three of its branches, and there remains but epithelioma as the only type of malignant growth appearing in the tongue. Though a few authorities contend that both epithelioma and carcinoma may appear in the tongue, yet Paget, Hutchinson, Thiersch, Billroth and Otto Weber find epithelioma to be the only form of malignant tumor which attacks the tongue. And these authorities claim that the only cases which they have met in which carcinoma was present there, were those in which the disease

had reached the tongue secondarily, after having commenced primarily in contiguous structures.

As is taught by pathologists, the constituent element of the epithelioma is the epithelial element, disposed in horizontal or concentric layers superposed on each other. And such cells, even in stratified arrangement, are sometimes found deep beneath the surface, so deep, indeed, that Weber claims that they have arisen from connective tissue elements; and the same is admitted, though unwillingly, by Thiersch, whose theory only allows of the origin of epitheliomatous cells from preëxistent epithelial cells.

Epithelial cancer, according to its site or its situation in respect to the surface of the tongue, may be grouped in two classes, viz., *excrescent* and *internal*, and each of these may arise from a papilla, wart, nævus or a limited abrasion, which may be a crack, fissure or a plain erosion. And these initial points of commencement, if examined early, have no characteristics of epithelioma.

If the unaffected lingual papilla be examined histologically, the cells, which invest it, have an arrangement similar to that possessed by all other normal papillæ of the tongue; but when the epitheliomatous change occurs, the papillæ become radically altered in their form; in fact, the papillæ become crowded out of existence by the invading strata or lines of multiplying epithelial cells.

In the excrescent papillary species the growth is outwards rather than inwards; tuberculated, crested or wart-like prominences, isolated or fused into an uplifted plateau, stand on a hardened base.

In the internal form, besides growth outwards, there is especially a development inwards of epithelioid cells, which penetrate inwards between the muscular fibers, and along the tissue which incloses the vessels and nerves. The invading new-formed elements crowd on and destroy the muscular tissue, and the walls of the lymphatics and of the blood-vessels. The cells in this deeper situation are more prominent than those which develop on the surface; the latter, from their remoteness from nutrient supply, and especially from their exposed situation, are being constantly detached, so that the uplifted structure presents a raw surface, and this eccentric or superficial growth, in sessile or in pedunculated site, rises often into crests resembling the cock's comb, and is usually situated on the dorsal or anterior face of the tongue, and less often near the epiglottis. It may also

have a mulberry shape, of red tint, and bleeding when touched. The lingual epithelioma of superficial site, occasionally attains immense proportions, too great to be retained in the buccal cavity.

The penetrating species commences, according to the author's observation, most usually on the side of the base of the tongue near one of the ends of the V which the calyciform glands form there; or, more definitely located, it begins in the sulcus between the base of the tongue and the palato-glossus muscle, and extends thence upwards on the base of the tongue, as well as laterally, on the wall of the pharynx. This small ulcer always rests on a hard base; it is bounded by irregularly notched or jagged edges, which from being undermined, sink and are infolded. If this ulcerated structure be compressed between the fingers, whitish or grayish vermiform bodies are forced out, which, examined microscopically, are seen to be a conglomerate of epithelial cells.

The ulcerating process is unilateral and rarely crosses the fibrous median septum of the tongue, and when situated posteriorly, in its lateral extension it finally attacks the alveolar process of the lower jaw. Instead of this posterior site, it may appear on the free border of the tongue anteriorly, and at or near the tip of the organ. In two cases, the writer saw the epithelioma on the free border, midway between the base and the tip of the tongue, and in a third, the disease occupied the anterior border of the tongue and extended backwards equally on each side, for the distance of a half inch from the median line.

In both the deep and excrescent forms, the ulcerative process finally reaches and opens blood-vessels, and thus hæmorrhage, slight or profuse, recurs and weakens the patient. The taking of food into the mouth and its mastication are the source of so much pain that the patient voluntarily abstains from food, and from this cause he emaciates and loses strength. The decaying, ichorous, fetid materials, which are generated and detached from the ulcerating surface, are partly swallowed, or they pass through the windpipe to the lungs; in the former case, the material being absorbed vitiates the blood; in the lungs such materials are both absorbed into the circulation, and act locally on the pulmonary structure, causing an adynamic pneumonia.

The morbid agencies just enumerated, after some months, are reënforced by the appearance of the disease in the lymphatic glands, and this metastatic development corresponds, as a rule, to the affected side of the tongue; only exceptionally does the

metastasis appear on the opposite side. The gland or glands which are infected, though swollen, are, for some time, very movable; later, they become adherent to the adjacent tissues and, finally, to the overlying skin, so that the whole is a conglomerated mass of heterogeneous structures, in which glands, muscles, vessels and nerves are almost indistinguishably fused together. The glands initially infected are those which lie internal to the angle of the lower jaw, and just behind or below the submaxillary salivary gland. This fused conglomerated structure later becomes very closely adherent to the skin, which is thickened and often presents one or more folds with depressions.

There is but little pain in this morbid mass of secondary infection. The swollen glands are painless, and this condition diverts both patient's and physician's attention from these glands until their presence is plainly declared by visible swelling. But as the treatment and prognosis of lingual epithelioma are intimately connected with the condition of these glands, the latter should be carefully examined: an examination which demands skilled tact and care in the early stage of the disease; the one finger on the outside and one on inside of the lower jaw, should include and explore the structures of the floor of the mouth, and especially, should the region around the submaxillary gland be examined; thus an indurated gland can be discovered if present; and should there be doubt, the normal condition of the opposite side will serve for corrective decision.

The mass of agglutinated tissues continuing to enlarge, finally the central portion commences to soften, and at length the skin is opened, and an ichorous fluid containing cheesy fragments is discharged. This opening is a small orifice at first, yet it continues to enlarge until it becomes a free crater-like outlet, which ever enlarges without any sign of healing. Should this mass be removed before it opens, there will be found in it a central cavity containing softened material; the outlines of the cavity are irregularly notched and jagged, and of dark, livid color. But when such cavity is allowed to open, though it discharges freely the breaking-down material, yet this has no limiting effect on the progress of the disease; the conglomerated mass continually incorporates into itself other tissues which are adjacent to it: from the original side invaded, it passes to the other, and the front upper portion of the neck is finally involved; and in this enlarged field other openings may form.

Another form of metastatic invasion of the structures of the

floor of the mouth and the upper part of the neck has been seen, in which there is little or no disposition to suppuration; there is swelling and rapid infiltration of the parts mentioned; the skin remains white, and the affection has no definite borders. It is accompanied by an œdema at the base of the tongue and entrance of the larynx; and the œdematous swelling may quickly cause death by occluding the glottis. The case here is allied to the purulent œdema described by Pirogoff, since, after death, if the affected tissues be opened with the knife, there escapes a sero-purulent fluid, with which the swollen structures are saturated.

The course and duration of lingual cancer, if the disease be allowed to run its natural course, will, according to Demarquay, be completed within fourteen months, and this brief period may yet be abbreviated, he says, if the disease be unwisely attacked; for nearly all authorities report recurrence after operation. One writer, however, Otto Just, presents figures much more favorable; he says that recurrence only takes place in twenty-five per cent of the cases. The author fully shares the opinion of Just, and further believes that even more than seventy-five per cent of patients could be saved if the disease were seen and treated in its primary stage by intelligent surgery.

Meddlesome ignorance too often monopolizes the precious weeks, when proper treatment might rescue the patient from death. Intelligent management can prolong life, though the disease is not cured; for after operation the average duration of life has been two years. The absence of glandular metastatic infection adds much to the prospect of non-recurrence; in fact, this may be regarded as almost a guaranty against return.

In case of relapse, the epithelioma commonly reappears at or near its primary site, or it may appear in the subjacent glands. It has been observed that when the disease recurs, it grows at a far more rapid rate than it did prior to the operation.

The causation of epithelial cancer of the tongue is unknown; it is evident, however, that certain agencies do promote its evolution; as such may be cited calcareous incrustations on the inner face of the teeth; sharp points or edges of the teeth, which may continually wound the border of the tongue; and the habit of thrusting the tongue into an interstice between teeth, or into the hollow of a decayed tooth. The use of tobacco probably is a causal agency, and this explains the far greater frequency of the disease in the male than in the female, who seldom uses tobacco. The fact that the man is less attentive to the cleanliness of his

mouth than woman predisposes the former to epitheliomatous affection, of not only the tongue, but of the entire walls of the buccal cavity.

Age has an important bearing in the development of epithelioma of the tongue; the disease seldom appears under forty years of age; it occurs oftenest between forty and seventy years of age, yet there may be exceptions to this, since Billroth saw the disease in a youth of eighteen years of age.

Diagnosis.—The diagnosis of lingual epithelioma is of the utmost importance, so that no error in treatment may be made; and one unfortunate error, which has sometimes been made, is that of confounding syphilitic affection with cancerous disease of the tongue. To avoid such misapprehension, the surgeon should have a definite picture in his mind of the manner in which syphilis affects the tongue.

Syphilis may appear as the primary chancre on the tongue, and then the appearances are similar to those of the disease when it is primarily seated on the mucous membrane of the lips; and to test the matter, if the chancrous lingual ulcer be cauterized and treated with a mild astringent, the ulcer will heal; but if it be cancerous, such mild local treatment will fail to heal the lesion. A primary syphilitic sore may heal spontaneously; the epithelial ulcer grows larger instead of less.

The secondary manifestations of syphilis in the tongue, according to one of the most competent authorities, Fournier, may present themselves in one of the following forms: (1) Ulcerating syphilide, or eruption; (2) non-ulcerating, gummy eruption; (3) gummy growth within the tongue. 1. The ulcerating eruptions are small lenticular ulcers, which are round when seated on the dorsal surface, but when on the sides they are more irregular in shape. They appear solitary, or in groups of crescentic form; they are indurated and chronic in duration, and when they are touched, or the tongue is moved, they are painful.

2. Non-ulcerating syphilitic eruptions of the tongue, named also lingual sclerosis or plastic glossitis, present themselves in the form of round and irregularly shaped nodules, which are situated in, and rise somewhat above, the surface of the tongue. The overlying mucous membrane is redder and smoother than the normal coating, and it appears thickened and as if the papillæ had been removed from it. The entire surface of the tongue may be the site of such syphilides, and then the teeth make impressions on the sides of the tongue.

3. Normal gumma (better gummi) may develop in the mucous membrane of the tongue or in the muscular tissue of the organ. Gumma lies in or near the dorsum of the tongue, and should it commence deeper, it grows towards the dorsal surface.

There are usually from one to four gummatous tumors in the tongue; and they may be small, or so large as to protrude the tongue from the mouth. It is diminutive when in the mucous membrane; but when in the muscular tissue, it may attain the dimensions of a walnut. Such gummatous growth may ulcerate, and present a hollow cavity filled with gangrenous structure; and this may remain open for years. The lingual gumma is painless unless it opens; but when it opens, speaking, chewing, swallowing and other acts in which the tongue is concerned, are interfered with and cause pain. The saliva is increased in quantity, and the breath becomes fetid. Taste is unimpaired, and the glands rarely swell. This is Fournier's description of the syphilitic eruptions of the tongue, which he says may be confounded with lingual cancer; the latter, however, appears in the old, while syphilitic eruptions appear oftener in the young and robust subject; cancer may be inherited, which is rarely the case with lingual syphilitic manifestations. Cancer retains its characteristics, though it becomes ulcerated on its surface; and its base has a better defined induration than is the case with the ulcerated gummy tumor. Cancer appears on one side, while syphilis is bilateral in its development. Lingual cancer is more spongy than the syphilitic growth; the former is inclined to bleed, while the gummy growth is not. Cancer has less steep edges than a gummy ulcer; the former granulates less, and is not so covered with gangrenous tissue, and it has a more fetid odor than the gummy ulcer. In the advanced period of lingual cancer, the adjacent glands become implicated; this is rarely the case in gummy ulcer. And the author will add that it is rare that secondary syphilis has so isolated a location as the tongue; if found there, it should manifest itself elsewhere.

Langenbeck in 1881 gave the following differentiating marks between syphilitic gumma and lingual cancer. Gumma presents one or more rounded flattened tumors, on which the mucous membrane appears smooth and shining; and the remaining mucous membrane presents a warty, fissured aspect. Gumma appears in the muscular structure of the tongue, and never in the submucous tissue of the floor of the mouth. Multiple tumors indicate syphilitic disease. Cancerous disease is more painful,

and it bleeds easily, and soon passes to the floor of the mouth, where gumma does not appear. Langenbeck observed cases in which neglected syphilitic disease of the tongue became cancerous.

Demarquay observes that gummy tumor of the tongue is, at first, round and hard, and, later, it softens at the center: conditions not found in cancerous disease.

Boyer states that cancer attacks by preference the sides and point of the tongue, while syphilis appears oftenest in the median part and on the base of the tongue.

Treatment.—Epithelial cancer is, in its commencement, a purely local disease; and in this stage, it is curable by appropriate treatment; but if the disease be allowed to progress and attack the greater portion of the organ, and especially if the glands beneath the floor of the mouth have become infected, then treatment will aim rather at palliation than eradication of the disease. Where the disease already occupies all, or the greater part of the tongue, non-interference should be the guiding rule; in such state, by an attempt to remove the disease, the surgeon's hand would only stir the fire and widen the area of the flames. But in all cases in which the disease is circumscribed to a portion of the tongue that can be so operated on that the track of extirpation will be wholly within the sound tissues, then an operation may be resorted to with a strong probability of curing the patient.

To reach the tongue which is to be operated on, if one examines and compares the methods of work which have been done, he finds that three routes have been used: through the floor of the mouth, through the mouth itself, and, thirdly, through the lower part of the cheek. Numerous methods have been proposed and pursued in the work of extirpation; though multifarious, these may be comprised in the following classes: cauterization, potential and actual; ligation, moderate or gradual; excision by the knife, scissors écraseur or thermal cautery. One or more of these methods finds illustration in the work which has been done by eminent surgeons, whose procedures in somewhat chronological order here follow:—

In 1842 Regnoli, to remove the tongue, made an incision from the os hyoides to the symphysis of the chin; and then a second incision along the inner border of the inferior maxillary arch; then through the two-flapped opening thus made, the tongue was drawn down, and excised. In this way he removed

the tongue of a girl, who recovered so well from the operation that she spoke clearly and distinctly.

In 1850 Nélaton found that division of the lower jaw through the symphysis was an important aid in the operation of excising the tongue; the jaw was divided by means of a chain-saw, and, after the removal of the tongue, he reunited the halves of the jaw by means of a ligature, which included the front teeth on each side; the incisors and canine teeth were tied. Sédillot, in a comparison of Nélaton's plan with that of Regnoli, prefers the former, since it renders more of the tongue accessible to the operator; he thinks, however, that mere fixation of the sides by dental ligation is an imperfect plan; and to more surely fix the parts, he would so saw the sides that one would have a solid angle which might be received in a hollow angle of the other end.

Near the same period, Syme operated in somewhat the same manner as Nélaton, namely, he divided the lower jaw through the symphysis, and English writers name this operation the method of Syme.

In 1858, Demarquay operated in the following manner: a vertical incision was made through the lower lip, when the lower jaw was divided in the median line with the chain-saw: the tongue was excised with the écraseur, and the divided bones reunited by means of a gutta percha appliance; a complete recovery was thus obtained.

Thiersch, in 1865, writing on lingual epithelioma, finds that it commences oftener on the edges of the tongue than elsewhere. And since the disease advances insidiously, undermining parts which are sound, he prefers to do the work of removal with the knife rather than with the thermal cautery or the écraseur. As a preliminary to the removal, he ties the lingual artery, which he ligates near the os hyoides, fixing the latter with a tenaculum, as aid in ligating. In one case, Thiersch tied the right and left lingual arteries, and in another case, not finding the lingual, he ligated the common carotid artery.

Nunneley, an English writer, in 1866, from his experience in five cases of cancer of the tongue, pronounces the operation of removing the organ to be one void of peril. In three of the cases, the disease did not return. He removed with the écraseur. To do this, Nunneley first thrust a curved needle between the hyoid bone and the lower jaw, letting it merge under the tongue, near the frænum; by this means the écraseur was drawn into the mouth, and over and behind the root of the tongue. To aid in

applying the écraseur, the tongue must be drawn well out of the mouth. The division of the parts must be done slowly, so as to insure the closure of the vessels.

Paget, to remove the tongue, first divides the genio-hyoid muscles near their insertion in the maxilla inferior; through the opening made, the tongue is drawn down, and then, an incision being made around the tongue through the mucous membrane, the loop of the écraseur is placed in this cut, and the division of the organ is now completed.

Buchanan, as preparatory step, first divided the lower jaw in the symphysis, according to the plan of Nélaton and Syme; and then, through this opening, he removed the tongue.

Gamgee, in 1868, removed the tongue by Regnoli's method, in which he separated the muscles from the lower jaw on each side as far back as the facial arteries; and he is undecided whether this plan is better than that of Syme, in which, as preliminary step, the jaw is severed at the symphysis. He favors the previous ligation of the lingual arteries. In 1868, Podrazky, of Vienna, reported the extirpation of the tongue for epithelioma, in which, as preparatory step, he tied both the lingual arteries; and he claims that this was the first time that double ligation of these vessels had been done at one time.

In 1871, Harrison, an English surgeon, to excise the tongue affected with cancer, first divided the frænum and the mucous membrane around the tongue, so that the organ can be drawn well forwards. Through a sublingual opening made, the loop of the écraseur is to be passed, and the tongue being included is thus excised.

Billroth, in 1874, wrote on the removal of the tongue which is affected with cancer. He directs special attention to the cleansing of the mouth, and urges that more care be given to this than is commonly done. Through an incision corresponding to the boundaries of the floor of the mouth, the tongue is drawn and cut off with scissors, and the vessels tied as they are opened. The crescentic cut is next to be closed, except its lateral endings, which are left open for drainage.

Menzel operated in a similar way, yet, as a preliminary, he tied the lingual arteries, as advised by Czerny.

Axel Iversen, in 1874, wrote on the operation of removal of the tongue partially, or in its totality. He opposes those methods which mutilate much by extensive cutting, viz., division of the maxilla inferior. Though such mutilating operation be done

where the growth is far advanced, it does not eradicate the disease: the latter soon recurs. Iversen advises not to operate in cases in which the disease has extended beyond the papillæ circumvallatæ. Where the affection has extended well backwards, he prefers the method of Heyfelder and Jäger, viz., to reach the growth by an incision made through the cheek. Iversen operated on several cases, in Copenhagen, in which he modified somewhat the cut of these operators, viz.: instead of incising horizontally, outwards from the angle of the mouth, he did this on a level with the teeth of the lower jaw. This cut curved downwards, so that a convex flap was formed. Iversen claims, as advantages for this incision, that it shuns branches of the facial nerve, avoids the duct of Stenson, and does not injure that part of the cheek in which the tendinous portion of the facial muscles lie; and the wound made, having been closed by twisted suture, heals by first intention. Iversen condemns the use of the écraseur for the excision as an instrument that is uncertain and painful; but he recommends the knife and the galvano-cautery. He claims, likewise, that the ligation of the lingual artery does not guarantee against hæmorrhage. He removes the affected glands, which is easily done when they are not adherent to the surrounding structures.

In 1881, Guillier, following the method of Verneuil, advises thorough removal of the cancerous tongue and at an early period; and should the glands have become affected, he counsels their removal, as well as the removal of the structures which lie between the tongue and the glands. Recurrence is rare in the lingual stump; it occurs oftener in the sublingual tissues in the floor of the mouth. To do this work radically, let an incision be made through the floor of the mouth from one angle of the lower jaw to the other; and this cut demands the ligation of the two facial arteries. A double ligature should be placed on each vessel, and the vessel then divided between the ligatures. Next, let the tongue be drawn down through the crescentic cut and divided with the thermal cautery. If the disease be unilateral, remove only the affected half of the tongue, dividing antero-posteriorly with the écraseur. In case the palate and tonsil are affected, divide the lower jaw through the symphysis.

Whitehead published in 1881 his method of operating: he dissects the tongue from the floor of the mouth, and then divides the organ near the epiglottis, tying vessels as they are divided.

Berg, a Scandinavian, writing in 1881, finds that lingual cancer has a special tendency to travel antero-posteriorly; exceptionally, it passes through the raphe:—facts to be remembered in operations on the cancerous tongue.

In 1881, Wölfler describes the method of operating then pursued by Billroth, who, within thirty months, had operated forty-five times. He does not divide the lower jaw, nor make the submental flap as he once did, but now operates through the mouth; thus septic pneumonia is warded off. He ties one or both of the lingual arteries; and the cut for the ligation of the artery may be enlarged and the diseased glands removed through it. He divides the frænum and mucous membrane around the tongue, so that the latter can be drawn well out of the mouth. Drainage is made through the floor of the mouth. Wölfler states that the secondary pulmonary affection, which follows these operations on the tongue, may be of a mild catarrhal character, which subsides in a few days; or there may follow a severe pneumonia, from which the patient may recover; yet, sometimes, death is thus caused. The cause of pulmonary trouble, in all the forms, is the swallowing of septic material, a part of which passes to the lungs.

Langenbeck's plan is to divide the lower jaw, and then excise the tongue with the thermal cautery.

The method of operating by Baker, of St. Bartholomew's hospital, is as follows: To hold and fix the tongue, a thread is passed through each side of it a half inch from the median line; and to loosen it, so as to allow of extension, the attachments of the tongue are divided with scissors, the divisions being done close to the lower jaw. If the disease be unilateral, the mucous membrane is to be divided along the median line, and the two halves separated with the finger; this done, remove the diseased half of the tongue, and also any glands which may be affected. The removal of the glands is most easily done through the floor of the mouth by external excision.

Kocher operates by first performing tracheotomy and plugging the fauces; then an incision is to be made along the anterior border of the sterno-cleido mastoid, and, from the middle of the muscle, carry a second cut to the hyoid bone, and thence along the digastric muscle to the symphysis of the jaw. The flap described is reflected aside, and the facial artery and vein and the lingual artery are then tied. The attachments of the tongue are next to be severed, and the organ drawn through the opening

and divided with scissors or galvano-cautery. If the entire tongue is excised, tie the remaining lingual artery. The canula must remain in the trachea for some days, and the aseptic dressing be removed from the fauces twice daily, and new ones placed there; and at these dressings the patient must be fed.

In Volkmann's plan, if the tongue can be drawn out, the diseased portion is excised, and the mucous membrane brought over the wound, which is closed by sutures. Also, if a portion of healthy tongue remains, this is turned around so as to form a rounded end of the lingual stump. But if the tongue be more extensively affected, then let a thread be passed through it by which traction can be made. An incision is then made downwards from the angle of the mouth; a canine tooth is extracted and the jaw divided at this point; through the breach, thus made, the tongue can be drawn out and excised. The cut surfaces are now to be faced with mucous membrane and sutured; and the jaw is to be sutured with wire. A drainage tube is to be placed in the tonsillar fossa and carried out through the lateral wound. The writer thinks that Volkmann's plan of dividing the lower jaw should find few imitators.

Near this period, Hueter and Lesser report extirpation of the tongue affected with epithelioma. Seven operations are reported, in all of which the lingual artery was tied; and all recovered.

The operation of tying the lingual artery is now generally practiced as a preliminary to extirpation of the tongue; and a description of how this may be done is here given.

From his experience in this ligation, the author should state that it may be easy or difficult, according to the conformation of the subject's neck; in those whose neck is long, and with scanty adipose tissue, the artery is easily found; but where the neck is short, thick and laden with a thick couch of fat, the operation becomes extremely difficult; and it is no wonder that one surgeon was compelled to abandon the lingual, and ligate the carotid artery.

Demarquay in 1867 reported the ligation of the lingual artery in eight cases; and in 1868 he published a mémoir on the subject. He claimed that the operation was not a difficult one to one well versed in the anatomy of the parts. He says the operation was first suggested by Béclard and was first done by Mirault. Besides, as a preliminary to excision of the tongue, this ligation may be done to control bleeding in the wounds of the organ; and in such cases the haemorrhage has not returned after the ligation.

Demarquay counsels this ligature to retard the growth in cases in which the cancer has advanced so far that it cannot be removed. At the time he wrote his article the ligation had been done by Mirault, Moore, Roux and Deguise. To reach the artery Demarquay finds Blandin's plan to be the best; this is done by an incision made above the great cornu of the hyoid, and extending from the anterior edge of the sterno-cleido-mastoid muscle to the median line of the neck. If the neck be short, as soon as the submaxillary gland is reached, open its capsule and let the gland be pulled upwards. The digastric muscle and ninth nerve are now brought into view; the artery lies in this field in a triangle formed by the hyoid cornu below, the hypoglossal nerve above, and the carotid artery behind; the artery lies just above the hyoid bone, and is displayed by a horizontal cut through the fibres of the hyoglossus muscle, behind which the vessel lies hidden.

Near the same time the lingual artery was tied by Hueter in the operation of lingual excision. To find the artery, Hueter incises horizontally above the hyoid bone, and, uplifting the skin, there is displayed what he names the lingual triangle. This triangle is bounded below by the two legs of the digastric muscle and above by the hypoglossal nerve. The digastric portions are the sections of the digastric muscle which lie before and behind the hyoid bone. The space included in the triangle does not exceed a square centimetre in surface (a centimetre equals about two-fifths of an inch in length). Hueter does not deem the operation a dangerous one; on the contrary, Weichselbaum, who has written on the subject, pronounces the operation dangerous. When the disease occupies the middle portion of the tongue, Weichselbaum advises to tie both lingual arteries, since according to Hyrtl, the dorsal portions of the lingual arteries sometimes unite and form a single vessel in the median line.

Anatomists have found that the situation of the lingual artery is not uniform in the first part of its course; exceptionally, instead of lying above the hyoid bone, it may lie behind or below it. If the artery is not discoverable, the ligation of the external carotid should be done. The lingual should be tied as far backward as possible, since, done thus, no branches remain through which the blood can enter the tongue. Should, however, the vessel not be discoverable in this part of its course, or if from inflammatory or cicatricial agglutination of the structures the vessel is not accessible, then it may be sought for, more anteriorly.

In its anterior portion the vessel may be found by making a horizontal incision midway between the inferior margin of the lower jaw and the hyoid bone. The exposed submaxillary gland must now be drawn upwards by a transfixing tenaculum; and when this is done, there is offered to view the anterior leg of the digastric muscle, and above this the hypoglossal nerve; in the space between these, and close beneath the hyoglossus muscle, lies the lingual artery. To find the vessel, divide the hyoglossus horizontally, and cause this cut to gap, and the artery will be found. This search for the vessel will be facilitated if the surgeon has recently dissected this region; for no matter how accurate his anatomical knowledge may once have been, it is within the experience of the writer that the sketches which have been copied in the mind long ago, wander, in time, from the true picture in nature; accurate correctness is only maintained by repeated rehearsals on the cadaver.

As the linguist, who would retain intact a language which he has learned, must, from time to time, rehearse his grammatical rudiments, so the operative surgeon, to do the best work, must ever and anon renew his early association with the cadaver. As a mnemonic guide which represents the site of parts which have a close relation to the lingual artery, the one subjoined has been constructed by the writer; in the posterior site of the vessel the trilogram CAD represents the initial letters of *corna*, *artery* and *digastric*, in the order in which the structures stand from below upwards; but anteriorly, after the artery has passed beneath the posterior leg of the digastric, the symbol DAN represents the series in which appear from below upwards, *digastric muscle*, *artery* and *ninth* nerve; and the two syllables conjoined form the word CADDAN. Such devices, as elusive artifices, amuse memory; they become pebbles, which, dropped into the tub of the Danaids, close some of the openings through which are wont to lapse so many of the facts which we store there.

As conclusion of the subject of excision of the tongue for the relief of epithelioma located in the part, the writer will subjoin a brief account of his method of doing the operation. The lingual artery is to be tied on one or both sides, according as the tongue is unilaterally or totally affected with the disease. An indispensable aid in the operation is to have the lower jaw well depressed and held so; and, for this purpose, the author has devised and had constructed an interdental gag, which is exhibited in the adjacent illustration. This instrument when inserted has the advan-

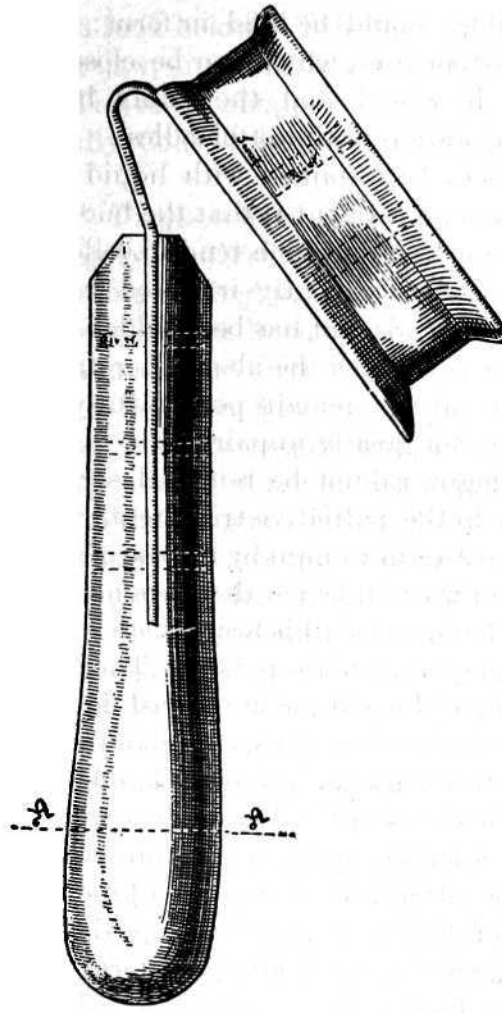

FIGURE 87. Exhibiting an interdental gag devised by the writer. (Constructed by Dr. A. B. McKee.)

tage that it does not encroach on the buccal cavity; and the operator has untrammeled access to the tongue. The handle of the inserted gag is held by an assistant who also clasps and steadies the head. The tongue is next seized by strong clasp-forceps and pulled aside so that its sublingual and palato-pharyngeal connections can be brought into view and severed with scissors. Thus liberated, the tongue can be pulled well forwards, when a circumscribing line is incised between the affected and unaffected structures; and this line must lie within the sound tissues. Through this guiding incision the excision can be continued and completed. The part removed must be examined, and should it appear that the disease has not been wholly removed, the excision must be continued further. The line of

excision, if possible, should be bifid in form: that is, the stump should be in two portions, which can be closed by sutures, and thus the wound be closed, and the stump have a round end. Thus done, the operation is almost bloodless.

The patient is to be sustained with liquid food. An important part of the after-treatment is that the buccal cavity be often cleansed of septic materials which tend to collect in it; and further, let the cavity be frequently irrigated with mint-water, to which five per cent of alcohol has been added.

The writer has performed the above operation thirteen times, and eleven of the patients remain permanently cured; and their power of speech is not greatly impaired.

In case the tongue cannot be removed, scrupulous attention should be given to the palliative treatment; the patient's pain should be reduced to a minimum by the use of narcotics. This is an humble field of work in which there are no trophies to be won by the surgeon's hand, yet for his heart there is ample field for the exercise of his highest duty to his patient. The unfortunate victim of cancer is too often ill cared for in the last days of his suffering; yet no case appeals more earnestly for kind and unceasing care than does his; and in this work the surgeon's hand should be the first and the last. The slaves of the Aztec prince were slain to accompany their dying chieftain, and to carry lamps which should guide his feet through the dark vales of death: of kindred nature should be the devotion of the medical and surgical attendant to him whose days of agony linger seemingly interminable before they reach the supreme hour.

In the list of anodynes which modern chemistry has so augmented, no one exceeds opium and its compounds in efficacy; the patient should have morphia in doses increased correspondingly, as tolerance of the remedy is developed; a quarter of a grain should be commenced with, and this be increased to a half grain, and finally a grain three times a day. Nutrient liquids are to be used as food. And to lessen the pain of their ingestion, the tongue should be cocainized; in fact, as a local anæsthetic, a five per cent solution of cocaine may be penciled on the raw surface, from time to time. A very efficient means of lessening the pain is section of the sensory lingual nerve. In 1866 Colles, of Dublin, advised the section of the gustatory branch of the inferior maxillary nerve; and, as Hilton announced, the same thing had previously been done by him. This section is done by an incision which is a half inch behind the last molar tooth, and

three-fourths of an inch below. This cut is directed towards the angle of the lower jaw, and must sever or detach the soft parts from the bone. The relief, obtained thus, was great; but as the pain returned finally, Colles thinks a portion of the nerve should be removed.

Wounds of the Tongue.—The protected site of the tongue screens it from injury; nevertheless, it is sometimes wounded, being reached by some cutting, penetrating, contusing or burning agent. The gunpowder missile may, also, wound the tongue.

According to the author's observation, the tongue is oftenest wounded in the child from falls, in which the tongue, being thrust between the teeth, is caught and bitten; or the child having some sharp-pointed object in its mouth, in falling, this object is thrust into the tongue. From these agencies, longitudinal, oblique or transvere cuts may originate; and the wound may be in the body or border of the tongue. In convulsions, epileptic or tetanic, the tongue may be caught between the teeth and severely bitten. And those who have care of such patients should be directed to prevent such accident, by interposing some object, as a knife handle, piece of rubber or other body, between the teeth, so as to release the tongue, and, in some measure, protect it from injury.

The treatment of the open wound in the tongue does not differ essentially from that of wounds in the dermal surface of the body. The wound must be accurately closed with sutures, and, as far as possible, rest should be given to the part. To introduce the sutures, the tongue must be drawn out by the aid of clasp-forceps, and then the edges of the wound must be carefully coaptated; and since the muscles of the organ will move despite its fixation, the adjustment of the wounded edges is not easily done. Metallic suture is better here than silk; and, since the tongue swelling buries the suture, and this remains hidden for some time, the wire should be so cut that the end of it can be found and caught, when the time arrives for the extraction of the suture. If the tongue have been divided in its entire thickness, deep sutures must be introduced. If the border be implicated, the first suture must be placed there; thus proceeding, a notch or marginal irregularity will be avoided. These sutures must not be closed too tightly, lest they cut the included structure; and they must remain in place for a period of a week, or even ten days. Too early removal of the sutures has led to failure through reopening of the wound. During the time of

treatment, liquid or semi-liquid food of bland character should be given the patient.

In wounds of the tongue in which a part of the organ has been detached, or is merely adherent by a mere fibre, an attempt should be made to reunite and save the part. In 1870, Peltier reported a few cases of the kind, which he had treated or had observed in the practice of others. The results obtained were very satisfactory; and he accounts for this on the ground that the wounds are usually in children, in whom nutrition is in a high grade of integrity. Also Beranger Féraud, in his dissertation on the reunion of parts which have been severed from the body, gives eleven cases of such reunion of parts detached from the tongue. In such work of restitution in cases in which there has been complete detachment, as well as in those in which the separation is incomplete, the raw surfaces should be well cleansed before closure by suture.

Foreign Bodies Lodged in the Tongue.—As before remarked, the protective ramparts around the tongue screen it from injury so that wounds of it are rare; for similar reasons, the lodgment of a foreign body in the tongue is a yet rarer occurrence; nevertheless, the annals of surgery present occasional records of such injury. Examples of such are a bullet, a fragment of a tooth, fragment of wood or a piece of a pipe-stem.

The famous case of Boyer is often repeated, in which a bullet remained in the tongue for four years, when it was extracted by him. In the extraction of teeth, a mal-adroit hand has left a fragment of a molar in the tongue; such a case is reported by Herbert.

In all cases of a foreign body lodged in the tongue, a well-defined swelling occurs about the object, and if this be carefully inspected, there will be found a breach of the surface: an opening through which a probe can be passed to the body; or, this wound may heal and only a scar remain to indicate the point of entrance. Such marks, with the patient's history of an injury, will aid in the diagnosis; and besides this, more definite knowledge is gotten by the insertion of a probe or needle, by which the body is felt.

The treatment of such injury is to fix the tongue with clasp-forceps, and then make an incision through the surface of the swelling, which will furnish the nearest approach to the body, and after the extraction of the object, the wound will soon heal.

Roof of the Oral Cavity.—The roof of the oral cavity consists of two portions, which differ in structure: the anterior part, which

is hard, fixed and motionless; the posterior one, which is soft and movable, and hence is named the pendulous veil of the palate.

The hard palate is a simple layer of bone which is lined on each side by mucous membrane, and this membrane on the oral side, is the one which specially demands our attention, since as a passive agent it shares in some of the most complicated work done by the surgeon in this region. The bony roof ends in, and is bounded on the sides and front by, the alveolar process of the upper jaw, and the space included between them is closely invested by mucous and fibrous structure, which is continuous behind with the pendulous veil of the palate. The roof of the mouth, in its normal state, is a vaulted arch, and this arch, at its highest point above the dental plane, is from a half inch to four-fifths of an inch in height; yet Tillaux, who has given these figures, finds numerous deviations from them; the arch may be low, and of the slightly curved, Moorish type, or it may be high, resembling then the Gothic form. In the usual form, the longitudinal and transverse diameters of this vaulted space are of nearly the same length; yet when the vault rises Gothic like, the transverse diameter is lessened; but if the arch is lower, the space becomes wider.

The mucous membrane of the palatal vault rests on a dense stratum of fibrous tissue, and in this fibro-mucous structure nerves, glands and vessels lie. The nerves belong mainly to the sympathetic system, and descend from above through the anterior and posterior palatine foramina. These nerves are derived from the spheno-maxillary sympathetic ganglion, whence branches radiate in such multifarious directions as to puzzle or tire the knife which seeks to trace them. These branches are distributed to the internal ear, the tonsil, and the soft and hard palatal structures; and the anterior branch traverses the naso-palatine foramen, and finally reaches the anterior part of the palatal vault. The site of the naso-palatine foramen is often indicated by a wart-like papilla. There sometimes exists here a minute canal which traverses the wall, and through which a fine wire may be passed. Pressure on the lower end of this canal acts on the naso-palatine filaments which emerge there. It has been found that pressure on this part of the palate will arrest sneezing. And use was made of this fact by Prochaska; those whom he had operated on for the removal of cataract were instructed, when they felt the sense of approaching sneezing, to press with the thumb behind the incisors and thus arrest the act.

Muciparous glands exist in the fibro-mucous glandular structure; these glands are especially numerous in the lateral portions of the palatal roof, and to them is due the increased thickness of the fibro-mucous palatal structure. These glands are similar to the mucous glands of the lips.

The arteries are the posterior and anterior palatine, which descend to the hard palatine through foramina of like name. These vessels supply the nutrition of the osseous roof of the mouth. Tillaux says that any lesion which separates the palatine fibro-mucous structure from the overlying bone causes osseous necrosis; evidently an error, for if it were so, many uranoplastic operations would cause death of the bone; yet such necrosis is a rare event.

It is important to study the site of these vessels. The posterior palatine is a derivative of the external carotid through the medium of the internal maxillary artery; it is one of the final branches of the latter. The vessel descends through the posterior palatine foramen, and emerges near to and at the side of the dens sapiens. After its appearance here, the artery runs forwards along the base of the alveolar process until it meets the anterior palatine, with which it forms inosculation. In the course of the posterior palatine along the side of the vault, the vessel lies in a furrow, which, sometimes, is converted, by a covering of bone, into a long canal; but, more frequently, the vessel lies in a shallow furrow, or, at most, it is not more than half buried in the bone. Branches are sent off on each side; the most of them, however, pass inwards and forwards. According to Tillaux, the position of the artery is such that it can be shunned by an incision cut near the base of the alveolar process. The cut should be made thus in the uranoplastic procedure; "for gangrene will never arise if one preserve the posterior palatino artery in the flap."—(Tillaux.)

Though no muscular fibres are contained in the fibro-mucous coat of the hard palate, yet wounds here gape, and, if a vessel be opened, there will be much bleeding; and to check this the actual cautery is the surest means.

Behind the hard palate lies the soft one, which in structure is more complicated than the former. The antero-posterior diameter of the palatal vault is normally about three inches; of this, one-half belongs to the hard palate and the remaining half to the soft palate. The distance between the posterior border of the soft palate and the posterior border of the pharynx is a very variable quantity. The uvula, or posterior portion of the soft

palate, differs much in its length, and from disease it may undergo enormous elongation.

The soft palate is lined above and below by mucous membrane, and between these lie muscular, glandular and fibrous structures.

From underneath, ascend and are fused in the soft palate the palato-glossal and palato-phryngeal muscles, and its upper surface receives the levator and tensor palati muscles. The tensor palati has recently been deprived of some of the function which was once attributed to it; instead of acting on the soft palate, as formerly taught, it is now thought to pull on the lower wall of the Eustachian tube, and aid in maintaining this patent.

The fibrous structure lies in the front portion of the soft palate, constituting its anterior third. This fibrous structure lies between the hamular processes of the pterygoid plates, and is fastened to, and is continuous with, the posterior border of the long palate; and such is its firmness of structure that one may readily be deceived respecting the posterior limits of the bone: viz., he may suppose that the bone reaches farther backwards than it really does. This fibrous portion may be designated the tendinous origin of the so-named tensor palati muscles. In the movements of the soft palate the fibrous layer does not participate.

The glandular portion of the soft palate lies next to the inferior mucous coat; though glands lie underneath the superior mucous coating, yet those below are much more numerous, and these glands are the starting point of the adenoid tumors which sometimes arise from the palatal veil.

The vessels of the soft palate, which are named palatine, are derived from the internal maxillary, the facial and the external carotid; and as all the blood is originally received through the external or common carotid arteries, tense pressure on either of these will control hæmorrhage from a wound of the soft palate.

The lymphatic vessels proceed to glands which are situated at the angle of the jaw.

Inflammation of the Palatal Structures.—The palatal vault is the site of inflammatory processes, which may arise primarily there; or such process arising in the adjacent dental and alveolar structures may extend to the palate. Those which arise in the alveolo-dental structures are usually tractable to treatment, and do not leave much trace of their action. There is, however,

another class which depends on some constitutional disease, and often causes some destruction of both osseous and soft structure: these are scrofula and syphilis. Scrofula may develop here a localized inflammation, which runs a long course, and ultimately, through carious action or more extensive necrosis, destroys a portion of the bony vault. The disease probably commences in the superior or inferior periosteal investment (often in the latter), and it thence extends to the bone. The site of such periostitis and subsequent caries is commonly near the middle part of the palatal vault, where the bone is thin, indeed, nearly transparent. The syphilitic gumma appears in the same region, and may end in perforation of the septum between the oral and nasal cavities. The treatment of the cases comprised within these dyscrasic classes is that employed against the constitutional disease: to wit, anti-tubercular and anti-syphilitic remedies. The chief curative agent is iodine, which, in the form of tincture, should be applied frequently to the affected point; and iodine in some form should be given internally. Should the case be syphilitic, the treatment should be iodo-mercurial, the details of which are given elsewhere. The writer's experience justifies him in expecting much from the local use of the compound tincture of iodine.

In the soft palate an inflammation may arise primarily, or it may appear through propagation of an inflammation which began in parts adjacent. The loose texture of the soft palate permits of extensive swelling, in which the uvula is implicated. The swelling is dependent on œdematous infiltration rather than on accumulation of blood in the part. As functional disturbances from such inflammation are cough and difficulty of swallowing. Dysphagia arises from the enlargement and from the partial loss of the action of the muscles in the soft palate which are concerned in deglutition; and as result, the choanæ being imperfectly closed, food may enter the nostrils behind. The secretion of the mucous glands is augmented and becomes more tenacious than normal, hence arises cough or hawking to get rid of this disturbing material.

Treatment.—If seen early the treatment should be rigidly anti-inflammatory; multiple scarification should be done in the swollen structure; it should be painted with the following:—

℞. Tr. Iodini Comp.
Tr. Gallæ.. ... .aa ℥i
Misce.

Fragments of ice should be used and the bowels well evacuated. Treatment of this kind, commenced early and pursued diligently, may arrest the affection; as a rule, however, it will proceed to suppuration. The pus is rather in the form of diffused infiltration than in well-defined isolation from the containing structures. It may be discovered through the mucous membrane as whitish streaks. The treatment is to open the affected structure with properly directed incisions, viz., antero-posterior openings. Such incisions allow the escape of existing pus; and they also permit the escape of serum, with which the swollen structures are surcharged. Extensive suppuration may destroy so much of the palatal tissue that a perforation of the veil will afterwards remain; this is rare; and the more usual result is an extensive scar, which by its contraction renders the palate tense and restricted in its motions. The orifice which remains may become closed; yet the condition in which the part afterwards remains is not wholly satisfactory, since the palate is left abnormally tense.

Wounds of the Palate.—However well the palatal structures may be secured from injury by their position, still traumatic agency may enter here, and implicate the soft or hard palate, or both.

The soft palate of the child is not unfrequently wounded by a sharp-pointed object, often a toy, which, being held in the mouth, is thrust backwards into the roof of the buccal cavity, by a fall of the child on its face. Such injury the writer has seen caused by a whistle, by which the soft palate was pierced by a flap-like wound; and thus the wound may vary in form and situation. One of the worst conditions is that in which the posterior border of the veil is opened; since the muscles on each side greatly widen the gap thus made. Whether the wound be a marginal cleft or one which perforates the veil anteriorly, the proper treatment is to close the breach by metallic sutures, as early as possible; for if thus done, the edges of the wound being raw, they readily unite. One or two stitches will suffice. If the case be one of flap-form, the edges should be accurately coaptated, and two or more sutures introduced, so as to retain them in place. If accurate union cannot be obtained, then the pendent, or unattached border should be closely trimmed off; and thus a fringe-like scar is avoided. In case there has been a loss of structure in the operative work of closure, it will be necessary to make lateral incisions so as to permit displacement inwards; of this further details will be given hereafter.

The bony palate may be injured by causes similar to those

above mentioned. Yet a greater degree of violence is required to perforate this part. Such perforation has arisen from violent contact with some sharp-pointed object. The most frequent causal agency, however, is the gunshot missile; a large portion of the cases are contained in the records of military surgery; but in the modern period of suicidal fashion, the pistol ball furnishes no small quota of these wounds. In the statistics of military wounds in the Crimean war, of two hundred and twenty wounds of the face, there were nine perforations of the bony palate; and in the war in Italy, Chenu reports that there were ten perforations of the palate in seventy-seven wounds of the face. In the wound from a shot, there is usually other injury of the contiguous parts; the ball in its passage may wound the cheek, jaw or the base of the skull; and in the latter case, the missile may wound the brain, and cause an injury of such gravity, that to deal with the palatal wound would be idle work, akin to that of dressing a fracture on a dying man.

In case the palatal bone is perforated, and fragments of bone remain attached to the soft parts, the broken pieces should be restored to normal site, and the flaps of muco-fibrous structure should be retained in site by properly placed sutures. A large flap may thus possibly be saved and aid in closing the breach through the bone. Denucé has given the history of a case which illustrates what may be done in closing such a wound. Through a suicidal shot the fibro-mucous investment of the bony vault was detached and, as a large flap, was found hanging in the mouth; this Denucé uplifted and retained in site by sutures, which were carried through the breach and the nares, and fastened on the cheek. A satisfactory result was obtained.

In brief, the immediate management of such a case is to replace the osseous fragments and reattach by sutures the torn shreds of the palatal veil; subsequently, when the parts have healed, some plastic procedure may be resorted to, to complete the closure. At the primary dressing, however, an attempt at complete closure may be made, should this be permitted by the conditions present.

Tumors Arising from the Palate.—Both the hard and the soft palate are the occasional sites of tumors.

Aneurism.—The palatine artery, from pressure or direct traumatic cause, can become the site of an aneurism; in recent years there have been recorded cases of such aneurism arising from lesion due to the pressure of the dental palate. Such aneurism

has been cured by the actual cautery; also by opening and emptying the sack, after previous ligation of the palatine artery on the proximal and distal sides of the tumor: that is, by the old method of Antyllus. Ligation of the external carotid artery might also be done.

Pedunculated or polypoid growths have been seen on the soft palate; they arise oftenest near the uvula from the posterior border of the palatal veil. These growths often are of such diminutive size that they cause no disturbance; but if they become large enough to interfere with the function of the part, they should be excised.

Other growths have been observed here of cystoid character; such have been seen by Robin and others, and probably arise from the closure of muciparous glands. Cystoid sacks containing petrified concretions have been mentioned by Parmentier, in 1856, as occurring here; the origin of these he finds in glandular occlusion. Such cystic or cystlike tumors should be freely opened and their contents evacuated by curetting.

Solid growths of non-malignant character arising from the palatal roof of the mouth have been seen by Michon, Nélaton, Langenbeck and others. Such tumor, as to its structure, may be chondroma, adenoma, fibroma or osteoma, according as the cartilaginous, glandular, fibrous or osseous elements predominate in the composition of the growth.

The adenomatous palatal tumor appears on the palatal veil, where the glandular elements abound; but the chondroma or fibroma springs from the structures of the bony vault.

Langenbeck, in 1859, saw a case of chondroma here in a syphilitic subject who was twenty-seven years old. This tumor had existed a number of years, and had grown to such a volume that it filled the entire roof of the mouth. The growth was easily removed. The writer in 1870 saw a palatal chondroma in a young woman, which had been many years in its development, and had attained such dimensions that it filled the entire palatal concavity. It was convex above, or rather a mould of the roof of the mouth; and below it was a smooth plane, on a level with the crown of the teeth; and in length it extended from the incisors to near the posterior border of the soft palate. This remarkable tumor was nearly white in color, and was slightly movable, showing that it had only a pedunculated connection with the palatal vault. The tumor was removed by means of a thin-edged chisel which was inserted between the front part of the growth and the

alveolar process; the detachment was thus easily done, and the attachment was discovered to be at the point of union of the four angles of the palatal process of the palatal and superior maxillary bones, viz., at the spot where the problem can be solved of touching at once with the point of a needle five different bones, the vomer being the fifth bone. The growth was probably due to the exuberance of cartilaginous formative material, which may be conceived to exist at such a point of convergence; the osteogenetic forces overstepped the lines at which their action is usually limited; and the surplus of cartilage, the antecedent stage of bone, was molded into an enormous chondroma. What was remarkable was that so large a development could have grown from so small a pedicle. This tumor did not recur. A plan of removal sometimes resorted to is that of cauterization; this, however, is very painful, and the better plan is to directly extirpate it; and if it is imbedded, the containing capsule should be opened, and enucleation done.

Malformations of the Soft and Hard Palate; Acquired or Congenital.—Commencing posteriorly the uvula is first to be considered. This terminal appendage of the pendulous palate is sometimes seen consisting of two portions, which meet and fuse at the base; the uvula has its cleft as well as the palate. This uvular division is probably the remnant of an embryonic cleft which has nearly closed in utero; or, viewed from another side, such division may be the commencement of a palatal cleft which remained limited to the uvula. Such deformity causes so little inconvenience that its existence is often unknown to the patient. Should, however, any disturbance arise from it, it would be an easy task to pare and unite the parts by suture.

The uvula may become the site of abnormal enlargement in which there is thickening and elongation. And this may be a congenital condition, or have arisen so imperceptibly that the growth was unobserved. In such cases the abnormally long uvula may cause disturbance through contact with the walls of the pharynx, or the base of the tongue. This contact may awaken a reflex movement and annoy the patient by coughing and a constant effort to clear out the throat. A habitual cough may thus originate and give suspicion of some organic disease of the air-passages. In fact, it is claimed by a German writer that such continued irritation may awaken pulmonary disease.

The uvula may become elongated temporarily, through inflammation of the pharyngeal walls which implicates the soft palate.

Thus the uvula may become greatly lengthened and thickened, and greatly distress the patient through cough and efforts to expel what seems to be something foreign in the throat. The thick, tenacious mucus excreted by the inflamed mucous follicles is also an irritant.

Treatment.—The uninflamed uvula which is abnormally long, should be shortened by excision. In this work some have advised to remove the entire uvula; others recommend to preserve a part of it. Smith, in the *British Medical Journal*, in 1872, wrote on this subject, and recalled and recommended the method announced twelve years before by Jearsley, who counseled to radically excise the part; for he claims that if a part be left, the scar on the end of this will maintain an irritation. Smith advises to remove with scissors, and to so cut that the remaining scar will be directed backwards and upwards. Should much bleeding follow, apply chloride of iron, and if this fails, ligate. Smith excised his own uvula with the écraseur, and found that the operation was a painful one. An account is told of a patient who did more than Smith; for the uvula of the former being greatly elongated, he cut it off with his incisor teeth. The method of Smith and that of his rival, though deserving worthy mention, will have but few followers; the renown which Mucius Scævola has in history on account of the self-sacrifice of an arm is proof of the rarity of such temper among men.

The entire extirpation, as counseled by Jearsley, is improper, since the uvula has its function in deglutition; for it guarantees the complete closure of the posterior nares, and thus insures against entrance of fluids and solids, during swallowing, into the nose. In one case in which the writer had excised the entire uvula, the patient was so dissatisfied with her condition that an attempt was made to restore the lost part. This was done by short vertical incisions through the posterior border of the pendulous palate, on each side of the normal site of the uvula. The frequent movements of the soft palate retained the lateral cuts patent, so that a short uvular stump was constructed. In other cases in which the excision was close to the soft palate, the patient complained of tension in the palate; he was dissatisfied with his condition, and regretted the removal of his uvula. Therefore, since the uvula has the function in deglutition above mentioned, and probably has another in phonation, by which a nasal sound in speech is lessened or avoided, the entire removal of this appendage to the soft palate is an error; there should be left a stump, at least, two lines long.

The excision of the uvula is best done with a pair of curved scissors and long-handled clasp-forceps. The patient is to be so placed that when the mouth is well opened, the structures of the pharynx are brought well into view; the uvula is then seized near its end with the forceps, which are to be clasped so that they will not abandon their hold. The part is then to be drawn forwards in the median plane, and then to be excised so that the section will be at right angles to the part and there will remain a stump of which the sides are of equal length. The blades of the scissors should be sharp, so that they will cut and not crush, and, above all, will not let the uvula slip from them. The work must be done at one stroke; if done by two strokes, the remaining surface will be uneven; one side will probably be longer than the other. Hence in removal of the uvula, no rule deserves closer observation than that the excision should be done in one act.

If the uvula be enlongated through inflammation, as is often seen in pharyngitis, tonsillitis and sometimes in diphtheria, then an attempt should be made to reduce its volume by scarification and astringents. To scarify it, seize with clasp-forceps, and, with a pointed bistoury or scalpel, make a number of vertical incisions in the swollen tissue. As local application, a strong solution of tannin or alum should be applied directly, or the same may be used as a gargle when there is general pharyngitis. Should these means fail to return the uvula to normal proportions, then it should be removed in the manner just described.

When the uvula has been excised, there is slight bleeding for a few minutes; only exceptionally does this demand the attention which will presently be considered. A mouthful or two of cold water, as a rule, checks the bleeding. Within a week the wound heals, and during this time the patient may be directed to rinse his mouth and throat occasionally with a weak solution of borax or chlorate of potash.

As stated, exceptionally, the excision of the uvula may be followed by continued bleeding; two examples of this have been seen by the writer; in one the uvula was not inflamed and was removed to get rid of a troublesome irritation in the throat, caused by contact of the part with the base of the tongue. The patient was anæmic, feeble and sickly in appearance. The removal of the uvula was followed by very slight bleeding, so little, indeed, that at the time no attention was given to it, but on the following day the man presented himself in my office and stated that his "palate" was bleeding and had done so ever since

the operation. On examination there was found to be a large drop escaping from the wound as often as once in every two seconds, and the blood was arterial. This hæmorrhage had weakened the man, and it was necessary to resort to some hæmostatic procedure; the one chosen was ligation, which was done as follows: The stump, which had been left long enough to grasp, was seized with clasp-forceps, and then a silver wire was passed around the stump above the forceps and twisted enough to check the bleeding. The wire did not destroy the vitality of the small portion of the stump which lay beyond it. This ligature was allowed to remain in site for a week, when it was removed and no more bleeding ensued.

Bleeding occurred in a second case, in which the writer removed a uvula that was elongated, swollen and much inflamed. The subject was a plethoric one with a marked apoplectic habit. Some hours after the excision of this uvula the stump began to bleed, and continued to do so, until the writer was called, who found that there had been lost a considerable quantity of blood. The short stump which had been left did not permit ligation in the way in which it was done in the case just described. A circumscribing suture was passed by means of a needle through the structures around the bleeding surface; thus the bleeding was controlled, though some difficulty was met in doing the work: a fact which the reader will be fully convinced of, should he be forced to resort to either of the plans here mentioned, in an impatient, indocile subject, and whose restiveness is increased by the suspicions that his ills are due to an error or faulty work on the part of his surgeon.

Hence, as seen, though excision of the uvula is usually one of the minimum acts of minor surgery, it may, when hæmorrhage follows, rise to a place of no small importance in surgical handwork. And these exceptional cases are verifications of occasional experience, that the minutest breach in the human organism by a surgical instrument may be the opening prelude to an eventful drama. Even a simple suture may awaken a phlegmonous or erysipelatous inflammation which may devastate a wide field of the organism: ravages, however, possible of avoidance by timely care. As the arrow aimed at the smallest mark must be poised and directed with the greatest accuracy, so the minutest acts of operative work should be planned, done and afterwards cared for with scrupulous attention, and, especially, vigilance should not remit in the after-attention. This precautionary

precept finds apt illustration in the two cases of bleeding from excision of the uvula here cited.

Palatal Adhesion.—The soft palate may become adherent to the pharyngeal wall above, so that the choanæ or posterior opening of the nasal passages can be occluded; and such occlusion may be complete or incomplete. When it is incomplete, the adhesion may be unilateral, bilateral or median; bilateral adhesions are the most usual.

As causes which may induce palatal adhesion are the ulcerations which may originate from syphilis, scrofula and lupus. Paul of Breslau has collected thirty cases of such adhesion, of which twenty-six were due to syphilis; in the few cases seen by the writer, the cause was scrofula. Total adhesion is rare, but partial is not infrequent.

Such fixation of the soft palate causes interference with breathing and swallowing. In case of complete closure, respiration is greatly interfered with; the patient can only breathe through the mouth, a condition which is not only disagreeable, but it exposes the lungs to the action of cold air, which might be tempered with warmth if it traversed the nasal passages. Such total closure prevents the detachment and removal of the excreta which tend to collect in the nasal passages; the expulsive effort cannot be made by which such materials can be dislodged and expelled. Breathing through the mouth dries the tongue and the mucous membrane lining the buccal cavity. The voice is also somewhat changed.

In case there remain some opening, these several impairments of function are lessened in degree; the patient can probably breathe through the nose, which to him is a great boon; for patients, in whom the occluded nasal passages had been reopened, have assured me that to breathe again through the nostrils was one of the greatest pleasures: an illustration of the great value of a seemingly unimportant part of the body; but if once lost, such part perforce reveals its importance.

Palatal adhesion impairing, as it does, voice, taste, smell, swallowing and the power to clear the nostrils, demands surgical attention; the choanæ must be reopened. The work can be done partly through the mouth, and partly through the inferior nasal meatus. By the mouth one may enter, and with a blunt instrument similar to a raspatory, the separation can be effected. In case the adherence be extensive, it will be easier to do some of the work from above through the nose. For this purpose a blunt-

edged instrument with a handle curved similar to that of the palatal arch, may be passed into the nose and made to descend down the wall of the pharynx, and separate the palatal structures. In his student days the writer saw a case in which during the operation his preceptor, Dr. Cooper, cut a twig from a pear tree which stood near the window, and having trimmed one end into a blunt edge, this was carried along the floor of the nose until it reached the posterior cul-de-sac, when, being thrust onwards, it passed down the posterior pharyngeal wall, and soon appeared in the throat; and by further work with the happily improvised instrument, the palatal structures were liberated from their attachments. A piece of whalebone, similarly trimmed, might be used, especially if it be softened in hot water, curved and allowed to cool. No hæmorrhage attends the work.

The reëstablishment of the occluded posterior nares will be found a tedious procedure, and the subsequent maintenance of permeability will be a yet more embarrassing task; for, though the passage be well opened, without subsequent precautions it will quickly reclose. The position of the parts renders it impossible to invest the raw surface with a mucous coat, an indispensable requisite to prevent reclosure; hence the wounded parts must be maintained asunder until they cicatrize. To do this, carry along the floor of the nostrils a cord, to the distal end of which when seen in the fauces a plug of lint is fastened; thus a temporary tampon can be placed in the choanæ; and this must be done daily for many weeks. Finally, if this plan be patiently pursued, the part becomes invested with a cicatrized surface; and since scar tissue tends to contract, the introduction of the obturating plug must be continued for some time longer; and at length it need be introduced only occasionally, until finally the opening will remain permanent. The writer would suggest that the patient would be more tolerant of the work, as well as encouraged in its action, if the obturator were traversed by a tube so that the air could pass through it in respiration.

Destruction of the Uvula and Soft Palate.—Syphilitic, scrofulous, lupous and malignant disease, through destructive ulceration, may destroy, partly or wholly, the uvula, as well as the soft palate. In the unfortunate event that both these structures be totally destroyed, it is probable that no operation which the surgeon might perform could furnish relief; such cases would fall within the province of the dental mechanician; and it is probable that even his most ingenious device, though phonation, breathing and

smell might be aided thereby, would be found a poor substitute for the lost parts, and be a disappointment to the patient; still, such appliance is better than nothing, and probably better than what could be gotten through the essays of the surgical plastician; the work of the latter might, however, find place where the destruction had been incomplete.

CHAPTER XIX.

PALATAL CLEFT OR DIVISION.

PALATAL cleft may be congenital, or accidentally acquired. Congenital cleft may involve both the soft and the hard palate; or the division may be limited to one of these parts. And in each of these cases the cleft presents varieties. Thus, in the soft palate, there may be merely a division of the uvula; or the cleft may extend into and end at any point in the median line of the soft palate. Cleft of the soft palate occupies a median position.

In the bony palate the fissure may be unilateral, bilateral or median in site; and, in its extent, it may reach partly or wholly through the osseous vault. There is fissure in which the cleft in the hard palate extends partly, or wholly, through the soft palate; and also a cleft may reach through the soft palate and penetrate the osseous vault to a greater or less distance.

The unilateral osseous fissure is normally situated on the left side; and when incomplete, it occurs in varying grades, from that in which the alveolar process shows a slight depression, to that in which the cleft reaches nearly through the vault. The unilateral fissure begins in the portion of the alveolar process corresponding to the interval between the outer incisor and the canine tooth. And when the cleft is reduced to its minimum form, the only traces of it may be a slight depression in the outer face of the alveolar process; or it may be limited to imperfect form, or mal-position of the two corresponding teeth. The unilateral cleft, when it is extensive, is not confined to the side of the vault; in the soft palate the breach occupies the median line.

The bilateral fissure may only implicate a part of the palatal roof; or it may traverse the entire extent of the palatal structures. In the bilateral cleft, which, from the osseous structures which it divides, might be well named alveolo-palatal cleft, the united fissures resemble the letter Y, between the anterior branches of which lies the premaxillary bone. The premaxillary bone may

be nearly complete, and then contain three or four teeth; or it may be reduced to a rudimentary fragment; and finally, in the worst cases, the bone may be wanting and the Y-gap then assumes the shape of a broad I. The double-fissured cleft may be incomplete, posteriorly.

As rarer complications, there may coëxist a cleft in the bony palate, and also one in the soft palate; and the two are separated by a bridge of normal tissue. An osseous palatal cleft is usually associated with labial cleft; and the extent and gravity of the one has its correlate in the extent and gravity of the other, arising from similar causes; and the labial and palatal clefts often have many points in common.

The cleft in the soft palate is of V-form with apex in front. The base of the gap, when the parts are most widely separated, nearly equals the breadth of the soft palate; and the author has observed that the absence of tissue is often greater on one side than on the other. The tissue composing the sides may be of web-like thinness; or it may be of the usual thickness of the normal palatal veil; conditions which have a bearing on the success or failure of work undertaken for the closure of palatal cleft.

Besides the forms of cleft which have been described, there has been observed one which has a median position, since it lies in the anterior part of the sutural line of the superior maxilla. This is a mild form of malformation, since it lies merely between the middle incisor teeth and does not reach further back than the anterior palatine foramen. This median fissure may be associated with unilateral or bilateral cleft.

The osseous palatal cleft, whether it be long or short, may vary much in its breadth; thus the two sides may be so near that the mucous membrane of one side loosely touches that of the other; or the intervening space may be a quarter of an inch or more in breadth. The overlying nasal septum may overhang the vacant space, not reaching fully to the level of the adjacent palatal processes; or the septum may reach to and be attached to one of the lateral palatal processes.

Besides palatal clefts which are acts of nature and are congenital, there is another class which originates from disease, accidental violence, or from the invasion of surgery itself. From syphilitic or tuberculous disease, the soft and bony structures of the palate may be the site of breach or opening; also, such disease in parts adjoining, may extend, attack and open the palatal roof. The most frequent perforations from disease are those

caused by constitutional syphilis; a periosteal or subperiosteal gummy growth, situated on the superior or inferior face of the bony vault, may destroy and perforate the bone and soft parts: and the resulting breach will be greater in proportion as it is situated further backwards; for the palatal processes are so thick in front that they are seldom perforated by syphilitic disease.

The soft and hard palate may be perforated through accidental agency; and these clefts may vary as greatly in site and character as possibilities are permitted within the scope of chance; among such agencies may be mentioned the gunshot missile, the thrust of a sharp-pointed object, etc.; the most frequent is that in which the subject falls and thrusts such object through the palatal structures.

Perforation can arise from neoplasms which, arising within the nasal fossæ or the maxillary sinus, at length come in contact with, and finally pierce through, the palatal structures; and in this case the bony arch is oftener perforated than the soft palate; for the latter will yield and recede before the advancing growth; and perforation can only occur in cases in which the tumor is large, and the pressure has been long continued.

And finally, an opening may be made through the palatal structures, both hard and soft, as a pioneering route by which the surgeon may reach growths which exist within the nasal fossæ. This operative route is seldom chosen, since the resultant conditions are unfavorable to the successful closure of the opening in the palatal structures; and as the cleft remaining would entail much functional impairment, the surgeon, if possible, should avoid forming such breach.

Whether the palatal cleft be of ante-natal or subsequent origin, it is the source of much inconvenience to its possessor; even in slight grades of palatal cleft this is true. Integrity of the palatal structures is necessary for the proper accomplishment of suction, for the retention of food in the buccal cavity in the act of chewing, and thirdly, for well-regulated deglutition; also a perfectly formed palate is requisite for articulate speech and modulated voice; and its absence interferes with smell and taste.

The interference with the act of suction seriously obstructs the nutrition of the infant which is the subject of such malformation; in such an infant, the chances of living, or of reaching physical maturity, are much lessened. And when food is to be masticated, the escape of a portion of the aliment into the nasal

passages causes much annoyance. And, conversely, the broken partition between the buccal and nasal cavities permits the escape into the latter of the nasal and catarrhal excreta, of which the absence of suction prevents the normal dislodgment and elimination. Deglutition is faultily accomplished. Entrance into both the nasal and the air-passages is but imperfectly guarded against, and pulmonary affection might arise from nutrient material which has lost its way.

The functional impairments cited are slight when compared with those of phonation and articulation, for the patient has the privilege of concealment in regard to the former defects, but in respect to his voice, every word he utters reveals his defect, and tells the story of his malformation. The hollow nasal tone of his vowel sounds, and the ill molding and tripping utterance of his palatal consonants, are more disagreeable to the subject's ears than to those of his listener. That this is but a feeble glimpse of the subjective side of cleft palate is more than confirmed by the appeals for relief on the part of victims of such deformity. If the patient be an adult, as has been the case in some treated by the writer, his appeal for relief, though in words deformed in tone, accent and articulation, is eloquent enough to enlist in his behalf both the heart and hand of the surgeon. In such a case, Roux, the pioneer surgeon in this work, has recorded his experience in touching lines.

Before describing the means which may be used for the relief of cleft palate, a brief reference will be made to the causation of the deformity. The origin of congenital cleft palate, like that of labial cleft, is referred to an imperfect development of the primitive elements of the embryonic face. At the fifteenth day of fœtal life, as before stated, there are to be found three parts which are destined to form the future face, viz., a superior or frontal plate, and on each side of this a labial or mandibular plate; this lateral plate or process is first single; later it divides into two parts, of which the lower branch uniting with a similar portion from the opposite side, becomes the lower jaw and the lower lip; but the upper part of the lateral bifid plate, destined to form the upper jaw, does not fuse with its opposite fellow. About the twentieth day, there are seen two processes proceeding from the frontal plate, which, descending, form the incisive, or premaxillary bones. And soon afterwards, there springs from the frontal plate a process which is the future vomer, or septum separating the nostrils; and this vertical process is met by two

horizontal plates from the superior maxilla, which become the palatal plates, and separate the buccal from the nasal cavities. Continuous posteriorly with these horizontal palatal processes, there is developed the soft palatal veil. Soon afterwards, ossification of the future upper jaw commences by four ossific centres: one for the malar portion, one for the palatal, one for the canine, and one or two for the incisive portion. Of these four portions the incisive is the one which has been specially observed, on account of its bearing on hare-lip and cleft palate; this incisive portion uniting with its fellow of the opposite jaw, there is formed the premaxillary, sometimes called the intermaxillary bone. This bone occupies the triangular space of which the apex is at the anterior palatine foramen, and the base forms the median section of the alveolar process. The origin of cleft in these structures is thought to occur as follows: Let there be an arrest of development of the canine piece and the intermaxillary bone, and unilateral fissure will result; and let there be such arrest on each side, and bilateral cleft will arise. And, again, let the development of the horizontal palatal processes be checked, and a fissure will remain between these parts; and such fissure may be a continuation of the anterior unilateral, or bilateral fissure.

The causes which have been assigned for the arrest of development of the palatal and alveolar structures lie rather in the domain of plausible theory and conjecture, than within the range of ascertained facts; they remain as problems to be solved by the future teratologist.

As has been stated in respect to the labial cleft, so in the case of the palatal cleft, it seems that the causes which led to arrest of fusion may be suspended, and the parts may resume their normal growth, and proceed to perfect development; that is, a cleft that has formed in intra-uterine life may close before birth. And continuing the comparison with the lip, as in the latter a cleft may close after birth, so a palatal cleft may vanish through late closure. Trélat saw a man in whom a congenital palatal cleft had closed when he was twelve years of age. Yet intra-uterine as well as post-natal spontaneous closure is a rare event; and the hope of relief in this wise is so seldom realized, that if it be indulged in by the parent and physician they may, like Œsop's traveler, wait long on the river's bank expecting its waters to run away.

Treatment.—The methods which may be resorted to for relief

in cleft palate are mechanical and operative. The mechanical method consists in the employment of an obturator by means of which the opening is occluded. Such obturators, in manifold forms, have been constructed by those who have given study to this subject. The difficulty encountered in this work is in that part of the device which is destined to maintain the obturator in site. This has been attempted by wing-like or arm-like processes, which pass into the superjacent nasal passages, and thus hold in suspension the occluding part. Or the suspension may be done by lateral springs which rest in the nasal passages. The fixation may also be effected by the aid of hooks and clasps, which are attached to the teeth or alveolar processes. In case of a rounded or oval breach, the closure has been accomplished by means of a device similar to a double button, and which resembles the modern sleeve-button.

These obturators are constructed of India rubber or gold; also, for this purpose aluminium might be used; and this metal commends itself by its lightness. An important requisite which these contrivances should possess, is that they should be securely fastened in their position, and thus the bearer secured from all peril of swallowing them. The unending task of caring for such device is a serious objection to it; hence, the aid of surgery is often sought by the unfortunate subject of palatal cleft.

Inasmuch as the work of closing the breach in the soft and in the osseous structures is different, it will be more convenient to treat of each separately, and, thus proceeding, the closure of cleft in the soft palate will first be considered.

The pioneer in the closure of cleft palate by operative means was Roux, who performed his first operations in 1819, and he thought, at the time, that he was the first one to do the operation; this, however, was an error, since he had been preceded by the elder Graefe, whose operation, though a failure, was done in 1816. The method of Roux was the better one, and was so acknowledged by Graefe. A further investigation of the subject has brought to light the fact, that the operation of closing the soft palate by suture was proposed to the French Academy in 1779 by Béziers. Priority here, as elsewhere, has proved a Protean entity, a flitting fugitive, which, though sought and temporarily possessed by rival claimants, has in the end escaped their grasp and fled to other hands. Such emulation, however, should be commended, since it is of generous source and is inspired by justice to give the palm to him who has earned it. Gold too

often finds its way to the hand of him who has not earned it; the curators, by which the field of science is vigilantly guarded, do not permit such wrong; the earner is secured in his earnings, often through the mutual aid of his competitors.

Staphylorraphy, which signifies sutural closure of the soft palate, was a name invented and given by Roux to this operation. As a surgical procedure it is tedious, delicate, and for successful termination, it demands some degree of experience: the first essay of the operator is commonly a partial or complete failure.

Before describing this operation, it is proper to advert to certain procedures in which closure has been attempted, and sometimes attained by plans which may be called non-operative. Among these may be mentioned the plan of cauterization, which was practiced by Cloquet. Observing that contraction followed burns, in 1855, Cloquet counseled to use this means for the closure of palatal and labial clefts in subjects who are unfit for plastic operation. Cloquet does not cauterize the entire cleft but only the angular end of the same: and this being repeated a number of times, the effect is similar to a number of sutures. In this way, as early as 1826, Cloquet cured, by means of twenty cauterizations, a palatal cleft which had arisen from constitutional syphilis. Afterwards, in another case, in which the cleft, having been closed by sutures, reopened, the opening was closed by repeated cauterizations. In this manner, a palatal cleft of traumatic origin was closed by Nélaton. The objection to this method is that it requires so long a time; but the advantages claimed for it by Cloquet are that it is attended by slight pain, and the patient, during treatment, need not suspend his business. To do the work, the galvanic cautery, the hot iron or the potential cautery may be used. Cloquet employed the nitrate of mercury. Some years ago, this plan was used by the author to complete closure in a case of cleft palate in which sutural closure had been but partially successful; the ferrum candens was employed, and the cauterization repeated a number of times, at intervals of two or three days; thus proceeding, the breach was lessened but not wholly closed. It is important in this work to cauterize only the angular end of the cleft.

Spessa, in 1844, announced that he had cured cleft palate by simply paring the edges of the opening, and then repeating this every fifteen or twenty days; and Spessa advises that the same be done to close hare-lip or vesico-vaginal fistula.

Near the same time, Dieffenbach advised to close small clefts by applying to the margins of the breach the tincture of cantharides; and this should be repeated as soon as the vesicated surface has healed. Other surgeons report closure in this way; and it seems that it was chiefly resorted to in cases in which an operation to effect closure had not been wholly successful.

Staphylorraphy is an operation for the closure of a palatal cleft which is limited to the soft palate; and the work would be of a very simple order, were it not for the almost unapproachable site of the parts which are to be operated on. The operation, in its simplest form, consists merely in trimming the opposite borders of the opening, and then coaptating and holding these together by suitable sutures: surgical acts so simple, if the breach were on the outside of the body, that they would not deserve mention, much less would they merit a special name. But this breach lies in the inmost recess of the alimentary vestibule, to which light has not ready ingress; the fragmentary structures are well supplied with sentient and motor nerves, so that when touched on either their buccal or nasal side, they are thrown into spasmodic contraction, which may be propagated downwards to the stomach, and provoke vomiting; and finally, an almost insuperable difficulty may be encountered in the scantiness of the structures; too short, in fact, to form a complete bridge across the gap. Hence, the energies of mechanical invention have been stimulated to devise means to overcome these obstacles; and among these aids may be mentioned gags, tongue depressors, palatal supporters, specially contrived needles, needle-holders, sutures, suture-clasps and sponge-holders. Myotomy and lateral incisions have been made tributary allies in this surgical work.

An important preliminary is to so discipline the palatal and pharyngeal structures that they will yield quiet obedience to the attacks made on them. The reflex sentinel who awakens these parts to their destined automatic action, must be made to temporarily sleep on his post; and this is done by so multiplying the movements of the parts that they finally cease to act. This is brought about by often touching the parts with some irritating object. The adult may do this himself, but if the patient be a child, the parent or nurse can do it. As instrument for this irritation, two or three stiff feathers may be tied together, and the plumed end employed; or the work can be done very successfully with a small tooth-brush. If such preliminary training be dili-

gently continued for a couple of days, the reflex movement will be so subdued that it will not interfere with the operation.

Though the cleft may quite divide the soft palate, yet sometimes there is an amplitude of tissue to quite close the gap, without tension. In these cases, in the act of swallowing, the two sides approach and touch each other. Such was the character of a cleft in a young Canadian physician, who applied to Roux in 1819 for treatment of his real formation;. the operation was a successful one, and Roux added another name to surgical nomenclature by naming the work done, staphylorraphy. And it is in cases of this character that the operation promises the best results.

When should the closure of congenital palatal cleft be done? A citation of the opinions given in answer to this question would burden the reader with confusing differences; some would do the operation when the child is a month old. Ehrmann operated when the child was five months of age; some would do it any time during the first year of life; Billroth and Owen would operate when the child is three or four years old; Trélat operates after the subject has reached puberty. Hence the surgeon finds authority which sanctions the operation at any age. The mortality which has followed the work done on young infants shows that early operations are very fatal. The condition of the child's health should be considered quite as much as its age. This rule was enjoined by Thos. Smith, who states that in a series of fifty infants which were brought to him for operation, he selected not more than one in eight of the number. This is an important rule to be observed, not only in the operation for cleft palate, but in all other surgical operations on infants; the feeble, sickly, emaciated and ill-nourished infant will generally succumb to the surgeon's knife; to such should be accorded the right which Dupuytren chose for himself, when, in declining an operation for empyema, he said that he "preferred to die by the hand of God rather than by that of the surgeon." The child, however, which is in robust health, will readily bear the operation, even though it be done in the early months of life, and this vigorous health, rather than months or years, best indicates the period suited for the operation. Staphylorraphy is extremely difficult to do in the infant, in consequence of the small space in which instruments must be used.

As instruments there are required a mouth-gag, a knife or scissors for trimming, clasp-forceps to catch and hold the margins of

the cleft, sharp, strong, curved needles and a needle-holder, fine gilded or plated copper wire for suture, small sponges and sponge-holders, and ice water.

As gag or instrument to retain the mouth open, that of Smith is most commonly used. This depresses the lower jaw and tongue, and retains the mouth well open. It does, however, more than this, it forces the tongue backwards; and this is a serious defect of the instrument: so much so that in using it, the author has been compelled to attach clasp-forceps to the tongue, and thus draw the latter forwards during the work. And to avoid this, the writer would use the interdental gag, which has already been mentioned in the chapter treating of excision of the tongue. The wedge-shaped portion of this gag has a hollow face above and below, so that it can be inserted between the upper and lower jaws, and thus the mouth is retained fully open. Another similar contrivance is one in which to the inserted wedge is fastened a strap which ends in a short hook-shaped retractor; this adjustable strap is carried behind the head, and the retractor hooked in the angle of the mouth. This instrument is self-holding; yet it requires attention, lest the interdental portion slip and allow the jaws to close. Simon of Prague, who recommends an early operation in the child, sometimes used a mouth-dilator which is always accessible, viz., the finger of an assistant, which, inserted into the mouth, retained the latter open. The writer fears that precept here was not illustrated by example.

A scalpel with short blade and a long handle, or long-handled scissors, are needed to trim the edges of the cleft. The short blade of the knife should have a straight edge, and end in a sharp point. The scalpel is better than the bistoury. Some operators prefer to trim with scissors, claiming that the raw margin can thus be made straighter than with a knife. Long-handled clasp-forceps must do the work of seizing and fixing the free border in the work of trimming. Short, rounded needles, with moderate curve, are needed to carry the sutural material; also a needle-holder, to carry the armed needle. There are several patterns of this instrument, and, in its stead, one may use clasp-forceps to carry the needle. Instead of the needle and holder, the two may be combined in one instrument, consisting of a long handle and curved and shaped as a needle, with eye near the point. The handle and needle portion are in one common piece; or the needle portion may be separable from the handle-bearing part, so that it can be screwed on, and unscrewed,

as required. Instead of this, a tubular needle is used by some operators; this is hollowed through the handle and needle portion, so that the sutural material can traverse it, and be protruded to the extent which is needed. The hollow needle carries wire. The objection to this instrument is that the needle portion must be thicker than a common needle, to insure against breaking. Langenbeck in 1860 announced that he used a long-handled needle which was fashioned after the form of Bellocq's naso-pharyngeal canula. The tubular portion had a sharp needle-like end, which was passed through the edge of the pared margin, when the contained spring was thrust out, and the thread fastened to this and drawn through the edge. With such an instrument Langenbeck found that he could introduce the sutures with great rapidity. A fault of the hollow needle is that it makes an orifice much larger than the thread or wire which it conveys; thus, cutting on the part of the suture is favored.

The material for suture may be wire, silk or horsehair. Silk is less used than formerly. Though horsehair is highly advocated by those who have used it, yet it is not in general use. Silver wire, or copper wire that has been coated with silver or gold, may be employed. Leaden wire was used in the early palatal operations; it soon fell into disuse. The writer prefers gilded copper wire, since it is stronger than pure silver wire, and hence, finer thread of the former can be used. The difficulty in the use of silk is to tie it closely, so as to hold the parts in contact. Tying a knot in the bucco-pharyngeal recess is not easily done. But the inserted wire may be closed by twisting the ends together; and the final tightening may be done with clasp-forceps. Or the wire may be closed by means of a wire twister; an instrument with a figure-of-eight end. The sutural closure should not be too tense, lest the included tissue be so constricted as to die; and then, though union of the sides may be obtained, small openings will be left at the site of the sutures, which will require some time to heal.

If one examines the history of staphylorraphy, he will find described many more instruments which have been devised and used in the work; in fact, the writer has mentioned but a minimum of those which have been invented; yet those here described, when their use has become facile through experience, will be found sufficient. The patient who has fasted for eight hours must be placed in a recumbent position, with the shoulders somewhat uplifted, and the face so turned backwards that when

the mouth is dilated the light will fall on the palatal roof. The patient should be so placed that the light can enter at the side of the operator, rather than from behind. To illuminate the buccal cavity, light, artificial or solar, may be reflected into the cavity by a mirror properly placed.

Children, and also adults, should be anæsthetized; only exceptionally in the adult, who prefers to be a witness of his operation, may this rule be dispensed with. Yet there is not unanimity of authority on this point. In 1868, in the Royal Medico-Chirurgical Society this subject was discussed by the members. Smith and Annandale advised anæsthesia; others opposed it; Prescott Hewett reported that he thus lost one case. And the same occurred to Langenbeck, the patient dying from the blood passing into the air-passages. And in another patient, Langenbeck barely saved life by performing tracheotomy and sucking out the blood that had escaped into the bronchi. Despite these accidents, the custom is to anæsthetize the patient, and with due care in spraying out the escaping blood with sponges which have been dipped into iced water, the bleeding will be controlled, and but little blood will escape downwards.

The mouth being retained open by the dilator, the surgeon seizes the margin of the cleft on the patient's right side, near the middle of the border, with clasp-forceps, and holding this in his left hand, and having drawn so as to make the part tense, he inserts the point of his angular knife near the forceps and then trims off the entire border upwards and downwards from the uvula to the summit of the cleft. And the same must next be done on the remaining side. Particular care must be used to trim the anterior angle, since a fragment of mucous membrane remaining would obstruct the desired closure. The lateral trimming should be done slopingly, one side inclining forwards and the other backwards; thus done, broader and congruent marginal faces are formed, adapted for union. After the marginal excision, the remaining raw surface will broaden through the retraction of the divided mucous membrane. Such retraction may be due to the recoil of the mucous membrane which has been displaced towards the median line, by the traction done with the clasp-forceps. In place of grasping the margin of the cleft, the uvula may be seized with forceps and the parts thus drawn in any direction most convenient to do the trimming. Instead of grasping and fixing with forceps, Thiersch and Le Fort pass threads through the parts of the cleft uvula; and these threads may be

held by an assistant, and thus each side can be drawn on as is needed in the work.

In the marginal trimming the operator must suspend his work, every minute or two, to permit the assistant to sponge out the blood. This is done with small sponges carried by special holders or clasp-forceps, the sponges being cleansed and cooled in iced water. Thus proceeding, there is no danger of much blood entering the air-passages. Though these interruptions prolong the operation, they secure against coughing and asphyxia. The writer, who has seen palatal closure done by Sir William Fergusson, was often an admiring observer of the tireless patience of this veteran surgeon; not unfrequently, the operation occupied a large part of the short afternoon of winter in London; his standing remark to his class was, "Those who wait to the end of this operation deserve a premium." Yet it was this patient work that enabled Fergusson in 1885 to record fifty-six operations with but two failures.

In the case here supposed, in which the sides can easily be united without lateral incisions, or division of the palatal muscles, the operator next proceeds to the introduction of the sutures; and, as already mentioned, these may be passed with a long-handled needle, or with short curved needles, carried by a holder. The operator will do well to learn each of these ways, since one is sometimes more convenient than the other. To use the long-handled needle, of which the eye is near its point, let the wire enter the eye on the curved side of the needle; for if thus inserted, after the needle has carried the wire through the margin, the wire can be caught with a tenaculum, and withdrawn from the needle. But if the wire be passed through from the convex side, then its extraction from the needle will be much more difficult, since after passing through the tissues, it will lie on the side of the needle farthest from the operator.

The needles which are carried by a holder should be round and of annealed metal; if more fragile needles are used, they may break in being forced through the palatal structure. The wire used should be at least two feet long, it should have a needle on each end, and after being passed through the needle, the wire should be so twisted that it cannot escape from the needle's eye during the passage. Some practice is needed to grasp the needle with the holder in such a way that the former can be made to pass properly through the margin; to do so, let the needle be grasped so as to form an acute angle with the holder; and thus

held, let it be passed from the nasal side, and emerge on the buccal face; and then the needle on the other end of the wire must be passed through the opposite margin. The two needles being removed, the ends of the wire are carried over the patient's head, and temporarily twisted together. This first suture should lie near the anterior angle of the cleft; and it is the most difficult one to place. The remaining sutures are to be passed in a similar manner, at intervals of a quarter of an inch, from the anterior portion of the breach to its uvular ending; that is, the work should proceed from before, backwards. Three or four sutures are commonly sufficient to effect the closure of a cleft which traverses the entire soft palate. The wires are next to be closed in the order in which they were introduced from before backwards; the closure being best done with a wire twister. This closure should fully coaptate the two sides, which, in the case under consideration, contain material enough to unite without tension. And the sutures being closed, the wire is to be severed, and the ends of the suture bent to one side, so that they will lie close in contact with the wall above. If there be observed gaping between the sutures, this may be closed by a more superficial suture, which is inserted by means of a needle that is much curved, and made to traverse and include both sides.

The operation being done, the patient should be placed in bed and remain quiet for a few days. The food used should be liquid, or such as can be swallowed with the least effort. The buccal cavity should be cleansed every few hours; and for this purpose mint-water may be employed; the patient if intelligent may do this himself. No effort of gargling must be made. The work of cleansing may be done by means of a syphon-like irrigator, by which a fine stream of fluid may be brought into the various recesses of the buccal cavity. In children, irrigation is the most convenient way of doing this work. Speech is to be restricted to whispering; and this limited to the words, *yes* and *no*.

In respect to the time when the sutures should be removed, authorities differ, the time given varying from four to ten days. From the writer's experience, sutures should remain longer in the child than in the adult; in adults, the removal can usually commence on the fifth day, when every second one may be withdrawn, the work beginning with the second one from the uvular portion; the remaining sutures may be removed about the tenth day. In children, the writer leaves some of the sutures a much longer period; and none should be removed before a week has

elapsed. If the child be refractory, care must be taken lest, in the act of withdrawal of the wire, some restive movement may tear apart the united edges; but if a long time has elapsed, then the union has probably become so firm that there is little peril of separation. In a few instances, the writer has allowed some of the sutures to remain in place for a month; in one case they remained a still longer period. Sutures permitted to remain a long time, should be cut short. Sutures which are thus allowed to remain, by their presence excite some irritation, which lessens, and tends to close the separated spaces. To remove the suture seize it by the twisted portion, divide the wire on one side of the twist, and then, drawing on the latter, the wire will easily be withdrawn.

The sutural union as above described, suffices for all cases in which there is an amplitude of tissue; frequently, however, the structures are so defective that, after being pared, they cannot be juxtaposed; or, if it be possible to unite them, the parts are so tense that the soft palate cannot perform its normal functions in the acts of swallowing and speaking; for in such tense state, in deglutition, the materials can enter the choanæ; and in speaking, the tone of the voice is nasal in character. Hence, to lessen these functional defects, certain collateral steps or procedures are sometimes resorted to; and these may precede, accompany or follow the sutural closure.

To avoid or lessen tension, Sédillot, who has studied this matter, finds that it has been done in one of the following ways: 1. Lateral incisions were made by Dieffenbach and Liston. 2. Mettauer, of Virginia, made four semilunar cuts, six lines long, curved externally, on each side of the palatal opening. 3. Warren divided the anterior pharyngeal arches; others, however, divide the posterior pillars. 4. Fergusson divided the muscles above the soft palate, viz., he severed the levator and tensor palati muscles, and this was done by a knee-shaped knife, which is passed above the palatal veil, and caused to cut from above downwards on each side; and when this is done, the soft palate remains motionless. In this section, Fergusson left the surface of the soft palate intact. Sédillot favors a combination of the methods of Fergusson and Warren; after such section, one is surprised at how much the existing breach is narrowed. Sédillot advises that the division of the muscles precede the trimming of the borders.

Smyly divided the muscles on the nasal side of the soft palate;

his method, announced in 1862, was to pass a long-handled knife along the floor of the nostril, the blade resting at the hamular process of the pterygoid plate; then, while the finger presses up the soft palate from below, the knife divides all the muscular fibres which act on the soft palate.

Instead of severing the palatal muscles, Gay, in 1852, loosened and dissected up the soft palate from the bony palate.

To quiet the palatal muscles, Pitha made an incision in the soft palate itself; this he did by inserting the knife near the hamular process, and cutting thence forwards and inwards, until he reached the long arch.

Besides these adjuvant incisions of the arches, and division of the palatal muscles, if sufficient laxity of parts is not obtained, one may make lateral longitudinal incisions through the sides of the soft palate, near the lateral attachment of the soft palate; such incision was done by Sédillot, and many other operators; and the writer may add that it is his custom to make such lateral incisions in nearly all cases. These cuts, one or two, may be made on each side, and they may reach quite through the velum; or, as Friedinger advises, these lateral cuts may reach but partially through. To maintain these cuts open when they reach through the velum, the writer and others have inserted in them plugs of lint, which were allowed to remain in place for a few days. To relieve tension, one or more of the plans mentioned may be employed; but to correct the defects in phonation which are often found to remain after the operation of staphylorraphy, certain corrective procedures have been advised; but before describing these, the nature and cause of the vocal defect should be treated of.

According to the studies of Czermak in this field, speech of normal sound demands a temporary closure or separation of the nasal passages from the bucco-pharyngeal cavity; and this closure is done by the soft palate. During the production of nearly all the articulate sounds, the choanæ must be shut; in the formation only of the nasal sounds, *m*, *n* and *ng*, must the choanæ remain open. The remaining sounds, both vowels and consonants, require for normal expression the complete closure of the choanæ; and if such closure does not exist, all the sounds are of nasal character. And this is most apparent in the sounding of the labial, lingual and palatal consonants. And in case of extensive labial clefts, the sounds of *e*, *g* and *z* cannot be correctly formed: *r* is changed to *erl*; *p*, *q* and *t* lose their sharpness, while the

vowels are not pronounced clearly and distinctly. And if there be a cleft through the hard palate, this interferes more with articulate speech than does a cleft through the soft one. The subjects of such defect become timid and prefer silence to speech; their language is limited and monosyllabic.

The closure of the cleft in the soft palate where the defect has been limited to that part, has often disappointed both the patient and the surgeon; in fact, this disappointment has sometimes been so great that the patient has asked to have the closed parts reopened.

In order to improve phonation Billroth operated at an early age; he found, however, that the voice was not thus materially improved.

Trélat taught that the subsequent improvement of the voice depended much on the antero-posterior diameter of the pharyngo-buccal cavity; if this diameter be short, the improvement will be much less than if the diameter be a long one. These conditions, whether favorable or unfavorable, are unchangeable, and must be accepted by the operator.

Passavant, who made this subject a matter of research, announced, in 1863, that defective phonation was due to the palatal tension, and the inability to close the choanæ; and as corrective means, Passavant advised to effect adhesion between the palatal veil and the wall above; he recommended to form adhesion between the median portion of the soft palate and the wall of the pharynx, so that only small orifices may remain.

Bearing on this subject Pitha made the observation that the voice was materially improved in a patient in whom there was accidental closure of the choanæ. Pitha further concludes that the uvula performs some part in the production of voice, and hence, in his operations for closure of cleft palate, he preserved the uvula; or if this part did not exist, he endeavored to form one.

Mason, an English surgeon, to improve the voice after closure of the cleft palate, cut away the soft veil from the pterygoid processes, on each side, close to the hamular process; the intention of such section was to allow the closure of the choanæ by the pendulous palate.

To improve the condition after staphylorrhaphy, Langenbeck, in 1885, advised to apply electricity to the parts, and to practice massage of the throat, and in the latter work the fingers must be introduced into the throat, and the structures rubbed and kneaded.

After the staphylorrhaphic procedure has been done, should the work not have been wholly successful, and one or more gaps remain, the operator should not hasten to repair these defects; for undue haste, through the reopening of the points of adhesion, may lose what has been gained. But after three months have elapsed, such remaining gap may be trimmed and closed by suture. If the opening be small, closure may be attempted by cauterizing with the hot iron, nitrate of silver, or by cantharidal vesication.

In the case of cleft in the soft palate which has been acquired by wound or disease, closure may be attempted by some of the methods described for closure of congenital cleft. If the breach be a wound, of which the edges are raw, closure may be done by simple suture; but if the wound has cicatrized, leaving an opening, pare the borders of the latter and unite by suture. But when the breach has originated from disease, an attempt at closure should not be done until the tissues around the opening have become sound or freed from any scrofulous or syphilitic taint, which has been the cause of the palatal perforation. If the cause be syphilitic, which is the usual one, the patient must first be submitted to a course of appropriate treatment for a number of weeks, until the disease has yielded; then such operation can be done with a prospectively successful event. If there has been but little loss of structure, the work can be done by trimming and sutural closure; but if the breach be a greater one, then lateral incisions must be made, on one or both sides, so as to admit of free movement towards the median line.

The lateral incisions which are made to aid in the closure of congenital or acquired palatal cleft, should, in most cases, reach quite through the soft palate, and must be from a half inch to an inch in length, and should be made near the lateral, attached part of the pendulous veil. In some cases the writer has made these liberating cuts after sutural closure of the breach; for if thus done, they may be incised where there is the greatest tension.

The lateral subsidiary incisions in the soft palate soon close; and so rapid is this healing that some operators have maintained them patent for a time by means of plugs of lint inserted in them for three or four days. There is no danger that these openings will not heal; for plastic nature, so tardy in the median line of the palatal vault, redoubles her effort to repair breaches along the sides of the roof of the mouth; she seems indulgent of a central breach, but cannot tolerate a lateral one, and the impor-

tant principle here figuratively expressed is the underlying groundwork on which rests the chief operative procedures resorted to for the closure of clefts through the long palatal vault: procedures to which the reader's attention is next directed.

Uranoplasty.—Uranoplasty is derived from *Ouranos*, signifying the sky or firmamental vault, and *plazein*, to mold; and the procedure dates from 1824, when Krimer, a German, made the first effort to close a breach in the osseous vault. The operation was done on a girl eighteen years of age, in whom Krimer dissected up two lateral flaps, turned them over, and shifted them over the gap. The work was only partially successful. Near the same time, Dieffenbach performed a similar operation with only partial success. Dieffenbach proposed to divide or split off a portion of the bony roof, and push this into the opening. This operation, as well as another one proposed by Dieffenbach, in which the palatal bones should be united by silver wire, seems never to have been done by him. In 1850 Bühring wrote that he had performed such an operation for the closure of a cleft which was two-thirds of an inch wide; following Dieffenbach, whom he cites, Bühring split off the margins, and forced these towards each other by means of lint, which was stuffed in the lateral openings. As Bühring had neglected to pare the edges, there was no union until, at a later period, he trimmed the borders, reopened the lateral openings, introduced waxed silken sutures, and thus succeeded in getting closure. In the same year, Wutzer published an account of similar operative work; he announced that, in 1834, he had closed the bony palate in a young man as follows: cuts which exposed the bone were first made antero-posteriorly, two lines from the border of the cleft, and then a knife was thrust through the soft palate at the junction of the latter with the osseous palate. Through such orifice made on each side, a small saw, made from the mainspring of a watch, was passed and the bone sawn through from behind forwards. Through the lateral clefts thus made with the saw, strong threads were passed and tied so as to approximate the long bony bridges. In this way partial union of the bridges was secured; the gaps which remained were made to close by means of tincture of cantharides. In this manner complete closure was obtained, yet phonation was not much improved.

Roux, who had done so much in the field of staphylorraphy, at an early period, announced five uranoplastic operations, of which three proved successful. Uranoplasty, first proposed and

done on German soil, was cultivated and attained great perfection in the hands of Bernard von Langenbeck, who published, in 1860, an exhaustive account of his method. He first reviews the method of Dieffenbach of splitting off parts and sliding these inwards; also, his own efforts to close the breach by uplifting and displacing inwards the palatal mucous membrane; but the unsatisfactory results gotten by these ways of operating, led Langenbeck to try a third method, in which he used, as reparative material, the muco-periosteal covering of the hard palate. He was emboldened to try this plan from having observed that the detachment of the periosteum does not endanger the life of the uncovered bone; also, that tissue, which is invested with periosteum when placed on naked bone, will adhere to it; and finally that when tissue is shifted which carries periosteum, the latter will produce bone in its new situation; and thus the new bone will fortify and strengthen the transplanted structure. In his first essays, from the want of proper instruments, Langenbeck was unsuccessful; later he was more fortunate, when he was armed with the following instruments: (1) Blunt hooks to pull back the angles of the mouth. (2) Mouth mirror and tongue-depressor. (3) Long-toothed forceps. (4) Assorted knives, one lance-shaped, one with a convex edge, and a third one of sickle-shape. (5) A raspatory. (6) Elevators. (7) Needle-holders. (8) Thread of different colors. (9) Thread holders to hold and separate the threads which have been passed. (10) Sponges, syringes and forceps.

This armament of instrumental equipment is greater than that used by many operators; the mouth mirror and tongue-depressor were not used by Dieffenbach, who says: "One must seize the proper moment, as he who would shoot a swallow on the wing. And hence, one must not use corks which are forced between the teeth to hold the mouth open; nor should the tongue be depressed with spatula or handle of a spoon, in order to see better and have more room to work in."

Langenbeck begins by seizing the uvula, or side of the soft palate, and then he trims off the border from behind forwards. Trim from without inwards, since thus more of the mucous membrane will be removed. Next, the levator palati and the palato-pharyngeus muscles are to be severed; the latter is incised by a cut, which penetrating near the hamular process cuts from without inwards and forwards. This incision avoids the posterior palatine artery. The hard structures which invest the

bony roof are next to be divided on each side by an incision which passes along the alveolar process close to the teeth and reaches to the bone. These lateral cuts begin at the incisions that were made to divide the muscles; and they terminate at the interspace between the inner and outer incisor teeth. Or if the closure can be accomplished by one lateral flap, let this end in front at the space between the outer incisor and the bicuspid tooth. The bridges are a third of an inch wide in front; and the palatal artery enters them behind. The bleeding that follows can be arrested by pressure or cold water. Next detach this bridge from the bone, commencing in front; and in the separation be sure that the periosteum is uplifted. The detachment of the structures is easily done behind; in front it is tedious, and must be done cautiously.

When the detachment has been completed to near the posterior edge of the osseous roof, the posterior or upper mucous covering of the velum is to be divided, and the separation of the parts is then to be continued until the swinging bridge is quite detached from the horizontal palatal plate; and when this is done, the bridge swings freely and the two are actually in contact. The sutures are next inserted, of which the number may vary from ten to twenty-two; and these must be introduced from before backwards. Langenbeck begins to remove the sutures on the fourth day, and finishes on the tenth day.

After the operation the patient is to be fed on liquid food; and to allay thirst ice may be given.

Gangrene occurred in no case. There was much swelling of the shifted structure, so that the lateral vacant spaces were nearly covered on the day following the operation. This swelling was due to the tumefaction of the uplifted periosteum. And in no case was there necrosis of the bone. The periosteum of the shifted structure, which was placed on the inner edge of the gap, seemed to quickly adhere to the subjacent bone; and this adherence tended to lessen the cleft, in case the bridges failed to unite in the median line. New bone was produced from the periosteal surface of the flap that covered the cleft; such new osseous growth was verified in two cases, which had been operated on by Langenbeck.

Langenbeck urgently insists that uranoplasty should be done before staphylorraphy; also that staphylorraphy should not be done in infants, since, through its interference with swallowing, nutrition is interfered with. Two children, between one and a

half and two and a half years of age, operated on for closure of the soft palate, died from not taking food; uranoplasty might be done at an early age, since it does not seriously interfere with swallowing.

Uranoplasty gave much improvement in speech; and this was much greater if the operation was done before twelve years of age.

Soon afterwards, Langenbeck reported forty-two operations of uranoplasty; in some of the patients the cleft was wide, being an inch or more in breadth, and the sides stood nearly vertical.

In some of the patients, he let one lateral incision end at the inner incisor tooth, and the other at the canine tooth. Having found that the swinging bridges often sank too low when the sides of the cleft were vertical, to correct this, Langenbeck resorted to the device of intermediate attachment; this consisted in leaving the flap adherent to the bone adjacent to the first molar tooth. Such a peduncle of adhesion on each side, prevented the excessive swaying downwards of the swinging bridges.

Both silk and silver sutures were used; yet preference was given to silk.

In some cases, in which one or both sides of the palatal bones stand vertical, Langenbeck varied the operation somewhat from the plan above given; in place of lateral peduncular attachment, he made an attachment to the vomer, which, for this purpose, is to be denuded, so that the uplifted flap can be sutured to it. This may be done on one or both sides, according as one or both palatal margins lie in vertical position.

As has been mentioned, Langenbeck let the uranoplastic operation precede that of staphylorraphy in children; but in adults he advised that staphylorraphy should precede uranoplasty.

Langenbeck claimed that operations in which palatal closure was done materially improved the voice; and that the improvement continued until the lingual defects nearly disappeared.

Soon after this publication, the English surgeons claimed that a similar operation had been done by them: Hulke asserting that both Fergusson and Pollock uplifted the periosteum along with the mucous membrane, in the flap that was used for closure of the palatal breach. But while these discussions in regard to priority were in action, Fergusson resuscitated the abandoned method of Dieffenbach, in which, on one or both sides of the cleft, portions of the palatal bones are split off, and moved median-wards into the breach; and in 1876 he reported fifty-six

operations, in which there were but two failures; and the announcement of this successful work gave favor and fashion to the osteo-plastic procedure. A plea in favor of this procedure is that it dispenses with the tedious dissection of the muco-periosteal tissue. And if the cleft reached through both the soft and the hard palate, the closure of both was comprised by Fergusson in one operation.

To perform this operation, the work begins with paring the edges of the cleft along its total length; then an incision should be made on each side, parallel with the alveolar process, but somewhat internal to the latter, quite through the muco-periosteal structure. These lateral incisions begin in the soft palate, and extend forwards to within a few lines of the alveolar arch. Through the bone thus exposed, the blade of a chisel may be forced, either with the hand or with a mallet. To make the entrance of the chisel more easy, and to prevent fissured deflection of the osseous wound, Fergusson was accustomed to first pierce the bone with a number of openings by means of an awl-like instrument. It may be recalled that Dieffenbach used a three-angled borer, with which he pierced the bone in the operation of closing palatal cleft. The chisel, with which Fergusson split off the bone, was used as a lever to pry or force the fragment inwards. The lateral portions being thus prepared, sutures are introduced, and the parts united. In the lateral openings, lint was introduced. The sutures, in most cases, merely passed through the soft structures; should this not be feasible, holes may be drilled through the detached parts, and the sutures passed through their margins. Or, as Fergusson sometimes did, the sutures may pass through the lateral openings, and thus closure be done.

The writer, who has performed this operation several times, has sometimes found difficulty in the union of the detached portions; and this can occur where the breach is very wide; also in cases in which one side of the horizontal palatal process is attached to the vomer. In case of great breadth of breach, it requires sutures of strong tension to effect median coaptation; and in such a case, operated on by the author, the excessive pressure on the detached parts by the wire in which they were included, caused strangulation and death of a portion of the united parts; the staphylorraphy was successful; but the attempt to close the osseous breach was a partial failure. Cases in which such a result menaces the operator, are those in which, besides great

width of cleft, the structures which bound the cleft laterally are atrophied, the bones reduced to thin plates, and their covering to film-like tissue which is poorly supplied with blood. The writer has seen such tissue which was almost like tendon in its bloodless character. In patients having a cleft of this kind, it is wise to leave the osseous breach untouched, and to limit the work to closure of the soft palate; the opening which then remains may be closed by an obturator, which can be devised and constructed by the mechanical dentist.

In cases in which there exist conditions similar to those mentioned, or in which there has been failure to obtain union, rather than abandon the patient to the unending annoyance of wearing an obturator, there are other operative methods by which closure may be attempted. For this purpose, occluding material has been obtained in the nasal passages, from the pharynx, from the adjacent alveolar wall, and from the contiguous cheek; and, lately, a new mode of closure from the remaining palatal vault itself has been proposed by an English surgeon.

Lannelongue, in 1876, closed a cleft with material which was obtained from the nasal septum; he since reports two closures thus effected.

Schönborn, in 1876, reported the closure of a cleft in the palate by means of material obtained from the wall of the pharynx. The aim of Schönborn was to close the breach in such a way that the posterior nares would be closed, and thus phonation improved. To do this, a flap which was nearly an inch wide, and two inches long, was dissected up from the pharyngeal wall, and this flap, adhering below, was inclined forwards and sutured in the gap. By such a procedure, Schönborn thinks a defective velum might be repaired.

In 1868, Thiersch reported that, two years previously, he had closed a breach in a hard palate, in which a uranoplastic operation had failed in the following unique manner: two teeth were removed from the side of the upper jaw, and then a section of the alveolar process was removed with a chisel. Through the breach thus made, there was carried a flap which had been formed from the entire thickness of the cheek. This flap was over two inches long, and was fastened in the cleft by eight sutures. The gingival integument was preserved so that the exposed portions of the alveolar process were fully covered therewith. The scar which remained in the cheek was not conspicuous. A portion of the flap died, yet enough lived to greatly

improve the patient's condition. An inconvenience, however, was afterward experienced from the beard growing from the flap which had been transplanted into the mouth.

The alveolar processes have furnished material for closure of the anterior portion of the osseous cleft; and as these cases are often associated with hare-lip, in the operation of repairing the lip, something may be done in closing the adjacent palatal breach. When the bony cleft is a small opening, the closure of the labial cleft in the infant will aid in the spontaneous closure of the front portion of the palatal cleft; but if the latter be a larger breach, then something more should be done, in case the patient be a child. For this purpose, on one side in the bicuspid region, divide the alveolar arch vertically with a small saw; and having drilled holes through the process on each side of the cleft, pass a silver wire through, and close the median cleft, leaving a lateral one in the arch, which will afterwards fill up. In this work of median displacement, care must be used to spare the dental roots; neglect of this rule, cost the patient a tooth in a case operated on by the author.

Another procedure has been announced, in 1890, for the closure of the osseous cleft; its author, Davies-Colley, proposes its use especially in cases in which there has been a failure to get union

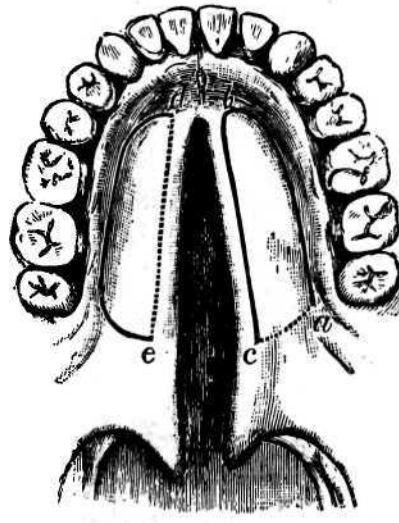

FIGURE 88. Showing Davies-Colley's uranoplastic procedure.

by some other method. The understanding of this procedure, is facilitated by the accompanying diagram, Figure 88. To do this, two flaps are to be constructed from the hard structures of the bony palate. The first, formed on the broader side, is made

by an incision, which, commencing at *a*, near the last molar tooth, runs forwards along the alveolar arch to *b*, near the incisior teeth; thence it curves inwards and runs backwards near the margin of the cleft, until it reaches, at *c*, the soft palate. The flap thus traced out is now to be carefully dissected from the bone. Next an incision is made on the other side, which is to begin near the anterior end of the cleft at *d*, and thence passing outwards to the alveolar arch, it is to be carried backwards along this arch to *e*, in the soft palate, where the cut ends near the cleft. The structure, thus circumscribed, is to be dissected from the bone, so that there will be formed a semi-elliptical flap, which has attachment along the inner margin of the cleft. This flap is now folded inwards so as to lie on, and close the greater part of the palatal cleft. To retain this flap in place, two or three sutures are used. Next, the pedunculated flap from the other side is turned across the median line, so that its raw surface will rest on the raw surface of the previous flap; and this is retained in place by a few sutures which pass through its anterior end. Should this crossing flap not readily reach to the point where it is to be fastened, then the flap must be dissected up somewhat more at its base. The procedure of Davies-Colley when completed is shown in Figure 89.

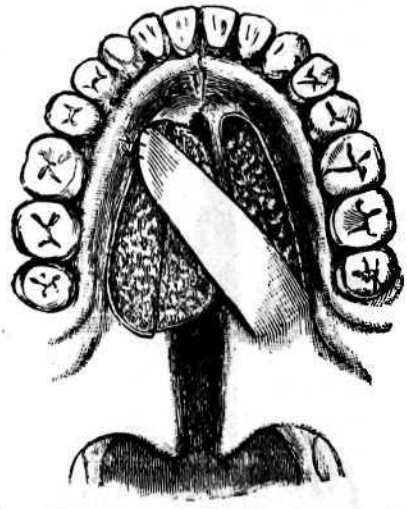

FIGURE 89. Showing the appearance after closure of the parts according to the plan of Davies-Colley.

Davies-Colley, who recommends this operation in infants in whom the breach is wide, or in whom an operation has failed, gives the following as its advantages and disadvantages: its advantages are that there is less hæmorrhage; less bruising of

the parts; less sacrifice of tissue, less tension of flaps; and it can be performed at an early age, viz, between one and two years of infancy. Its disadvantages are that the bony palate alone is closed, and that an opening is apt to be left in the front part of the cleft.

In concluding the chapter on staphylorrhaphy and uranoplasty, it must be added that, though surgery has accomplished here some of its most commendable achievements, yet the best work done seldom greatly improves the patient's defective speech; to drop his ill sounds, and to acquire the normal shaping and expression of the elements of articulate language, depend on the individual effort of the patient; he is in the position of one who learns a new language; he need not hope to reach faultless excellence, yet perseverance will bring him towards such a goal; possibly so near, that he will not differ much from the many who have no palatal defect. Besides diligent practice in articulation, in which there must be repeated a series of words containing the defectively pronounced sounds, there should be practiced passive motion of the parts, in the form of friction, massage and kneading. But to accomplish any great benefit, there must be an unabated, untiring effort; fortunately, the desire to escape from the chagrin which the sound of his voice continually renews in the rational child or adult, is generally present as a prompting spur to such diligence. The implantation in the human heart of the desire to merit the approval of others lies at the foundation of things great and small; it builds a bulwark in defense of public morals; and equally awakens in the individual a dislike of his abnormal feature or word, and inspires him with courage to break the fetters of such embarrassment.

CHAPTER XX.

TONSIL.

Surgical Anatomy.—The tonsil's function, though the part is so accessible to research and inspection, remains to be determined; if a collection of lymphatic glands, as some contend, it has failed to be the metastatic point for development of the elements of malignant disease which may be located in the tongue, pharynx or choanæ. It is composed of closed spheroidal spaces or vesicles, which are adjacent to depressions which mark the surface of the tonsil; and from the resemblance of this surface to that of an almond, the tonsil has derived the name by which it is popularly known in some languages.

The tonsil lies between the arches of the palato-glossus and palato-pharyngeus muscles; and as these arches do not stand vertical, so the contained tonsil has an oblique position from before backwards, and from without inwards; and this obliquity permits the view of the part when the jaws are fully separated. Its volume is variable; nominally it is a half inch long, a third of an inch thick, and the same in breadth, and when it is of this normal size, the tonsil scarcely rises beyond the sides of the arches which inclose it.

The tonsillar surface, instead of being dotted with depressions, may be entirely smooth, or the surface may be rough and irregular in consequence of ulceration or suppuration. And again, there have been seen cases in which the tonsil presented near the middle part of its surface a gap or common space, into which all the mucous follicles emptied. The deeper or external portion of the tonsil rests on the superior constrictor of the pharynx.

Between the ramus of the lower jaw and the pharynx exists a prismoidal, triangular space named the maxillo-pharyngeal space; its base rests against the vertebral column, and its narrow part ends at the insertion of the constrictor muscles. In this space are contained the internal carotid artery, the internal jugu-

lar vein, and the pneumogastric and sympathetic nerves. The tonsil rests on the inner wall of this space and has close relations with the internal carotid artery; the vessel lies outwards and backwards from the tonsil, while the internal pterygoid muscle lies inwards and forwards. The insertion of the pterygoid muscle into the angle of the jaw, and the position of this angle, are such in reference to the tonsil that the latter can be pressed outwards against the jaw; this fact, pointed out by Richet, was utilized by him in the establishment of compression of the tonsil in the case of a hæmorrhage from the part.

An occasional abnormal situation of the internal carotid artery was noted by Chassaignac; he observed that sometimes in the aged subject, the vessel in the maxillo-pharyngeal space is curved inwards, with convexity directed towards the tonsil, so that the artery, in such a case, is unusually imperiled through a wound of the tonsil.

The tonsil receives its blood from the inferior palatine, which is a branch of the facial artery; also from the ascending pharyngeal branch of the external carotid, and from the posterior palatine, a branch of the internal maxillary artery. Hyrtl has observed an occasional anomaly in which the inferior palatine artery (called also the internal palatine) is so large as to replace the internal maxillary artery; and, in such case, the inferior palatine gives off the branches which are normally derived from the internal maxillary artery. Such enlarged anomalous vessel might be the source of a dangerous bleeding. Normally, the external carotid is so distant from the tonsil that a wound of the latter could not reach it; yet Führer has shown that from a morbid rigidity of the vessel, where it passes behind the posterior belly of the digastric, the external carotid can approach so near the tonsil that the vessel would be imperiled in extirpation of the tonsil. Besides the structures which lie in the maxillo-pharyngeal space, there is a loose cellulo-adipose tissue which communicates with the cellular tissue of the neck; and through this tissue inflammation located in the tonsil can travel downwards; and in case of suppuration, the pus has appeared below the chin, and on the neck even as low as the clavicle; at this remote point it was observed by Velpeau.

In regard to the site of the tonsil some further points should be noted. It may be wholly sessile, and be closely adherent to the parts in which it rests; or it may be so loosely attached, especially in cases in which it is enlarged, that it is so easily

moved that it seems to be peduncated; in fact, the free portion is much larger than that of the base. It also sometimes extends so far downwards in its fossa that the lower part can only be seen by depressing the tongue. The tonsil may scarcely reach to the environing arches; or it may extend to them so as to be tightly embraced, or even constricted by the arches; a constriction which augments when the arches are inflamed. In such anatomical condition, the astringent application used to allay inflammation seated here, would add to, rather than abate, the congestion of the tonsil.

An important anatomical relation, which the writer has frequently seen, is the adherence of the stylo-glossus or stylo-pharyngeus muscle to the tonsil; in some cases the arches may be so shifted upon the body of the tonsil that the latter is partly buried up; the arch being so continuous with the tonsil, that it is not easy to separate one from the other. In this way the upper posterior portion may be concealed. Such adherence or muscular development may conceal pus which is seated in the upper posterior part of the tonsil, and it may also greatly interfere with the excision of the part.

Chassaignac describes what he names a "demi-capsule" of the tonsil. This structure lies on the outer face of the part and separates it from the constrictor muscle. This capsular structure is much denser and stronger than the remaining tissue of the tonsil; for if one pushes a probe through the tonsil, it is arrested by the capsule, which is difficult to perforate. He claims that this capsular septum affords protection in the work of enucleating the tonsil.

Chassaignac also describes a movement of the tonsil, which he calls "spiroid;" this is seen when the base of the tongue is depressed; also when there is the movement of retching or vomiting in the throat; at such times, the tonsil will be found to make a rotatory movement, in the direction of the vertical plane in which it lies. The writer has seen that this movement sometimes interferes with seizing the tonsil, in the work of excision.

Tonsillitis.—Tonsillar inflammation has been named, according to the casual agency which produced it, catarrhal, rheumatismal, exanthematous, etc. Many of these cases lie outside of the province of surgery.

The clinical conditions and manifestations present in inflammation of the tonsil are the following: There is the feeling as if there were some body in the throat, which the patient tries to

dislodge and swallow, or expel from the throat; and these movements are often involuntary, and are the sources of pain and annoyance; such pain, at first slight, soon increases, and finally becomes very severe; and then swallowing becomes nearly impossible; in fact, the passage of a small quantity of fluid excites a painful cough, and some of the passing material enters the posterior nares. In the worst cases, the breathing is so difficult that the patient, if an adult, fears strangulation. The pains shoot towards the ears; and from swelling, the Eustachian tube may be partly or wholly closed, and some deafness thus arise. Or the swelling, valve-like, may momentarily occlude the tube, and then the part may reopen; and thus a painful crackling arises; especially, when the lower jaw is moved. The face is flushed; the tongue is often dry from breathing through the mouth, and the pulse accelerated, and the temperature elevated. Should the swelling descend into the larynx, the dyspnœa may become so great, that, to escape the impending suffocation, tracheotomy has been done; usually, however, relief may otherwise be obtained.

The normal secretion of the tonsil is increased in amount, and is altered in character; it is extremely tenacious and adherent to the pharynx, so that there is excited a teasing cough, accompanied by repeated efforts to clear the throat.

The site, extent and nature of the disease are to be learned by an inspection of the pharynx. In the adult this can usually be done through simply directing him to open his mouth, breathe outwards, and articulate the sound *ah;* but in some cases, it is not easy to open the mouth; the lower jaw is fixed by contraction of the masseter muscles against the upper jaw, so that it is with some effort that the mouth can be opened. When this can be voluntarily done, then by means of the handle of a spoon or a tongue spatula, the base of the tongue can be pressed downwards, and a full view of the tonsils obtained. This work, in the adult, can be done with the surgeon's finger; and often, as the writer has verified, the index, by pressure at different points, can open a view which cannot be obtained with any tongue depressor. But woe betide the finger that is thus trusted in the child's throat; it may be badly bitten; and what is worse, it may when wounded be poisoned by the septic fluids of the mouth; hence the use of the tongue depressor is preferable.

To inspect the child's pharynx and tonsils is often a difficult matter; the youngster, with the liberty of childhood, fortified by

indocility, in which the parents take pride, declines to open his mouth; and will only do so under a discipline to which he has been a stranger. In such a contest, the surgeon stands in a position not to be envied; but as it is a contest in which discipline wages war with the raw recruit, the former usually wins; yet to insure his victory, the surgeon would do well to exclude the parents from the scene; as, from the writer's experience, an appeal to the latter may render the contest a much more doubtful one.

In the exploratory view one learns the extent of the disease, whether one or both tonsils are affected, and in which one the swelling is greater; for, as a rule, one is much more affected than the other. The swollen tonsil is often covered with a film of pseudo-diphtheritic matter.

The trismus-like contraction of the masseter muscle is so great sometimes, that the lower jaw cannot be depressed, and an accurate view of the pharynx is prevented. In such condition, should the disease be of much gravity, it will be necessary to open the jaws by the aid of an interdental lever; an instrument consisting of two blades which are united at one end, and are separable at the other by means of a screw, which being turned lifts one blade from the other. Through the space thus opened both eye and finger can explore the pharynx.

Fortunately for the patient, the acutely inflamed tonsil runs a rapid course, and ends by resolution or suppuration; or the inflammation may lapse into a chronic form, and then it can entail a permanent enlargement.

In the disappearance of the tonsillitis by resolution, the pain, swelling and dysphagia gradually vanish, and the tenacious mucous secretion disappears; or it is transformed into normal mucus. The diminution of volume is sometimes promoted by the bleeding which sometimes arises from the bursting of blood-vessels in the surface of the inflamed part.

In case both tonsils are inflamed, one is commonly more severely affected than the other; and thus one may be the site of resolution and the other of suppuration.

In almost all cases of acute tonsillitis, the ending is in the formation of pus; and such event is heralded by increase of the swelling and pain, and augmentation of the tonsillar and salivary secretions. The pain, though constant, appears in accessions of greater intensity, which reveal themselves in facial contortions. The patient is tormented with a sense and fear of suffocation, due to increasing narrowness of the fauces.

The pus in its site may be superficial, deep or subtonsillar. It may be in the front, posterior, or inferior part of the tonsil; or it may be in the summit; and when in the summit, or posterior part, it may be partly covered with the pharyngeal arch, and masked from view. It may likewise be invisible when located in the lower part of the tonsil; and in this situation the patient's life may be further imperiled by swelling and œdema reaching into the larynx. Pus in this inferior site, in opening may descend into the larynx and asphyxiate the patient.

Pus formed in the subtonsillar location instead of pointing towards the fauces, has been known to form for itself a way through the outer wall, and to appear beneath the skin at the angle of the jaw; or it may gravitate downwards and appear on the side of the neck even as low as the clavicle.

Weber has described a species of suppurative inflammation which commences beneath, or within the pharyngeal muscles, which implicates the tonsil. And this affection sometimes takes on a phlegmonous character, and then, under the name of phlegmonous angina, it occupies a large portion of the pharyngeal wall. This form of disease is of a graver character than any of the preceding ones described; it may have a rapidly fatal termination, as the writer has witnessed in a few cases.

In severe cases of tonsillitis, whether ending or not ending in suppuration, the disease induces swelling of the adjacent soft parts; and in this tumefaction the glands participate, which are situated in the parotidean sulcus behind the ramus of the jaw. These glands rarely suppurate. The cervical tumefaction induces a temporary wry-neck.

When the event is the formation of pus, the site of this may often be detected with the finger before it is visible to the eye. Unless deep-seated the pus soon approaches the surface, and, without aid, will open itself a way into the pharynx. If located deep in the tonsil, the material may reach the internal carotid artery, and by erosion open this vessel. Grissole, Caytan and Le Fort report each a case in which this accident happened. Caytan saw a case in which a secondary suppuration ensued, and the latter penetrated the artery and caused a fatal hæmorrhage; the opening was spontaneous. The history of the cases reported by these surgeons shows that the bleeding, which has sometimes followed the lancing of a suppurated tonsil, may have arisen from the erosion of pus rather than from the point of the lance. It is fortunate that in the field of operative surgery such peradventures

exist, in which the surgeon's conscience and reputation may find refuge when his thoughtfully planned work ends in failure. Though in such refuge the bitter flavor of disappointment may alloy the solace therein found, still the result is to stimulate the professional mind to renewed vigilance in operative effort, and to more carefully studied endeavor; and if the surgeon's work be thus planned and guarded, the deciding balance will rarely incline towards non-success.

Tonsillitis may terminate in gangrene of the part. Such event has been seen by Trousseau, Hardy, Frank and Borsieri. According to Borsieri, tonsillar gangrene is the expression of the highest intensity of tonsillitis. It probably depends on some special condition of the body; and perhaps is due sometimes to infection of the part with some toxic agent. That such infection does not occur oftener is a wonder, when one considers the heterogeneous materials which are in constant transit across the pharyngeal isthmus, and the numerous follicular pockets into which these matters may pass and find lodgment, and, by retention, become septic, if they were not primarily so. And from such morbific cause disease proportioned to the originating agency can arise; and such tonsillar affection may vary in grade from a transient irritation to a destructive gangrene.

Other concomitants of tonsillitis are affection of hearing, and palsy of the muscles concerned in deglutition.

The inflammation, as has been stated, is seldom limited to the tonsil; it often travels to the Eustachian tube, and, entering this canal, may so swell its walls as to nearly or quite occlude the passage; and thence arises temporary deafness, which may be partial or complete. Such impaired hearing vanishes as the tumefaction subsides. But if the disease pass along the tube to the tympanum, and suppuration occur there, the hearing of that ear is seriously compromised. And in the worst cases, the suppurative process, wandering far from its tonsillar site, has passed to the tympanum, and thence it has migrated and entrenched itself within the mastoid antrum, requiring, in such cases, the opening of the outer wall of the mastoid bone. Such migratory action, fortunately, is rarely seen.

Palsy of the pharyngeal muscles originating in tonsillitis, has been observed. Its appearance in the tonsillitic patient is much less frequent than in the diphtheritic; so much so that in the cases reported it was claimed that there had been an error in diagnosis. Palsy thus arising may be limited to the

site of the inflammation, or it may be much more diffused. It appears early. From the loss of movement of the palatal veil the tone of the voice is altered; and the approach of the paralysis may be suspected when a nasal tone of voice is perceived. Besides phonation, deglutition suffers from pharyngeal palsy; in swallowing, food may stray into the air-passages, and in order to swallow, the patient is sometimes forced to close the nostrils; for such closure, in some degree, replaces the normal closure of the choanæ by the palatal veil. In this condition an inspection of the pharynx will show that the pendulous veil is hanging loosely, and if the parts be touched, they are insensible and are not awakened to normal reflex movements. The possible ill resulting from such palsy is the passage into the larynx of foreign materials, as particles of food, which entering the lungs may irritate and inflame their tissue; and in a patient already reduced in strength, from such irritant ichorous pneumonia may originate.

This paralytic condition of the throat is sometimes followed by retinal affection; and vision is impaired from this cause as well as from interference with the power of accommodation.

In a few cases this anginous palsy has become general, and the patient has been deprived of motion in large sections of his body. This paralysis, both local and general, is rarely permanent in duration.

A singular complication of tonsillitis is that in which the genital organs become consecutively affected. In 1857, Verneuil reported his observation of a case in which there occurred an effusion into the tunica vaginalis testis, as a metastatic sequel of inflammation of the fauces. He claims that there is a morbid determination towards the genital organs in tonsillitis. In 1859, James, an English writer, endeavored to show that there is the relation of cause and effect between tonsillitis and an affection of the ovaries. In a young woman who was the subject of a tonsillitis, James saw implication of the ovary corresponding to the inflamed tonsil; and then, the other tonsil inflaming, the ovary on that side also became inflamed.

In 1886, Joal and Verneuil reported observations of similar metastasis, in which orchitis or ovaritis appeared consecutive to tonsillitis; the cases were not seen in those under puberty, nor in the aged; and such secondary disease lasted from fifteen to twenty days.

Youth is much oftener the subject of tonsillitis than infancy or old age, and the young, vigorous and robust are oftener

attacked than those of feeble habit. Its causation is obscure: in fact, undetermined; yet its frequent coincidence with exposure to cold air, or sudden change of temperature, makes it probable that such variation has, at least, a predisposing agency. As a rule recovery may be expected.

Treatment.—Louis and others claim that tonsillitis is not materially shortened in its course by treatment; in cases which were vigorously treated Louis reports that the disease ended in nine days; but when it was allowed to run its course, it lasted but one day longer. Few patients, however, are tolerant of passive expectation; and should the physician imbued with the nihilistic skepticism in his art, now prevalent, prefer to confide the matter to nature, he will scarcely find concurrence on the part of the patient. And an extended observation has convinced the writer that a proper management of tonsillitis both abridges the disease and greatly ameliorates the patient's condition.

A century ago, when venesection was the chief weapon wielded against disease of the sthenic type, acute tonsillitis, with kindred inflammatory affections, rendered the customary tribute. This practice, after being consigned to seeming oblivion for a time, has recently been recalled into use; Aran, Mestivier and others have reported excellent results from general bleeding. The mass of recent authority, however, is unfavorable to general blood-letting; the latter is being superseded by the use of leeches, externally applied, or by scarification of the inflamed surface. The use of leeches, applied to the skin as near as possible to the affected part, has been done; experience not confirming the benefit once claimed for leeching, this practice is being abandoned; in fact, instead of relief following the abstraction of blood by leeches, it is claimed that the patient is rendered worse by the local congestion which is thus induced.

Mention should be made of venesection from the ranine or sublingual veins; such treatment was recommended by numerous ancient authorities, as Hippocrates, Galen and many others. The fear of causing a hemorrhage which would be difficult to check, inspired some of the lines of caution which Celsus has written when treating of operations in the sublingual region. And, though bleeding from these vessels has lost much of its ancient credit, yet Aran states that in the Department of the Gironde such bleeding is still commonly practiced, and praised in the treatment of tonsillitis. Aran has so often been witness to the good effects of such depletion, that he advocates its use. And

the writer would add that there scarcely would have been such unanimity among the ancients in the use of such bleeding, if it did not possess some advantages; the limited list of therapeutic means used in antiquity permitted an accurate verification of their utility or inutility; and the credit in which sublingual bleeding was held during so many centuries, would seem to justify a re-trial of the plan, as Aran has done.

The immediate or direct abstraction of blood by scarification of the tonsil is commended by all recent authority. As a rational procedure it commends itself in this, that thus the engorged surface is emptied of its blood, and the several vessels do not admit of the return of the blood and its passage through them. To scarify properly, the surgeon's bistoury or scalpel should have an edge that is faithfully sharp; the incisions made should be superficial, transverse in direction, and numerous. And to promote the bleeding afterwards, the patient should gargle with tepid water, that has been made alkaline with carbonate of potassium or carbonate of sodium, or with tepid lime-water. If the scarification be well done, it need not be repeated.

After the local depletion has thus been effectively done, to favor contraction and retraction of the inflamed structures, astringent gargles should be prescribed; and, as agents of this class, one may select the mineral or vegetable astringents: for example, alum or tannin. And as adjuvants the topical use of tinctura iodini composita, tinctura gallæ, or tinctura benzoini composita may be resorted to. In those cases of abnormal disposition of the environing pharyngeal muscles, in which the tonsil is begirt as with a constricting band, the localized and isolated use of the latter remedies is better than the diffused application, as happens in the use of gargles; since the latter, acting on the parts around, constrict and congest the in-walled tonsil; but if the latter alone be touched, the full effect of the remedy will be obtained. The patient should also be given fragments of ice, by which the heat of the mouth will be lowered.

To these means saline cathartics should be conjoined.

The prompt and judicious use of the procedures and remedies mentioned will, sometimes, stay the disease midway in its course, and secure the desired termination by resolution; but quite as often these means do not arrest the progress of the inflammation; it then proceeds to suppuration.

Inflammation rarely limits itself to an isolated structure, or an organ; it commonly overleaps the artificial barriers which have

been set for its isolation by the classifying hand of the nosologist, and this often occurs in affections of the tonsils; inflammation may appear in it primarily, or it may extend to it secondarily from contiguous structure; and hence, when the event is suppuration, the pus, according to the location of the inflammation, may be tonsillar, or peritonsillar, in site. Pus is oftenest developed in the connective tissue which lines the niche in which the tonsil lies; and this is most frequent above or behind; and, as previously remarked, the focus of pus is discoverable by touch rather than by sight. Free scarification, opportunely done, often prevents suppuration; but this failing, and pus forming, the latter must be liberated by incision. If the purulent material be near the surface, it is reached by a slight cut with the lancing instrument. The opening may be made with a scalpel or bistoury; and if the hand be inexperienced, the incising blade may be wrapped with cloth, so that only a small portion of the pointed part will remain exposed; such protection, however, to a disciplined hand would prove but an impediment. If the pus be deep, then a shallow incision may be made over it, and afterwards, a blunt dissector or large blunt probe may be pushed through the remaining wall. But if the pus lies behind and adjacent to the tonsil, care must be used in opening; since the internal carotid artery lies external to the pus, being only separated from it by the superior constrictor muscle and the pharyngeal fascia. Pus in this situation has perforated this thin wall, and, by erosion, opened the artery and caused hæmorrhage, speedily fatal, as was observed by Grisolle. If it becomes necessary to liberate with the lance pus seated over the vessel, the point of the instrument should be directed rather towards the posterior pharyngeal wall, than towards the side; the bistoury should pass backwards and not laterally. Thus doing, the fatal work of opening the vessel which has been reported by Béclard and others, will be avoided.

Some writers advise against opening the collection of pus, and prefer to allow it to burst spontaneously; such is the teaching of Stromeyer, who claims that lancing the suppurated tonsil awakens new inflammatory and additional suppurative action. It is true that after one collection of pus, another may appear later; yet this second one was in process of formation, and if the first had not been opened, the two would finally have fused together; but opening the two as they respectively mature, greatly limits the suppurative process; and materially lessens the patient's pain.

When the pus has exit, the subjective accompaniments of pain, discomfort and functional impairment, at once lessen and gradually disappear. As a detersive gargle to aid in the removal of the excreta, some alkaline solution, as aqua calcis, may be used. This will be rendered more agreeable to the patient by the addition of menthol or mint-water; mint-water, to which carbonate of potassium has been added, will act well. By treatment as described, the purulent content will be eliminated, the hollow breach will close, and, afterwards, the tonsil will present an irregular surface.

There are patients, usually adults in the prime of life, who are the subjects of recurring attacks of suppurative tonsillitis, the disease occurring annually, or at longer intervals. In such persons an attempt may be made to arrest the disease at its onset, and for this purpose, Bell, in 1842, announced that gum guaiac, given internally, is an excellent remedy, and at the same time the patient should be purged. Herpin, of Geneva, cauterized the surface of the tonsil with pure nitrate of silver. Reel-Ogez, as abortive treatment, advises to gargle hourly with the subjoined solution:—

℞.	Plumbi Acetatis	...gr. v ad. x
	Gum Acaciæ.	...ʒiv
	Syrupi.	.....℥ss
	Aquæ	.....℥v
	Misce.	

These, and other local remedies, are inferior to simple scarification of the surface of the tonsil; if this be done early, and well done, the disease may often be arrested in its incipience, and resolution obtained.

Hypertrophy of the Tonsil.—The tonsil may be abnormally enlarged as a permanent condition. The structural conditions present consist mainly of a multiplication of the component elements; the stroma of connective tissue, intervening between the lacunæ and follicles, is thickened and hardened, so that it resists and creaks under the incising blade. Though hard, the structure is usually more friable than normal tonsillar tissue. In the enlarged lacunæ are lodged masses of epithelial excreta; and sometimes calcareous concretions are found there. The tonsil's volume is commonly augmented to two or three times its normal size, and, exceptionally, this may be much exceeded. The color may be normal; often it is pale and bloodless in hue. The sur-

face may be smooth, or it may be rough, lobulated and pitted with depressions. As a rule, the enlarged tonsil is painless; more rarely, pain can be awakened by pressure.

When the tonsils are much hypertrophied, they displace the palatal veil, so that this part, partly or entirely closes the choanæ. They touch each other in the median line, or so nearly do so, that a small space remains for the passage of air and food. Sometimes, the adherent pharyngeal arches repress the tonsils, and then their encroachment upon the pharynx is much lessened.

Tonsillar hypertrophy may impair audition and phonation, impede respiration and deform the chest, and cause catarrhal trouble in the nostrils, pharynx and air-passages.

Disturbance of hearing, for a long time, was thought to depend on the closure of the openings of the Eustachian tubes. In a study of the subject, Harvey, Crisp, and others, deny that deafness is thus caused; they refer it to lessening of the calibre of the tube through tumefaction and swelling of its lining membrane. In fact, the direction of the enlargement of the tonsil is rather away from, than towards, the tube; and the effect of it is to pull open the mouth of the tube. But, as the tube's lining is thickened by extension of the tonsillar trouble, whatever lessens the latter, improves the hearing. And the observation of this fact was the secret of the successful career of an eminent charlatan, St. John Long, who some years ago enjoyed, in London, a transient era of prosperity in the cure of deafness. His treatment consisted in the excision of the tonsils, and thus, it is said, he cured or relieved many cases of deafness. But as many cases of deafness do not originate from such cause, the immense practice of this empiric soon fell off, and he was remanded to the obscurity from which he had lately emerged.

The obstruction of the choanæ interferes with the normal development of the vocal sounds; the patient speaks with a nasal tone; or rather, the voice seems muffled.

The enlarged tonsils obstruct the entrance of the air to the lungs, and thus respiration is seriously embarrassed. The child which is the subject of such hypertrophy, ceases to breathe through the nose, in consequence of the labor which nasal respiration demands; the child breathes through its partly opened mouth, and in so doing, it presents a picture of mental imbecility and forbidding stupidity. It is, however, during sleep that the enlarged tonsils specially obstruct breathing; the tongue then, particularly in the dorsal position, presses the epiglottis backwards

and downwards, so as to nearly close the glottis; in this closure the large tonsils concur, both by their volume and weight. Such sleep approaches the nature of profound anæsthetic narcotism, and the analogy is close when one records that the little sleeper is often congested in its face, and slightly cyanosed, owing to the want of a proper amount of air. The guttural rhoncus of the inspiratory effort and the occasional closure of the mouth and temporary suspension of breathing, often alarm the parent or nurse. And so great has been the parental anxiety, that it has been recorded by Roger that the mother of such a child was accustomed to nightly watch her infant, and with her hand press the chin downwards, so as to prevent the mouth from closing.

This unusual respiratory effort, when prolonged in the child, finally induces a deformity of the thorax. In 1828, Dupuytren called attention to the frequent coincidence of deformity of the chest-wall with enlarged tonsils. He merely noted the concurrence of, and not the causal connection between, the two conditions.

Warren, of Boston, in 1838, published his observation that enlarged tonsils cause deformity of the chest. And, near the same time, similar observations were made by Coulson, of London.

Moity, in 1858, announced that enlarged tonsils impair hearing, taste, and dwarf the intellect; the retarded flow of blood to the brain interfering with its normal evolution, mentality is thus abridged.

Most writers upon this subject describe two classes of thoracic deformity associated with tonsillar deformity: one in which the subject is rachitic, and the other in which this constitutional disease does not exist.

In these cases of perverted thoracic form, the deformity concerns chiefly the lower part of the chest; the upper part retains its normal contour. In the lower half of the chest the ribs are incurved; and this depression is greatest near the middle portion of the ribs. The sternum likewise shares in the deformity; the lower portion is deviated inwards, while the upper part remains in normal position. The thoracic deformity due to rachitis differs from that of pure tonsillar hypertrophy; in rachitis the costal cartilages are unduly prominent, while the ribs are sunken at the sides of the chest, so as to form two vertical gutters, one on each side, extending through the entire height of the chest.

Different explanations of the thoracic deformity from hypertrophied tonsils have been offered; Robert thinks that it arises

from the diminished tension of the air contained in the chest during the effort of inspiration, the weight of the external air forces inwards the lower part of the sides of the chest. This explanation does not account for the upper part of the thorax remaining in situ, though it is acted equally on by the atmospheric pressure.

Lambron, who has published an exhaustive monograph on the tonsil, refers the incurvation to the action of the diaphragm. In ordinary breathing, the inspiratory effort is made by the diaphragm; and as this muscle is inserted into the ribs forming the lower half of the chest, the deformity is limited to the lower portion of the chest. A favoring condition which the author suggests, is the greater mobility of the lower ribs, which becomes especially conspicuous, when the normal chest is inflated by a deep inspiratory effort. Emphysema of the lungs is often associated with the tonsillar and costal deformity; and it is correlated to the incurvation of the lower part of the chest, since the pulmonary tissue, by its expansion above, compensates for the diminished cell-room below. Again, the attending mobility of the lower part of the thorax, gives it some immunity against those diseases which find a starting-point in the summits or the upper parts of the lungs.

The tonsil is sometimes enlarged through constitutional syphilis; an instance of this was seen by the writer, in which a recovery was obtained through excision of the tonsil and antisyphilitic treatment.

Treatment.—As treatment, one may resort to means which will oppose or correct the predisposition to tonsillar enlargement: also means may be resorted to which applied to the enlarged tonsils, cause reduction of their volume; and finally, the attempts in these directions proving fruitless, the part should be removed.

The scrofulous or tubercular diathesis which often accompanies the hypertrophy, should be combated by means of iodide of potassium, iron and arsenic. Sulphur baths, and the local use of sulphureted water in the form of douche directed on the tonsil, have acted curatively against its enlargement. The remedial efficacy of this treatment will be especially manifest in those who are likewise the subjects of herpetic or eczematous disease.

Patient effort in the use of topical remedies will lessen the enlarged tonsil; of these means, the best are those which have an astringent action. One of the most effective is a combination of iodine and galls, in the following mixture:—

℞. Tr. Iodini compositæ.
Tr. Gallæ. ....aa ℥i
Misce.

Let this be applied with a brush to the tonsil, once daily. This compound is better than pure tincture of iodine, which is often used, topically. Also, one may apply to the part a saturated solution of glycerine and tannin. Astringent gargles containing alum, zinc or borax, if diligently used, may have some agency in lessening the volume of the tonsil. It is probable that friction or massage of the tonsils would favor their reduction; the rebellious reflex movements of the parts, which at first would be awakened, would soon disappear. As a means to curtail the volume of the tonsils, in 1869, Ruppaner applied to them the following mixture: caustic soda, caustic potash, and caustic lime, in equal parts, were moistened with alcohol and applied with a glass rod to the tonsil. From six to fourteen applications were needed to reduce to normal form. With such treatment, Ruppaner reports that he cured one hundred and twenty-three cases. If the general and local treatment here mentioned fail in its purpose, the part should be excised.

Tonsillotomy, Amygdalotomy, or Excision of the Tonsils.—The chirurgus or surgeon of ancient Rome excised the tonsils; says Celsus: "When the tonsils have, through inflammation, become indurated, and they are covered with a thin coating, one should thrust the finger in around them and thus pluck them out; but if they cannot thus be loosened, it is proper to catch them with a hook and cut them off (*hamulo excipere et scalpello excidere*)." Near the same period, Ætius, who lived fifty-four years after Christ, directed to remove the prominent part of the hypertrophied tonsil; that is, about half of it; for those who excise the entire tonsil, remove also sound structures, and cause great bleeding. Paul of Ægina counseled the removal of the tonsils; and his method was followed by Albucasis and the Arabian physicians; their method was as follows: The tonsil is first to be caught with a dissecting hook, and to be lifted up as much as possible without acting on the surrounding parts; then the tonsil is to be removed wholly from the cavity in which it is contained by means of a bistoury, which is held in the hand, and corresponds in its form to the curvature of the tongue. Albucasis feared when the base of the tonsil was large, that in its removal, there might occur a hæmorrhage which would be difficult to control.

In the middle ages, tonsillotomy, sharing the fate of the liga-

ture, fell into disuse; and in the *renaissance* of medicine, the operation was approached with timidity and distrust. Ambrose Paré mentions ligation of the tonsils; but he advised tracheotomy in patients menaced by suffocation by enlarged tonsils. Guillemeau, pupil of Paré, did not favor tracheotomy, but he advised the ligation or excision of the enlarged tonsils, of which the base is small. He advised care in the selection of the cases in which the tonsils should be removed. Soon afterwards, Severini, of Naples, in an epidemic in which the tonsils were affected, cauterized and excised these parts. Dionis, who wrote in 1672, opposed excision, eradication, and other means employed to destroy the tonsils; he thought the parts had some functional importance, and should not be removed. Portal adopted this advice. Junker favors partial excision; and he prefers to do this with the ligature. Heister opposes excision as barbarous and difficult; he prefers to remove by means of cauterization. He speaks of the danger of the excised tonsil falling into the throat. Sharp claims tonsillar ligation as an English procedure; and he believes that, thus operating, the hæmorrhage which may follow excision can be avoided. In 1734, Wiseman, in writing on removal of the tonsil, considers cauterization, actual or potential, as the simplest method. In cases in which he did excision, he first passed a thread through the tonsil, and then, cutting behind the thread, he guarded against the excised part falling into the glottis: a fatal accident which occurred to Moscati, near this time. As a safer plan, Moscati afterwards crucially divided the tonsil, and when suppuration had ensued, he excised each fragmentary quarter that remained. Museux, who invented the toothed forceps which bears his name, used this instrument to fix the tonsil, which he excised with curved scissors. Early in this century, a rude tonsillotome was devised; the tonsil, engaged in the end of a furcated staff, and held there with a tenaculum, was excised with a blade that passed through the ensheathing furcated staff.

In the early part of this century, Samuel Cooper preferred the use of the ligature to excision. Dupuytren used toothed fixing forceps, and he cut off the tonsil with a bistoury, of which the greater part of the blade had been wrapped in a bandage. In 1840, Pappenheim heralded an innovation, in which he introduced his left hand in the mouth, and, having seized the tonsil with the thumb and finger, and then pressing down the tongue with the remaining fingers, he cut off the uplifted part with

curved scissors, held in the right hand. Dieffenbach caught the tonsil with a hook and excised with a knife. Syme and Liston, leaders in English surgery, operated with a hook and a bistoury, of which the greater part of the blade was wrapped in cloth. In 1858, Larghi, of Turin, revived the ancient method of Celsus, which might be named the ungual method; with his finger nails he detached the tonsil from above downwards; and he pronounces the plan an easy one. As the majority of the cases requiring tonsillar removal are in children, the plan of introducing the fingers into the mouth would imperil the operator quite as much as the patient; and between the two, it is probable that his own wounds would be the greater unless pains were taken to hold the jaws ajar.

Interstitial cauterization done by means of chloride of zinc, and much used by Maisonneuve, was tried in the enlarged tonsil; the difficulty of reaching the part, and the dangerous possibility of some of the escharotic material escaping into the throat, have caused this method, as well as others which consist in the use of potential caustics, to be abandoned.

Ligation, which has been advocated by many surgeons, besides being a difficult procedure, exposes the patient to the nauseous condition of swallowing much of the septic matter and gangrenous material which arise from this plan of tonsillar removal; and such toxic materials may descend through the trachea to the lungs and awaken disease there. To avoid these accidents, the constricting chain or wire of the écraseur has been passed through and around the tonsil, and the separation been done at once; but ligation, whether done instantaneously or tardily, is no longer employed as means of tonsillar removal.

Delay in doing the work in the child has been counseled with the hope that the tonsils might become of less volume, when the subject reaches puberty; such hope is but exceptionally realized; and, meantime, the delay may permit thoracic malformation to arise as the result of such hypertrophy. Besides the vicious conformation of the chest, and its attendant ills, which project a shadow in which the patient must ever afterwards walk, the young patient's existence is peculiarly menaced, should he become the subject of diphtheritic disease of the throat; for then, a slight addition to the volume of the tonsils may prevent the entrance of air to the lungs, and cause suffocation. Here the early removal of the enlarged tonsils in the child is a prophylactic measure against such casualty.

In regard to the age at which the operation should be done, Guersant, who is authority in this matter, counsels that it should be done early; he operated often in children from eighteen to twenty-four months of age; if done early, there is less danger of hæmorrhage. In one thousand children operated on, he never saw hæmorrhage; while in adults, it occurred in one-fourth of the cases. St. Germain would fix as time for the operation the age between two and eight years; though so excellent a surgeon would, no doubt, have done the operation at a later age, should the exigency have arisen. The writer, whose experience in this matter has not been limited, deems the period when the child has reached the age of reason, a more satisfactory time for the work than that of earlier infancy. In his surgical experience he recalls no operative work that was more difficult than a few cases of tonsillar excision in the infant. If the removal be done without anæsthesia, the work of immobilizing the patient requires a restraining force of assistants, and much boisterous effort; in fact, it is a struggle or a battle from which the operator would retreat could he do so with decorum, and especially so, where the infant has parental reënforcement; viz., a father and mother who, though feigning forgiveness, rarely pardon the rude way in which the victory over their offspring is won; and in such cases the requital which is made for the services has but a thin gilding of gratitude.

To render the task an easier one, the child may be anæsthetized; yet this aid brings the serious inconvenience that the throat is so nearly closed that when narcotized, the child's life is imperiled by suffocation; the base of the tongue and the tonsils falling together quite close the pharynx. Hence, during the work, the tongue must be continuously withdrawn from the mouth with appropriate forceps. Besides, when the patient is anæsthetized, there is danger of blood entering the larynx and causing asphyxia. The writer's experience leads him to operate without anæsthesia; and not unfrequently, the child may be beguiled into the work, and one tonsil may be removed before he becomes aware of what is intended, and ere the surprise which the work has awakened has fully passed, the remaining tonsil may often be removed.

There are two methods of tonsillotomy, which have their respective advocates: excision with a scalpel or bistoury, and excision with a special instrument named tonsillotome, or tonsillar guillotine.

To excise with a blunt-pointed scalpel, or bistoury, or blunt

scissors, there is required a pair of toothed forceps, or a long-handled tenaculum; also a tongue-depressor, intermaxillary gag, and sponges. If a bistoury be used, all of the blade, except an inch and a half from the point, should be covered with adhesive plaster, or a bandage to guard against any unnecessary cutting of the surgeon or patient. The tonsils having been cocainized, and the patient being a tractable subject, the work is done as follows: one assistant standing behind steadies and supports the head; another aid is ready to hold the hands, should the patient be timid, and a third may be needed to depress the tongue. The patient's right tonsil having been seized with the toothed forceps, is to be drawn inwards, so that its base or pedicle will be accessible to the knife; then with the cutting instrument, the tonsil is to be severed from below upwards, by sawing movements. Should the tongue fall backwards, it must be pressed downwards and forwards with a depressor; this act is often unnecessary, since, as soon as the tonsil is caught with the tenaculum or toothed forceps, it can easily be brought into view. The upward cutting is to be so done that the palatal veil and arches will not be wounded.

Should the patient be a rebellious child who has not reached the age of reason, or whose fears have temporarily bereft him of reason, then a small troop of assistants, says St. Germain, will be needed to coerce him into the necessary quiet; one should hold his head; a second should hold the arms, and a third may hold the legs, and a fourth may depress the tongue, and also sponge out the throat, as required. All the aids except the last, stand at the side, so as not to be in the way of the work. Nearly all this force of assistants (of which St. Germain doubles the number here mentioned) may be dispensed with, if the child be anæsthetized; and from the writer's experience, the restraint can be made without anæsthesia by two aids, namely, one can hold the child in his lap, and with one arm hold, support and steady the head, and with the other he can hold the hands, while with his knees he clasps and fixes the child's legs; the second assistant depresses the tongue and wipes out the throat when needed. And a third aid is sometimes required to hold in place the interdental dilator. The patient, finding that his efforts of resistance are overcome at every point, finishes by firmly and defiantly shutting his mouth and clinching his teeth. To meet this some address is needed; if the nose be held, in the moment when the mouth is opened, a spatula may be thrust between the teeth, and, being pushed back

to the throat, the retching movement thus induced fully opens the jaws, when some body, as a wedge-shaped piece of wood, may be inserted between the molar teeth, and the closure of the jaws thus prevented. At this point, the surgeon can proceed with the use of his bistoury, and complete his task at his leisure.

Early in his professional career the writer did the excision with a pair of large curved scissors, an instrument which Cloquet prefers for the work. To use the scissors, the right tonsil should first be caught with the fixing tenaculum, and being properly lifted from its niche, the cutting is done with one stroke of the scissors. In using the scissors the operator should be careful to have the tonsil well included between the blades before they are closed. As said, in the use of either the bistoury or the scissors, the patient's right tonsil should first be removed, since, for the right-handed operator, this is the more difficult act, because the hands must be crossed in the work. The left one is next to be seized and removed; and as the patient is restive from what has been done, and there is some bleeding, it is well that the work concludes with the easier act.

Whether the bistoury or scissors do the cutting, the operation will fail of its purpose, if there be not excised one-half of the tonsil; so that the remaining stump will scarcely reach to the level of the bounding arches.

As the removal of the tonsils by the bistoury or scissors demands some mechanical skill, which must be acquired by repetition of the work, invention has sought to furnish the operator with an instrument which may do the excision with little or no manual dexterity. To do this, an instrument named tonsillotome, of various forms, has been devised. The original model of the tonsillotome was conceived and constructed in America by Fahnestock. Several modifications and improvements of this instrument have since appeared; in some the work is done by pushing, guillotine-like, or by pulling the cutting blade. The tonsillotome, in the main, consists of three parts: a staff which ends in an elliptical ring of which the inner border has a cutting edge; a second staff similar to the first, of which the ring has a cutting edge: and the two staffs are so attached together that the second can be moved on the first; and, as this is done, the tonsil, which is included in the rings, is cut off. And on the double staff there is fixed a transfixor and elevator, which has a barbed end like a fisherman's gig. The instrument is a combination of most ingenious devices, awakening admiration of the numerous

hands which have shared in the creation of its final, present form; and not the least curious is the arrow-pointed transfixor, which can be so adjusted as to lift the tonsil to any elevation above the cutting edges which may be needed.

Though this tonsillotome works so nearly automatically, yet some advice for its use is needed for the inexperienced. The cutting edges should be very sharp. The containing ring should not include any part of the adjacent muscular arches, the palatal veil, or the uvula. The original instrument was worked by both hands; the present one is worked with one hand; or if the left one aids, it is merely in steadying the instrument. In doing the work with one hand, the error is sometimes made of withdrawing the instrument as the cutting is being done; this must be studiously avoided by holding the outer staff in place, while the inner is moved inwards or outwards, according as the cutting is done by pulling (the usual way), or pushing; that is, one blade must be held in place while the other does the excision. If both be drawn together, the tonsil will escape from the grasp and much of it will be left behind. And the same will result if the cutting edge be dull.

No instrument is more difficult to be kept in good working condition than the tonsillotome. After each operation the component parts should be taken apart, washed and dried; otherwise it will rust and be unfit for use when next required. And should the edge be dulled, it must be sharpened.

As a training in the operation of tonsillotomy with the tonsillotome, the inexperienced would do well to learn the movements of the instrument in the section of some soft material; nor in this training practice, must the novice introduce his own finger, as the writer once knew a physician to do, with the result of cutting himself.

The operation consists essentially of three principal acts: First, having the patient's mouth securely opened, pass in the instrument and carefully include the tonsils, all neighboring structures being excluded; then thrust the adjusted transfixor through, and slightly uplift the included part; now, firmly holding the outer blade with one or more fingers, withdraw the inner or cutting blade; this last act severs the included tonsils, when the instrument with the excised part is withdrawn.

Of the three methods of removing the tonsils, viz., with the bistoury, scissors or tonsillotome, general authority and usage sanction the last instrument, as the one with which the excision

can be done most rapidly, easily and safely; if an exception be made, it is the use of the scissors in excising the tonsils in the adult.

The question is often asked by the patient whether the removal of the hypertrophied part will give future exemption from a regrowth of tonsillar structure; as answer, such exemption can be promised in those cases in which the greater portion of the tonsil has been removed; such a patient need not fear recurrence: but if, as often occurs, the removal has been but midway to the base, then the stump may regrow; yet such recurrent development rarely reaches such volume as to require another operation.

Another query often made is whether the excision will guard against tonsillitis in a patient who has been the subject of it; to this a reserved answer should be given; for the writer has observed several cases in which suppurated tonsillitis appeared, even though the tonsil had been removed. The explanation of this is that in the work a part of the tonsil had not been removed; follicular structure adjacent to, or concealed under, the pharyngeal arches, had escaped excision. In a few cases of the kind, in the interim between attacks, the writer has re-operated, doing the work with tenaculum and scissors, or with a sharp-edged curette, similar to that used by the gynecologist. The curette can excavate the tonsillar structure to a sufficient depth beneath the arches, when the latter encroach on the tonsil.

The work of tonsillotomy is not free from accident and unexpected contingency.

The most unfortunate accident that can occur is the wounding of the internal carotid artery. Béclard, Burns and other surgical writers have witnessed or known of this accident. The writer has been told by an eye-witness that in a tonsillotomy done by Dr. Geddings, a surgeon of South Carolina, the carotid was opened and the life of the child was only saved by quickly tying the primitive carotid artery. The ascending palatal artery may be abnormally large, and if wounded, a violent bleeding would occur.

An unfortunate contingency, yet luckily a rare one, is fracture of the cutting blade of the tonsillotome. The peril from such accident is that the sharp fragment may fall into the larynx or œsophagus, and in either case do great, and possibly fatal, injury. In such a case every prudent effort should be made to remove the foreign body.

In case the internal carotid be opened, the wound should

instantly be compressed with the finger, either directly applied or indirectly on a piece of sponge or lint; and while the bleeding is thus controlled by an assistant, the common carotid should be rapidly sought for and tied in its upper part. And if hæmorrhage still continues from the distal end, as commonly occurs, then the compression on the wound should be continued digitally or instrumentally.

In every case of tonsillotomy, the wound should be kept under observation until the bleeding has ceased, which commonly occurs after a few minutes. In the child, the blood may continue to escape unobserved, since it is swallowed; and in this way fatal hæmorrhage has occurred; the true condition being unsuspected until it was too late. An instance of this kind fell within the writer's notice. A surgeon of reputation excised the tonsils of a child one afternoon; the following morning the writer was hastily summoned and found the child dying; and with the history that its tonsils had been removed the day before, and that a short time before my arrival it had vomited a large quantity of blood; and until this vomiting, the parents had not suspected bleeding. The child died soon after my arrival.

The bleeding may cease, and afterwards start again; an instance of this occurred in the writer's practice. An enlarged tonsil in an adult was removed; some hours afterwards, the writer was summoned, and found that bleeding had commenced some six hours after the operation. On examining the throat, a small stream of blood was purling from the wound. This bleeding was easily controlled by the pressure of a finger against the wound; the pressure was made by the writer for some minutes, when the man offering to do the work, the task was committed to him with satisfactory result. A good recovery was obtained, though a large amount of blood was lost before assistance was sought.

Since fingers tire, or may be bitten by the patient, a better substitute for them is a forceps-like instrument, which once placed in position, will maintain constant pressure; but while such instrument is being gotten, digital compression may be done directly, or through the medium of lint or sponge laid on the bleeding surface. This immediate compression may be aided by indirect pressure on the common carotid, as advised by Gensoul, to control such bleeding. As instrument for the compression, long-bladed forceps may be employed; of these, one blade is passed into the mouth and placed directly on the bleed-

ing surface, or a piece of sponge may intervene; the other blade may rest on the angle of the jaw. A pair of forceps specially constructed for this work has been devised by Hatin. In the absence of a special instrument, any pair of long-bladed forceps would answer the purpose. And if this is not present, one might extemporize a compressor from a strip of lead or copper, which being bent into a U-form, one of its ends is to be placed on the tonsil, and the other outside, and then the ends can be forced towards each other, and remaining so, continuous compression would be made on the wounded surface. Such compression should be continued for two or three days; and the appliance should be removed in the morning, so that, for some hours, the wound could be carefully watched.

Where the bleeding was not great, Chassaignac controlled it with a piece of ice, which he pressed for some time against the bleeding surface. As local means in such cases, the writer would recommend tannin in powder, or the touching of the part with the tincture of galls or catechu; from his experience, the writer greatly prefers the vegetable astringents to the salts of iron, which are so often employed to control bleeding. The ferruginous astringents have some disagreeable accompaniments when used in the mouth to check bleeding. They darken the teeth, and injure their enamel; and they blacken the tongue and buccal mucous membrane. They overdo the intended purpose; for besides forming the hæmostatic clot, they have a superficial escharotic action on the excised surface; so that when the eschar falls there may be bleeding from the raw surface. To control slight but troublesome bleeding, the thermal cautery has been successfully used; the objection just mentioned against the salts of iron, obtains against the actual cautery; the work is liable to be overdone, and the detaching eschar leaves a surface which can easily bleed.

But in cases in which the bleeding is very profuse, it would be unwise to lose time in the use of the means mentioned, but the surgeon should proceed immediately to ligation of the primitive carotid artery; in such prompt action, there is much greater security than in delay; for if the latter course be pursued, so much blood may be lost that the patient may die from this cause, even though the ligation be done.

Tonsillar Tumors.—Apart from enlargement through simple hypertrophy, the tonsil is seldom the site of neoplastic development; still malignant disease of the type of sarcoma and car-

cinoma, or the latter's equivalent epithelioma, has made its primary appearance in the tonsil. The writer has seen a case of tonsillar sarcoma. Epithelioma developing in the walls of the pharynx, and still oftener in the base of the tongue, may attack the tonsil by migration. The author has seen several examples of this kind. Malignant disease here has its usual history of gradually implicating circumjacent and subjacent parts, with final ulcerative destruction of the structures: life ending, after months of torture, through ichorous pneumonia, or starvation.

Treatment.—In 1856, Langenbeck published the treatment of tonsillar cancer by thermal cauterization. Though the disease was not cured, yet in two cases thus treated, the disease was retarded, and life was prolonged for some months.

For a time, chief attention in treatment was directed to means which retarded the progress of the disease; but the unsatisfactory results thus obtained finally led to more radical measures, in which it was attempted to excise the affected tonsil. Operative work in this line has been done by Cheever, Mickulicz, Lange and others.

In 1883, Mickulicz reported the removal of tonsillar cancer, through an external opening, made as follows: An incision is made from the mastoid process to the os hyoides; the soft parts are then detached from the angle of the jaw, internally and externally, and the angle then exsected; through the opening thus made, an entrance is prepared into the pharynx, and the tonsil is reached and removed. Thus done, the vessels become visible and can be pulled out of the way; or if wounded, they can be tied. The mutilation of the maxilla inferior is a serious objection to the method of Mickulicz; and to avoid this, Cheever and Lange have made an opening at the angle of the jaw into the pharynx; and through such opening they reached and excised malignant disease in the base of the tongue, or in the tonsil.

In pioneering such a route to the pharynx, the position of the external carotid artery must be remembered; this lies under the parotidean sulcus, or depression between the mastoid process and mandibular angle, in which lies the dependent portion of the parotid gland. The lower branches of the cervico-facial portion of the facial nerve lie in the same depression, and they are necessarily injured or severed, in an incision here; hence the risorius Santorini muscle is thus temporarily, or permanently, palsied. The cutaneous incision should lie just behind the lower jaw,

commencing an inch above the angle, and extend an inch and a half along the lower border of the bone. In the horizontal portion of the cut, the facial artery will be met, and it must be ligated. From the middle of this semilunar cut, a vertical incision must be carried an inch and a half downwards. Through such a cut between the lower jaw and the digastric muscle, a free way is opened into the throat; and in its construction, the external and internal carotid being exposed early in the work, they can be avoided; and if the external jugular or its formative branches, and the facial artery be doubly tied and divided, the operation becomes nearly a bloodless one. This cervico-pharyngeal opening can be utilized for extirpation of malignant disease in the pharynx, tonsil and base of the tongue; and in the last case, the cut permits of ligation of the lingual artery in the first portion of its course, whereby one-half of the tongue will be rendered nearly bloodless.

This cervico-pharyngeal route, besides the facility which it offers for the removal of malignant disease within the throat, has the additional advantage that it opens to view the lymphatic glands which sooner or later become implicated, when there is malignant disease within the throat; and such infected glands require removal, and if this is not done, there will be speedy recurrence of the disease. The field, when well opened, must be diligently explored, and every gland which is found, whether large or small, should be removed. A favorite lurking place for such infection, as the author has verified, is in glands which lie on or near the bifurcation of the primitive carotid. The wound made also offers the best opportunities for thorough drainage of the excreta which are thrown off from the wounded parts; and thus pulmonary disease through swallowed ichor is avoided, and speedy healing of the wound is obtained; four weeks, at most, suffice for recovery. The scar remaining in the male is covered by his beard; and even in the beardless it is not very conspicuous.

As a more expeditious plan than the one just described, and one by which the loss of blood would be reduced to a minimum, the writer would suggest to begin the work by ligating the external carotid artery; and then through the cut made, continue the incision into the pharynx. This prophylactic ligation would enable the work to be done in almost bloodless structure, as the writer has verified.

CHAPTER XXI.

PHARYNX.

THE pharynx is the site of inflammation, which may primarily arise in it, or the affection may appear secondarily from inflammation, which, beginning in the tonsils, extends thence to adjacent parts; and in either case, the symptoms are cognate to tonsillitis, and, like it, tend to suppuration. The best treatment, if the patient be seen early, is to scarify the affected parts, and thus let the blood which has accumulated in the surface be evacuated. If the patient be an adult, in whom such treatment can be practiced with more facility than in the child, free scarification once suffices to arrest the inflammation; afterwards, resolution will be promoted by painting the surface daily with the following:

℞. Tr. Iodini compos.
Tr. Gallæ.... ... . .aa ℥ss
Misce.

similar to what was advised for the inflamed tonsil.

Abscess of the Pharynx.—Pharyngeal abscess was first carefully observed and written upon by Abercrombie, in 1819; a few years later, the disease was studied by Fleming, Gillette, Jacquemart and others. Such abscess may appear as an acute, or as a chronic process. It is often named according to its sites; thus we have abscess named retro-pharyngeal, latero-pharyngeal, and antero-pharyngeal, according as it is located behind, at the side or in the front portion of the pharynx. The most usual species is the retro-pharyngeal.

Acute pharyngeal abscess occurs most commonly in the infant; thus of forty-six cases observed by Gautier, thirty-five were seen in young children; and in twenty-six, the infant was less than one year old. Abelin saw the affection in infants only three months old.

Gillette, of Paris, in 1868, wrote on the retro-pharyngeal abscess, drawing his material chiefly from the observations of such

abscess by French surgeons. In retro-pharyngeal abscess, which is the common form, he claims that the point of origin and of commencement is in two lymphatic glands, peculiar to infancy, and which are situated, according to the researches of Gautier, Cocteau and others, on a level with the second vertebra, between the superior constrictor pharyngeal muscle and the anterior recti muscle of the upper part of the spine; these glands are usually two in number, separated by an interval of a half inch, and they lie in a loose connective tissue. They are nearly a half inch long and about a quarter of an inch broad; in the opinion of some observers these dimensions may be due to abnormal development, and in normal state, the glands are believed to be much smaller. In later childhood these glands atrophy and vanish. Gillette saw but one in a child which had passed beyond infancy.

The retro-pharyngeal abscess, which occurs so much oftener in children, is thought by Gillette and Verneuil to begin in this infantile gland. The cases seen have been of different dimensions; it may be limited to a small space, or it may reach down to the sixth or seventh vertebra.

Predisposing causes of the disease are rachitis, scrofula, tuberculosis, syphilis and feebleness of body. It is frequently preceded by disease in the throat, tongue and tonsils; and commencing in these sites, it is probable that it is thence propagated by structural continuity. As local irritant, a foreign body lodged in the throat, has caused abscess; thus a coin has acted.

There are two stages: the inflammatory and the suppurative: and in the former, there is difficulty in swallowing, return of the material swallowed, whether this be liquid or solid; dryness of the throat and a teasing cough. If the subject be an infant at the breast, it has difficulty in drawing the milk. Later, there is salivation, chills, œdema and swelling of the cervical glands. The voice becomes hoarse or suppressed, and the head is bent to one side, or backwards. There is often difficulty of opening the mouth, in consequence of contraction of the muscles of mastication; viz., a trismus which might mislead by awakening the suspicion of tetanus. If the jaws be opened, the exploring finger will find swelling in the throat.

Through narrowing of the faucial isthmus, not only swelling but also breathing is obstructed. Hearing may be impaired, or temporarily lost, through closure of the Eustachian tube. Sometimes vision may be interfered with. The pus, when formed in considerable quantity, may press on the vagus and the sympa-

thetic nerve; and thence fundamental trouble can arise in the peripheral districts which receive innervation from these nerves; this fact analyzed offers an explanation of the lingual, pharyngeal, laryngeal, pulmonic and gastric troubles, which singly or in union are present. The closeness of the internal carotid and internal jugular vein to the abscess may disturb the normal influx and efflux of the blood of the brain; and in the worst cases, the internal jugular may become the site of thrombus, which may reach up into the sinuses of the dura mater, and induce a fatal termination.

Pharyngeal abscess is generally preceded by some anginous affection or traumatic cause; and this in the child may be, for a time, overlooked. The first indication that pus is present, is the difficulty which the patient has in swallowing; and this evidence will further be enforced, if swelling be found in the throat. As the jaws are usually tightly closed, it is difficult to obtain a view of the affected parts; and to do this, the handle of a large spoon, or, better still, a spatula, should be passed between the teeth, backwards, to the fauces. The introduction of such an instrument will excite an effort to vomit, by which the mouth is well opened; and during this, a wedge-shaped cork must be thrust between the molar teeth, so as to maintain the jaws well asunder. Through the opening thus prepared, the finger can safely enter and reach the affected part; then palpation will detect fluctuation, or pointing of pus, if an abscess exists; as Gosselin says, the displaced pus recoils as soon as the finger is lifted. If the abscess has lateral position, the fluctuation is less sensible to the finger, and the touch will be aided, if counter-pressure is made with the other hand, on the outside. And if the pus lies still more anteriorly, it may be detected by bi-manual pressure on the sides of the throat.

From the divergent observations of different writers it is difficult to give the duration of the disease; among seven cases, the disease lasted from one to ten days; in twelve others, the course was from ten to twenty days; and in fourteen others, the duration varied from twenty to sixty days. However divergent and discordant these numbers may be, they do not deter the statistician from deducing his wonted percentage from them; a result of no use to the practitioner; to the latter, the important truth is that the pharyngeal abscess, through tumefaction, closes the fauces, through asphyxia, and finally, if unrelieved, destroys the patient.

The prognosis is more auspicious according as the disease

has been correctly diagnosed at an early period; thus Gautier, who collected twenty-five cases in which the disease had not been recognized, reports that all died; but in a list of sixty-six cases which had been early diagnosed, there were but sixteen deaths. Again Roustan found that in a series of eleven cases wrongly diagnosed, there were eleven deaths; but in twenty-seven cases which were correctly diagnosed, there were ten deaths. The reader, along with the author, will doubtless admire the candor that adorns these statements, and will, perhaps, wonder whether the admission of so many mistakes would have been made elsewhere. A writer who publishes his errors should be assigned a front place among those who are enlarging the domain of medicine; and the gaudy laurel which Fame hastens to place on the brow of him whose daring has ended luckily, would be more fittingly bestowed on him who has announced a failure.

There is a chronic form of pharyngeal abscess, in which the course and evolution are latent; and which, quite unheralded by any of the symptoms which attend the acute form, finally announces itself by difficulty of swallowing. Inspection then of the fauces reveals a collection of pus in the lateral or posterior wall of the pharynx. The patient, in such a case, is of tuberculous, scrofulous, or, more rarely, syphilitic habit. And along with the abscess, not unfrequently there may be vertebral caries seated in the body of one or more of the cervical vertebræ. And then, mingled with the pus there may be osseous detritus; or even a necrosed fragment of bone of some size may be found in the abscess.

Of whatever nature the general dyscrasy may be, the adjacent cervical glands will be implicated; and this tumefaction may lead to an exploration of the throat, and discovery of the pharyngeal affection, long before the advent of dysphagia.

Treatment.—The proper treatment of the pharyngeal abscess is to evacuate the pus at once; for if this be delayed, the purulent material will descend to a location from which the evacuation will be much more difficult. Instances have been observed in which the pus has descended into the posterior mediastinum, causing irreparable injury.

There are two routes through which the pus may be given exit: one through the mouth, and another in which the material is given outlet through an opening made in the upper side of the neck.

The usual method has been to open and evacuate the pus

directly into the fauces; and as far as possible, to allow the pus to escape through the mouth. This plan has certain troublesome accompaniments, to wit, that the material tends to escape downwards, rather than upwards and forwards; and then the material either enters the stomach and is absorbed, or it passes into the lungs, and awakens morbid action there. Again, the opening in the pharynx permits the lodgment of particles of nutriment, or other materials which may be swallowed. Notwithstanding these embarrassing conditions, the writer would open the abscess, on the inside of the throat, in every case of pharyngeal abscess of acute character. The opening may be made with a scalpel of long handle; meantime, the patient's head should be so situated that the liberated matter will have ready escape through the mouth. If the subject be a child, the jaws should be held asunder by some body interposed between the molar teeth. It is probable that the aperture made will close and require re-opening; this can be done with a probe or blunt dissector.

In the event of the abscess being of chronic development, and it being probable that the cervical vertebræ are involved, then it has been recommended to liberate the pus by means of an incision made on the side of the neck, so directed as to reach the purulent cavity. Such an operation was proposed and done by Chiene, of Edinburgh, a few years ago. And as a preliminary step in the work, he performs tracheotomy. Inasmuch as this would be no small quota of the assault made on the patient, the writer would not resort to it unless asphyxia were impending from occlusion of the pharynx; but if suffocation were imminent, tracheotomy should be performed as a prophylactic act. And if this be performed, then anæsthetic inhalation must be done through the tracheal canula. The incision is now to be made, commencing with an external cut, not less than two inches and a half long, along the posterior border of the sterno-cleido-mastoid muscle; and in this the ascending branches of the superficial cervical plexus should be avoided: easily done by carrying the knife behind them. Next, there will probably be met, especially in the dyscrasic subject, enlarged lymphatic glands, which should be removed. The advancing incision should be directed obliquely inwards and backwards; and thus the transverse processes of the second and third cervical vertebræ will be reached, in front of which the incision must pass. The sterno-cleido-mastoid is to be drawn forwards with a retractor, and the separa-

tion of the parts to be carefully continued until the pus is reached; and in this work, to avoid opening into the fauces, the jaws having been separated, a finger of one hand introduced into the pharynx will serve as a controlling guide to the work which the other hand is doing. The deeper portion of the dissection should be done with a blunt dissector. This opening must be near the transverse processes and the bodies of the cervical vertebræ; for thus placed it will be situated quite behind the vessels and nerves which lie in the lateral wall of the pharynx. When the pus cavity is reached, a free opening should be made, and the content washed out with an alkaline solution; and this may consist of a twenty per cent solution of carbonate of potash; such solution is approximately formed by adding three drachms of the salt to two ounces of water. The solvent quality of the alkaline solution will aid in cleansing out the cavity; and afterwards the rinsing out may be finished with an alcoholic or sublimated solution. The opening is to be kept patent by a drainage tube as long as pus is formed, and detersive irrigation continued until the escaping material is of serous character. If the bony wall be implicated, then the affected surface should be scraped off with a strong curette; and in this case the outlet to the site of disease must be maintained open for a much longer time; but if there be no osseous disease, the wound may be allowed to close in a few days, as was done in a successful operation of this kind reported by Carless, of King's College hospital.

Should the pus have lateral rather than median situation, then the incision should be made on the side corresponding to the abscess; and then the recovery would be more rapid, since in such a case the vertebræ would probably not be affected, and the opening to the abscess would be less deep.

The necessity of preliminary tracheotomy has been favored and opposed by those who have written on the pharyngeal abscess. The advantages claimed for it are that it at once disposes of the peril of asphyxia; and, especially, it guards against the penetration of pus into the air-passages, if the abscess is opened intentionally or accidentally on the inside. For, however carefully the opening be made into the fauces, some purulent material must be inhaled into the lungs. Even if the intra-pharyngeal opening is made with the head dependent, as proposed and practiced by Rose in operations on the nose and throat, then the strong inspiratory effort, which is involuntarily made, will carry purulent materials into the lungs. And even trache-

otomy cannot prevent this unless the pharynx below be plugged, which should be done with sponges. The same may be accomplished by tamponing the trachea above the opening made in it, which can also be done with sponges.

Notwithstanding the facts which have been offered as a plea in behalf of preliminary tracheotomy in pharyngeal abscess, the writer thinks there are but few cases in which it would be necessary.

Ulceration of the Pharynx.—Ulceration of the pharynx may arise from an acute inflammatory process, whence arises an ulcerative breach of surface; or the ulcer may arise from some constitutional disease, which may be of syphilitic or tubercular nature.

Ulceration occurring as an event of some acute inflammatory process, is usually of brief duration, vanishing soon after the causal affection has disappeared. For such ulcer simple remedies only are required; the following gargle may be used:

℞. Potass. Chlorat ....℈ii
Aquæ Menthæ.. ... .℥viij
Misce.

Use three times a day. For the same purpose claret wine diluted with an equal part of water may be used.

The chronic form of ulcer, which is but a local manifestation, and a fractional one at that, of a constitutional disease, is a most troublesome affection which may indirectly imperil life. The better knowledge now existing of syphilis and of the means to cure it rarely permits the development of severe pharyngeal ulceration; exceptionally, however, such secondary manifestation is seen. In such cases, the affection of the pharynx renders deglutition painful, so that the patient takes but an insufficient amount of food; whence follow debility, emaciation and a rapid waning of the forces of life.

Such dyscrasic ulceration is preceded by a period of infiltration; in the syphilitic subject this is gummatous in character while it is tubercular in the scrofulous patient; and later, the neoplastic infiltrate disintegrates, and, breaking down, there remains a corresponding breach or ulcer. And if there exist isolated points of infiltration, corresponding points of solution will appear, of which the widening areas enlarge until there is formed by their common fusion, a large denuded surface. And this eroding process, besides lateral and superficial extension, also penetrates into the subjacent structure.

Besides the mode of origination just mentioned, the pharyn-

geal ulcer may result from an abscess, of which, the inner wall sloughing, there may remain an ulcerated surface with but slight tendency to heal.

Pharyngeal ulcer, when occupying a large portion of the wall of the pharynx, if it heals, entails stricture of the pharynx: and this stenosis, as the author has observed, may reach such a degree of constriction as to partly or totally obstruct swallowing.

Treatment.—Isolated topical treatment of the dyscrasic ulcer would be of no benefit; such a mode would resemble the plucking of an occasional leaf from a tree while the trunk is allowed to remain in vigorous growth; to cure the patient, the genetic disease must be energetically treated; and the preceding syphilis, scrofula or other cachexy must take precedence in the management; and this having received the prior and major care, attention may next be directed to the local affection in the throat.

The ulcerated surface should be thoroughly destroyed either by curetting or the thermal cautery; and, in some cases, the curette may be followed by the cautery. Thus the diseased infiltrated tissue is effectually disposed of, and the remaining structure is placed in conditions favorable for healing. If the thermal cautery follow curetting, the former should be done sparingly. And along with the topical and constitutional treatment, the nutrition of the patient demands special attention; he should have a rich, generous diet, in which there should be a due proportion of solid food. From the writer's observation, meats in solid form contribute much more to the maintenance of the body, in such cases, than liquid extracts; in one patient, though he was bounteously fed on liquid food, yet emaciation continued; finally the use of meat in solid form was followed by immediate and rapid improvement. Hence in such disease, solid meats and eggs are invaluable adjuvants in treatment.

The cicatricial contraction of the healing pharynx tends to strictural narrowing, so that after recovery normal swallowing is greatly obstructed. To obviate this tendency to narrowing, dilating sounds or expanding instruments should now and then be passed through the pharynx.

Sometimes the case only comes under observation after the ulcerated wall has healed, and constriction has taken place. The appropriate treatment in such a case is to incise the wall vertically, and then dilate with sounds; or, what is better, one may use handled forceps; and the blades being passed below the constriction, the handles are separated, and the instrument

withdrawn. In this way the calibre can be widened, and by persevering effort, this can be maintained so; yet to be successful, instrumental dilatation must be continued for a year or two.

Pharyngeal Tumors.—The pharynx is the not infrequent site of growths which may arise there primarily, or extend to it through emigration from adjacent parts. These neoplasms may be benign or malignant in nature; the latter may be sarcomatous or carcinomatous in species. The notorious naso-pharyngeal tumor may arise from the upper part of the posterior wall; or from the roof of the choanæ; and for the description and treatment of this growth, the reader is referred to a preceding section of this work.

A benign tumor of polypoid character has been observed in the pharynx. Histologically, such tumor may be included in the group of the fibromata. It may appear at any point of the pharyngeal wall; and, when at the root of the tongue, or the base of the epiglottis, or where the pharyngeal isthmus merges into the larynx and œsophagus, then the tumor may be overlooked, and remain unseen and unknown to the patient until its increased volume encroaches on the entrance of the air-passages and interferes with respiration; or entering the œsophagus, swallowing may be rendered difficult, or be entirely obstructed. The tumor may be so located, as to obstruct both respiration and deglutition. A case of the latter kind was reported to the writer; the tumor had never been recognized during life; but the patient dying suddenly from suffocation, an autopsy revealed a tumor situated near the larynx.

The determination and diagnosis of the intra-pharyngeal polyp may be made by means of the sound, digital palpation and the pharyngoscopic mirror; and these are aided by the subjective symptoms to which the tumor gives origin. Any subjective sign should receive due attention, and lead to a searching exploration of the parts.

When found, such tumor must be radically removed; and the facility or difficulty of doing this will depend on whether the growth is pedunculated or sessile. If the tumor arise by a narrow footstalk, its extraction is easily done; by a pair of forceps, the growth can be twisted and plucked from its ground. And this may be done through the mouth. But if the location be deep, and the tumor have a broad sessile attachment, the task of removal becomes an arduous one; and the work may be done through the mouth; or a shorter route may be made to it by an

incision made between the larynx and the carotid artery. Through an opening thus formed, the site of origin could be reached directly, and the work of removal so thoroughly done, that a re-growth would be prevented. After closure of the cervical wound, the nutrition should be maintained by means of liquid food conveyed through an œsophageal tube.

Carcinoma may appear in the pharynx, primarily, or as an emigrant; and when occupying this site, modern surgery in the work of removal has sought to reach the growth by an incision through the side of the neck, or by an opening in which the maxilla inferior is divided.

Through the side of the neck, Langenbeck, in 1877, reached the growth by the following incision: let the knife start at a point midway between the chin and the angle of the jaw, and thence pass downwards over the great cornu of the hyoid bone until it reaches the level of the cricoid cartilage; in its course downwards, this incision follows the direction of the thyro-hyoid muscle. As the incision is carried inwards, the superior thyroid, lingual and facial arteries will be reached; the first and second must be doubly tied, and divided; and the facial may also be ligated, if it cannot be pulled upwards out of the way. The digastric and stylo-hyoid muscles when reached must be detached from the hyoid bone. Finally, the larynx is reached, and is to be turned around somewhat on its axis and pulled aside, when the pharynx being reached, it must be dissected from the parts to which it is connected. The diseased pharynx may be divided above, on a level with the pendulous veil of the palate; also below, at a point corresponding to the inferior limit of the disease. The detachment is not difficult if done at an early period before the disease has reached into, or beyond, the tissue which separates the pharynx from the parts external to it.

The risk after the operation is the penetration of pus and other materials into the lungs, and thence ichorous (gurgitant) pneumonia can arise; to prevent or lessen these risks, Langenbeck tracheotomizes and tampons the trachea above, and as further aid he sutures the epiglottis to the opening into the larynx.

Fischer first opens between the hyoid bone and the thyroid cartilage; that is, he performs sub-hyoid laryngotomy; and after removing the affected pharynx, he fixes the end of the œsophagus in the wound, and, letting it heal there, the patient is afterwards fed through this opening.

Küster and Kroenlein, as fore-act in pharyngotomy, divide

the lower jaw near its angle, and then pass directly to the affected part. Kroenlein operated as follows: a cut was made from the angle of the mouth to the angle of the lower jaw, and carried thence to the mastoid process; and then the lower jaw was divided at the angle, and the ascending portion was so pulled aside that the pharynx can be entered. After removal of the disease, the ramus is restored to place, and united to the horizontal portion by means of metallic suture.

Küster deviated somewhat from this plan, in this, that, to prevent subsequent maxillary anchylosis, he removed the ramus.

Lodgment of foreign Bodies in the Pharynx.—The pharyngeal isthmus is the site of lodgment of foreign bodies, which, in their transit from the oral cavity, are caught and remain in this space. Examples of such bodies are the pin, needle, fish-bone or other sharp-pointed object. The movements of the pharyngeal walls in deglutition are such as often arrest such body, and thrust its point into the wall so that it remains fixed there. A pin has thus been discovered lying crosswise, at the entrance of the œsophagus; or it has been found situated vertically, in one of the crevices or niches in the side of the pharynx; most often between the anterior and posterior arches. And sometimes, the object enters the choanæ; and there it escapes detection, unless this space be specially explored. In case of such accident, aided by what light the patient's account throws on the matter, the surgeon must make a systematic search of the walls and accessory recesses of the pharyngeal cavity, and if the object is not found, the finger should next explore the parts.

As recesses into which bodies can fall and elude discovery are two pockets which were described by Schutz, in 1844; these spaces are boat-shaped, and situated beneath the tonsil; they extend downwards and end on each side of the larynx. These fossæ are bounded behind by the palato-pharyngeal muscles; are an inch long, and are spacious enough to receive and conceal a body as large as a cherry seed; and if special search is not made for it, such object can remain hidden for an indefinite time.

When the body is found, whether in open or secluded site, it is usually readily removed by means of a long pair of forceps. It sometimes happens, however, that a sharp-pointed object caught in the throat has pricked or torn the surface; and though the object is extracted, such remaining wound makes it difficult to convince the patient that the object has been removed. And it may be added, that the sensation from such wound has often led

to a fruitless search for an object which has been swallowed, or dislodged from its pharyngeal site.

Hyrtl has directed attention to certain folds which lie in the pharynx on the posterior wall of the larynx. These folds correspond to depressions on each side, which sink inwards between the cricoid and the thyroid cartilages. This fold reaches from the arytenoid cartilage to the end of the great horn of the hyoid bone. The free edge of it is directed downwards and backwards, and can have an elevation of three lines. It becomes more apparent when traction is made on the trunk of the superior laryngeal nerve.

This fold of mucous membrane does not obstruct the act of swallowing; but it impedes the free escape of matter in the act of vomiting. And where the fold is of unusual development, it may present an insuperable obstacle to vomiting, as has been seen in some subjects. Sounds which are passed down the pharynx glide easily over this fold; but if the instrument has a prominence, this can catch on the fold in the withdrawal of the instrument; and if this be done rudely, the fold might be torn.

CHAPTER XXII.

SUBLINGUAL REGION.

THERE remains for consideration only a small section of the buccal cavity, viz., the free space beneath the anterior, or free portion of the tongue, known as the sublingual space or region. This space is of greater or less extent, according to the attachment of the tongue to the floor of the mouth. This space is invested with mucous membrane which abounds in muciparous glands. Where the tongue separates from the floor of the mouth in the median line lies the frænum, of which the restricting action on the lingual movements has already been considered. Close to the frænum lie the outlets of the Whartonian and Rivinian ducts, or ducts of the sublingual gland. These outlets are readily visible to the eye, and that of the Whartonian duct is so large that it will admit a small probe.

The outlets of these salivary ducts lie in the summits of irregularly-shaped papillæ, which are vascular and erectile; and when the tongue is uplifted, this erectile action is visible, while, at the same time, the saliva flows from or is ejected from them. These papillary bodies may enlarge and become the source of anxiety to the subject, whose repeated examination of them irritates and enlarges them. These enlarged outlets demand no surgical treatment; the patient must be counseled to neglect them, and, if possible, to forget them. The sublingual space, as ancient history tells us, was utilized by Demosthenes, who is said to have placed pebbles in it, in his elocutionary training; and in imitation of the orator upon the Crown, to the writer's knowledge, the modern sophomore thus trains his tripping tongue.

Beneath this space, and separated from it by the mucous membrane, lie the sublingual gland and the sublingual bursa of Fleischmann. The latter, from its occasionally being the site of ranular cyst, demands description, which, in the language of its discoverer, is as follows: "If from one or the other

side of the frænum, one dissects up the mucous membrane, there is found resting on the genio-hyoglossus muscle, close to the frænum, and behind the ducts of Wharton and those of Rivinianus, a small mucous bursa divided into smaller spaces by septa; this is the sublingual bursa, the existence of which is important to know, in order to have a proper knowledge of ranula." This bursa is found by an antero-posterior section of the floor of the mouth. Its origin is due to the separation of the lingual mucous membrane and the genio-hyoglossus muscle by the interposition of the sublingual gland. According to Tillaux, this bursal space is flat in form, and is divided in the median line, into two parts by the frænum; and it presents two faces, the one attached to the floor of the mouth, and the other attached to the anterior face of the genio-hyoglossus muscle. It is bounded in front, and at the sides, by the lower jaw, and reaches as far back, on the sides, as the first or second molar teeth. This bursal space lies behind the sublingual gland and the duct of Wharton; and, according to the admeasurement of Tillaux, it is, from before backwards, nearly two inches in length. This bursa in some subjects, is traversed by septa which divide it into separate spaces.

The free sublingual portion of the floor of the mouth may be the starting-point of epithelial cancer, which, as a slight erosion, may appear on each side of the frænum, and remain there stationary for a time; and later, it may extend and attack the tongue and the adjacent maxilla. Though the initial point of disease is near the frænum, it usually spreads unilaterally, rather than bilaterally. The ulcerating process, in its extension, finally attacks the lower jaw and penetrates the sublingual structures and the side of the tongue; by metastatic propagation, the disease travels along the lymphatics which surround the duct of Wharton, and appears in the lymphatic glands which lie next to the submaxillary gland; and, finally, the submaxillary gland itself is attacked. The sublingual gland also becomes implicated in the disease.

The proper treatment consists in thorough removal of the affected structures. The knife and thermal cautery should be associated in the removal; the cautery should complete the destruction of any diseased tissues which the knife may have overlooked. If much of the tongue is to be excised, the lingual artery must be tied as a preliminary act. To obviate recurrence, infiltrated glands should be removed, and also the submaxillary gland if it be indurated. Additional points concerning the

treatment will be found in the chapter treating of cancer of the tongue.

Ranula.—The sublingual region is the frequent site of a cystic tumor which is named ranula. This term signifies a small frog; but any relationship between this animal and the tumor is a matter which the writer suspects would puzzle anatomist, pathologist or naturalist.

The ranula may vary in volume from the size of a pea to that of an orange. When small, it lies superficially beneath the mucous membrane; but when large, it may extend deep into the sublingual floor.

Ranula, in reference to its cause, and the structures in which it originates, has been the subject of thoughtful study on the part of the surgical pathologist. In 1850, Haller of Dorpat, wrote a dissertation on ranula, in which he gives the different opinions which obtain in respect to its origin; and these he classifies in four groups: 1. Ranular cyst may arise from retention of saliva in the sublingual or submaxillary gland; or in the duct of the gland; or from rupture of the same into the surrounding tissues. 2. Or it may be a common cyst, originating as such do, elsewhere. 3. Or the content may be mucus, and arise from the retention of the content of a mucous follicle. 4. It may arise from the enlargement of the bursa sublingualis, which lies between the tongue and the genio-hyoglossus muscle.

From his individual studies, Haller concludes that the most usual mode of origin is from the sublingual bursa; and, as such, it is often divided into separate compartments.

Tillaux refers the usual origin of ranula to the sublingual bursa. His attempt to explain the rapid appearance of a large ranula, as dependent on augmentation of the content of the sublingual bursa, is not convincing.

Dassen, in 1858, wrote on ranula and ascribes its origin to the development of a cyst in the submucous tissue; and he asserts that it does not depend on closure of the salivary ducts, or of the mucous follicles.

Besides the ways enumerated in which ranula may originate, the writer has observed cases in which the cyst undoubtedly was connected with bursæ mucosæ which pertain to the muscles which lie in the floor of the mouth; since, in the removal of the ranula, its direct connection and relation with the sublingual muscles were verified.

A comparison of the content of the ranular cyst with saliva

has been made by means of chemical analysis. Normal saliva contains an organic principle named ptyalin; in examination of the content of ranulæ operated on by O. Weber, he did not find ptyalin. Sulphocyanide of potassium is usually found in saliva, and is detected by a solution of iron, the union of the two giving a rose-colored reaction. Weber did not get such reaction with ranular content. He intimates, however, that the retention of a secreted fluid, finally alters its composition; an example of which is that of bile retained in the gall-bladder, which finally loses all its normal character. And by analogy, the same might occur in the case of retained saliva.

Weber and others have sought for an anatomical connection between the ranula and the ducts of the sublingual and submaxillary glands; a probe passed into the latter ducts did not enter the cyst. Also chewing, which causes a flow of saliva from these ducts, which is easily discovered in the open mouth, does not lessen the volume of a ranula; and, further, if the mouth be so opened that one can see the ducts beneath the tongue, if pressure then be made on the cyst within the mouth or on the floor from the outside, then no fluid can be seen exuding from the ducts, nor is the volume lessened.

Again, as proof of non-connection between the ranular cyst and the salivary glands is the fact that when the duct of the latter is opened, or the gland wounded, the surgeon experiences great difficulty in closing the breach; but, on the contrary, if such breach be made in the ranula, the difficulty is equally great to prevent closure; the salivary fistula often remains open despite all surgical effort; a breach in the ranula, with equal persistency, will close.

From the preceding statements it may be concluded that the ranula usually has origin independent of the salivary glands; and if it does arise from the latter, it is exceptional.

Haller finds that ranula is definitely limited from the structures around it; it has a tendency to burst, and soon to refill again; and this quality to close and refill is the cause of the difficulty met in the attempts to cure the ranula. And the treatment should be resorted to early, since, as Allan Burns and others have found, a cure is far more easily accomplished then than at a later period. Besides, the cyst being allowed to grow, it may attain proportions perilous to life; or at least to the parts adjacent. Thus Ehrlich describes the following remarkable case, in the practice of Cline: "A patient called to consult Mr. Cline,

and was ushered into his waiting-room; quickly afterwards the surgeon heard a fall in his room, with screams and groans; and, on opening the door, the patient was found unconscious and suffocating on the floor. Cline, suspecting the cause to be a foreign body in the windpipe, was proceeding to perform tracheotomy, when he perceived that the man's tongue was crowded backwards by a ranula; he plunged a lance into this and gave relief by giving vent to a large quantity of pus and lymph." And in the records of the Society of Surgery, in Paris, there is described a ranula which had grown to such dimensions as to displace the teeth. To prevent such disaster as here mentioned, early intervention is prudent. For the cure many methods have been announced, of which a review here follows.

Paré and Tulpius opened the cyst and then applied a hot iron to its surface. Dionis opened and touched the inner surface with sulphuric acid. Jobert first dissected the mucous membrane from the cyst, and then he split the latter transversely, and drawing the posterior portion backwards towards the tongue, he stitched it there; and the anterior portion was pulled forwards and fixed there by a suture. In this way the cyst is maintained open, and not being able to refill, a cure is effected. Pétrequin cured ranula by passing a leaden suture through it and allowing this to remain in place until the cystic cavity contracted and a cure was obtained. Haller thinks the best methods are those in which an inflammation is excited; and this may be done by cauterization with the hot iron or seton, or by the injection of irritant agents. In a case treated by Pisani, in which incision, excision, suture of the walls and injection of irritating substances had failed, a resort was had to the introduction of a gold tube, which, being retained in place for years, finally effected a cure. Gosselin cured ranula by removing a large portion of the outer wall, and then cauterizing the interior surface with nitrate of silver; this cauterization was repeated every third day, and, thus proceeding, a cure was reached.

Paulli makes two classes of ranula: a primary and a secondary form; the primary is superficial, and seated on each side of the frænum; while the secondary form arises from the rupture of the primary one, and this may penetrate the floor of the mouth, in its growth, and at length reach and rest on the tendon of the digastric muscle. As means of treatment, he advises the injection of tincture of iodine, which, in curing the cyst, may also induce atrophy of the submaxillary gland. Paulli mentions

that Dupuytren cured ranula by the introduction of a small hollow cylinder into the cyst; instead of this Paulli inserted a ring that could be tightened or enlarged. The ring being placed in the cystic cavity, it causes an irritation, and granulations grow over and about it; and these must occasionally be removed.

Bryk, from the observation of nineteen cases of ranula, finds a not infrequent cause to be some inflammatory affection of the floor of the mouth, especially dental disease; and he makes three classes of the affection, viz., sublingual, submaxillary and retro-maxillary. His treatment consists of the seton, which is passed through the ranula, and allowed to remain there; or the work may be done by cauterizing with the galvano-cautery, the wire of which is passed through the cyst.

Michel, of Nancy, reports six operations for the cure of ranula, in which the cyst was dissected out from the floor of the mouth; in five of these cases he first slit the sack and then dissected out the parts; in the sixth case he dissected out the cyst without opening it. This radical treatment has been tried by the writer, yet the disease returned, due probably to imperfect dissection. In two cases the author stuffed the cysts with powdered capsicum; in one a cure was obtained; in the other the ranula reappeared, but was finally cured by repeated excision of portions of the cystic wall.

As an epitomized summary of means which may be resorted to, the following is offered: open and pencil the inner surface with a strong tincture of iodine, or with a strong solution of nitrate of silver, or chloride of zinc; forty grains to the ounce of either of these agents would be of sufficient strength. This escharotic application should be used every second day until its action has been tested; and, in case of failure, try the thermal cautery. Should failure attend all these modes of treatment, then resort to excision, partial or total. To perform such extirpation through the mouth is attended with much difficulty, and there is also danger of wounding vessels; to avoid these difficulties the work of removal may be done through the floor of the mouth. For this, let an antero-posterior cut be made through the skin in the median line, and then, with a blunt dissector, separate the genio-hyoid and genio-hyoglossi muscles; thus the cyst might be reached and enucleated; injured vessels could be tied and drainage easily provided for, and the work done, possibly, without entering the oral cavity.

In closing the chapter on ranula, reference should be made to

three bursæ described by Verneuil, and which, when enlarged, may be named pseudo-ranulæ. 1. The ante-thyroid bursa, which is subcutaneous and lies in front of the thyroid cartilage; and this cavity can communicate with a similar one which is situated behind the origin of the sterno-thyroid muscles. 2. A deep sub-hyoid bursa which arises through the friction of the hyoid bone against the upper margin of the thyroid cartilage; and this sub-hyoid bursa may be divided by a septum into two smaller cavities. This bursa may enlarge and then extend under the hyoid bone. Verneuil claims that the sub-hyoid ranula of Nélaton, in place of originating from enlarged sublingual mucous glands, arises from dropsy of the hyo-thyroidean bursa. 3. A supra-hyoid bursa, which is only exceptionally seen; this is bounded above and behind by the genio-hyoglossi muscles.

Verneuil combats the opinion of Nélaton that the sublingual mucous glands can, by abnormal growth, penetrate the sublingual structures, and, finally, appear under the chin; for such a development would be arrested by the dense glosso-epiglottic, hyo-epiglottic, and hyo thyroid membranes; and hence he claims that, should the foregoing bursa enlarge, the resulting cyst should not be included under the head of ranula.

The writer has observed and treated cases of the bursal cyst here described. The surest means of cure is to dissect out the cyst; and in doing this, unless the work be done with much care, the scalpel can penetrate the laryngo-pharyngeal cavity, and seriously complicate the recovery. A means of treatment unattended by the risk mentioned, would be to evacuate the content, and inject tincture of iodine into the cavity. And, as occurs in similar treatment of hydrocele, it may be necessary to repeat this procedure two or three times.

CHAPTER XXIII.

MAXILLA INFERIOR.

THE function of the lower jaw is to contain and retain in place one-half of the teeth; and, through the medium of eight muscles, it becomes the instrument by which mastication is accomplished; for the upper jaw is motionless in the acts of chewing, while the lower one is the sole factor of these movements. This important function must be borne in mind in the treatment of maxillary luxation and fracture, and in all operations in which the continuity of the bone is broken.

Surgical Anatomy.—Certain landmarks demand the attention of the surgeon, and should be accurately known; these are the mental foramen, the depression for the facial artery, the inferior dental foramen, with the prominence of Spix, and the condyle.

The mental foramen, through which escapes the terminal portion of the inferior dental nerve, is situated near the middle of the central portion of the body of the lower jaw, or beneath the second bicuspid tooth (Desprès). In the maturity of adult life this foramen lies midway between the upper and lower margins; but as the form of the jaw is changed under the wasting agency of years, this opening finally becomes situated much nearer the upper than the lower margin. It lies in the continuation of a straight line which passes through the supra-orbital and the infra-orbital foramina.

On the outside of the body of the lower jaw, near its union with the ramus, and nearly an inch from the posterior margin of the angle, there is a depression in which lies the facial artery with its accompanying veins; and this point is sometimes utilized for compressing the vessel, when incisions are made which may open the labial vessels. This depression becomes greater with age.

In the middle of the lower portion of the ramus of the jaw lies, on the inside, an opening for the entrance of the inferior dental nerve. This opening lies at the point of intersection of two lines.

one of which lies in the median line of the ramus, while the other is in the median line of the body; and such point of intersection corresponds to the axis of motion of the jaw in its upward and downward movements; and in such axis the nerve, as Hyrtl points out, is absolutely free from any pulling or stretching. A prominence exists on the lower edge of this foramen, known as the eminence of Spix, which may guide the searcher for the nerve in the operation of neurectomy.

Another important landmark is the condyle of the lower jaw, which lies in front of and close to the tragus. This rounded eminence is easily felt through the integument; and when the mouth is being opened, the condyle can be felt moving forwards; and as it does so, it becomes more prominent.

Between the condyle and the temporal bone is interposed an interarticular cartilage, of meniscoid form. The condyle has intimate relations with the branches of the internal maxillary artery and the accompanying veins; and these vessels may bleed freely if wounded in disarticulating the ramus of the jaw.

The maxilla inferior has only a limited range of movement, being arrested by the upper jaw above; and muscles and ligaments limit descent downwards.

The lower jaw, in its work, is an example of a lever of the third order; and in mastication the work done by the incisors requires more power than that done by the molars. The reverse of this obtains in forcibly depressing the jaw, when less power is needed in front than if the work be done further backwards.

Congenital Deformity.—The lower jaw is the subject of congenital defect and deformity, which have been studied by Ogston, who, in 1873, wrote on this subject. His classification is as follows: (1) entire absence of the lower jaw; (2) unusual size of the jaw; (3) unusual smallness of the jaw in its entirety; (4) abnormal smallness on one side. He finds that such deformities are rare. Entire absence of the bone has only been seen among animals. Enormous largeness is rare, and, when present, is associated with defect of other bones. Abnormal smallness is likewise associated with other kindred deformities; unilateral smallness is associated with other asymetrical conditions of the skull; and, finally, the temporo-maxillary joint may be absent. Congenital luxation of the jaw is a rare occurrence.

Alveolar Periostitis, Gingivitis, and dental Abscess.—The periosteal

and mucous tegumentary tissues of the alveolar process of the lower jaw are the occasional site of inflammation. Since a similar process occurs in the alveolar process of the upper jaw, a description of the affections in the one jaw applies to those of the other. As to the nomenclature, the term parulis is used to denote this disease.

As causes of parulis may be mentioned dental disease, in which one or more teeth may be affected, disease of the osseous alveolar structure, or a wound of the gingival structure itself. The affection may be seated on a small portion of the alveolar process; or a very large portion may be implicated. The writer has observed it oftenest in the upper incisor region; though, not infrequently, it appears near the lower molar teeth.

The inflammation may commence in the gingival tissue, and thence reach and attack the periosteum; or, commencing in the bone, it may pass to the mucous membrane. It may be on the inner or the outer side of the maxillary arch; or both sides may be simultaneously inflamed. And whether it begins centrally or superficially, at first the gingival tissue swells, is hard, and is intensely red. There is pain of a throbbing character, which is usually continuous; and this may be felt in a field which is much greater than the affected structure.

After a few days of tormenting annoyance to the patient, suppuration supervenes; pus forms on or near the bone, and commonly detaches, for a short space, the soft parts from the bone; and thus arises an abscess, of which the purulent content can be detected by the trained finger.

As just traced, such is the cause of an acute gingivitis ending in suppuration; a form, more slow in its march, is sometimes met, in which the causal agency is dental caries or disease of a limited portion of the alveolar process. This form may have a course which may continue indefinitely long; in its duration, years are often counted. The abscess which here forms, opens, and there remains a narrow passage or fistulous canal, which, traversing the soft parts, reaches to, and penetrates into, or passes quite through the alveolar process.

Treatment.—The treatment proper for the acute form differs from that required in the chronic; for the former, seek for the causal agency and remove that. But the all-important thing to be done is to combat the disease in its early stage, by freely scarifying the inflamed structures, and thus permitting the congested, stagnating blood to escape. The incisions should be made with

a knife which is faultlessly sharp, and when the bleeding has ceased, the affected part should be painted with a mixture composed of equal parts of tincture of iodine and tincture of nutgalls. Intervention in this manner, at an early period, may intercept and avert the approaching suppuration; but, as a rule, the patient allows this desirable opportunity to escape: the case usually has reached the suppurative stage when it is first seen; and, as already said, the experienced touch can distinguish the liquid content beneath, or within the tumefied structure. The proper management here, is to lay the abscess open, so that the purulent content of the abscess and the blood in its walls may have ready escape; and to effect this, the incision must be free, and reach to the bottom of the abscess, even to the roots of the teeth, whether the disease be on the upper or on the lower jaw. Thus, the abscess may easily be cured in most cases; but if the causal agency be dental or alveolar caries, or necrosis, the evacuation of the abscess gives but temporary relief, since there will afterwards remain a fistulous opening which will have indefinite continuance; and in its course, it will present alternations of closing, filling with pus, and reopening. The disease has now assumed the character of chronic abscess communicating with the surface by means of a fistula which, according as it is located, may be named a dental or alveolar fistula.

The dental fistula is preceded by an abscess, commonly of chronic development. The pus which forms on the alveolar process may open inwards towards the tongue; or outwards between the lip or cheek, and the alveolar arch; or it may pierce the lip, or cheek, and then appear on the outside of the attached portion of the lip, or on the cheek; or, after perforating the floor of the mouth, it may open through the skin behind the chin. Exceptionally, such pus has gravitated and appeared on the front of the neck. Around such fistulous passage, the tissues are cicatricially contracted, and are usually depressed towards the site of the dental or alveolar disease, whence the pus arises. Such fistula penetrates the bone, and may completely traverse the alveolar process. Or the disease may extend into the body of the bone, whether this be the upper or lower jaw. Suppurative disease of the antrum has found an outlet below, and resembled alveolar or dental fistula. One of the worst cases of alveolar fistula treated by the writer had its origin in an imperfectly evolved incisor tooth. A large portion of the premaxillary bone, in which the tooth was obliquely fixed, became the site of

destructive caries. Such fistula has been observed by the writer located in the lower jaw, and situated near the symphysis; and in two cases of the kind, the osseous disease reached almost through the bone, antero-posteriorly. The cutaneous opening would occasionally close, and afterwards, when pus reformed, the sinus reopened externally.

The dental or alveolar fistula is nearly painless, unless it should be so placed as to implicate the dental nerve; the chief trouble from it is the occasional purulent discharge; and it may further disturb the patient by causing some deformity when it has a cutaneous opening.

Treatment.—In those cases in which the affection primally originates in a decayed tooth, the latter should be extracted; but if the fistula has arisen from a limited caries of the maxilla, then to radically cure, the carious structure must be removed. For this work, a scalpel, small trephine, curette and small chisel are required. When practicable, let the work be done within the oral cavity; even when the fistula opens through the skin remote from the affected bone, it is possible, in almost every case, to detach the labial or buccal structure from the alveolar process, and find the affected point of bone within the mouth. The soft parts are now to be uplifted from the bone; and when the diseased structure is thus brought into full view, a trephine, of three lines diameter, is to be placed on the site of disease, and a circular section of bone around the fistula thus removed. Care must be taken that the trephine includes all the diseased bone: both laterally and in depth. All irregularities of surface are to be scraped or rasped off. After this, the adjacent soft parts are to be brought over the breach, and, if necessary, fixed there by a suture. This exsection may be done with a gouge or a round-edged chisel; yet done in the latter way, some affected structure is more easily overlooked than if one first circumscribes the whole with the trephining crown.

After the bone has been thus excised, the walls of the fistula must be trimmed, and the wounded surfaces so opposed and sutured as to efface, as much as possible, the preexisting deformity.

By the treatment, as detailed, of the maxillary fistula, whether dental, alveolar, or situated in the body of the jaw, an affection may be gotten rid of in a few days, which has worried the patient for years.

Wisdom Teeth.—The eruption of the posterior molar teeth, the

so-named *wisdom teeth*, is often accompanied by great trouble to the patient; and this is limited almost wholly to those of the inferior maxilla. This trouble may arise from the mal-position and ill-direction in which the teeth grow; or it may arise from the want of room for the appearance of this the last member of the dental family.

Where the germ of the tooth is situated abnormally, as the dental crown develops, it may impinge against the adjacent tooth, or the front edge of the ramus; or be directed against the walls of the alveolus on the inner or outer side. Thus ill-placed, the growing tooth causes pain; and this pain is the most excruciating when the crown is deflected towards the ramus. The worst condition is that in which the dental crown is so situated beneath the margin of the ramus that it cannot appear in the oral cavity; then, through pressure, it bores itself a way into the bone; or, if there be partial space for its appearance, it separates and uplifts the soft parts from the margin of the ramus; and these soft parts are maintained in a state of painful ulceration. Should there be ample space for the appearance of the tooth, the process of its eruption will be of transient duration, and the pain from it will be slight.

This dental trouble, in the cases in which some abnormal condition impedes the eruption of the tooth, announces itself by tumefaction of the superjacent or adjacent soft parts; the gingival tissue is red and painful; and there is a pseudo-trismus present, in which the temporal and masseter muscles are contracted and fix the lower jaw nearly immovably against the upper one. The swelling may extend and appear on the outside, near the angle of the jaw; and the lymphatic glands of the region may also swell. The affection finally ends in suppuration of the affected gingival structure; and in severe cases, this may involve the adjacent soft parts. Where the tooth is imprisoned beneath the border of the ramus, or, by ill-position, it is deflected from the normal outlet, in such cases there occurs alveolar necrosis, on a larger or smaller scale. This osseous disease aggravates that of the soft part, so that, in the latter, the suppurative action may traverse the soft parts and appear on the outside. The affection is rarely of so grave a character as this; in the cases in which surgical assistance is usually sought, the tooth merely crowds against the neighboring tissues, and, uplifting these, maintains in them a painful ulceration, which may continue for many weeks.

Treatment.—The management of such affection is determined by the causal agency and the resultant conditions. In the milder and usual form, relief will be obtained by catching with toothed forceps the tissue which is pressed open, and cutting this off with scissors. But to do this, the mouth must first be opened, and retained so. This may be done in one of the ways which the writer has described, when treating of operations on the tonsil; and in the absence of a specially devised instrument, a piece of wood of wedge-shape may be pushed between the upper and lower molar teeth; and to assist in opening the mouth, let gradual downward pressure be made on the chin.

If the trouble be of a severer grade, of the form in which there is insufficient space for the eruption of the tooth, if the crown has so appeared that a dental forceps can seize it, let it be extracted; but if the crown be inaccessible, then the next preceding molar tooth may be removed. Though this practice has the sanction of high authority, it should not be resorted to until reasonable effort has failed to get rid of the real offender. For example, by the aid of scissors and cutting forceps, the soft tissues and the bony structures can be so opened that the tooth can be exposed, and drawn; and though this work may cost the patient much pain, yet he will have ample recompense in preserving the preceding molar, which will remain with him as a lifelong friend; while the wisdom tooth is often only a transient sojourner, and, during its stay, is often the occasion of so much annoyance, that it will be a real boon when the cycle of evolution is completed which is destined to omit this tooth from man's mouth.

In case the dens sapiens is so ill-placed that it cannot escape from its alveolar prison, then a dental cyst or partial maxillary necrosis may result; and in such condition, operative intervention, adapted to the conditions present, must be resorted to; and if possible, this should be done within the buccal cavity; but if this be impracticable, then an opening should be made around the angle of the jaw, the soft parts reflected upwards and forwards, and the disease reached and removed.

Necrosis of the Lower Jaw.—The immediate or direct cause of necrosis of the inferior maxilla (and this applies equally well to the upper jaw) is inflammatory action ending in the formation of pus next to, or within the bone; and such inflammation is located in the periosteum. The necrosis may be partial, and limited to the outer lamella of the bone; or it may involve the entire thickness of the bone; and in the latter case, a large portion, or the entirety of the maxilla may die.

Along with the work of necrosis, the process of repair is likewise present, and new bone in diverse forms may be produced; for example, this can grow in regular lamellated form, of even, regular surface, and this may be as thick as the normal structure; or it may be of paper-like tenuity; and the whole may be a complete model, and an analogue of the necrosing maxilla, which it surrounds. The site of this new bone is exterior to the original maxilla, and it is produced from the inner face of the periosteal membrane; one isolated case is reported of reproduction of maxillary structure from the outer face of the periosteum. Instead of a regular osseous envelope of the form mentioned, the new growth may occur irregularly in the form named osteophytes; the mineralogical term stalactite is sometimes used to designate this formation. These osseous growths in spine-form or crest-like ridges, originate from isolated sections of periosteum which, from some exciting cause, are stimulated to excessive osteo-genetic activity.

The reproduction of bone in case of maxillary periostitis does not invariably occur; the inferior maxilla has been known to die, and no new osseous structure has replaced it. The writer has seen this where a portion of the lower jaw had been lost by necrosis. Such defect in reproduction is fortunately not the rule; and where restorative material is nearly or quite absent, it will usually be learned in the history of the case, that new bone has been formed, and afterwards it vanishes through absorption: especially, if the dead sequestrum has been removed prematurely. The reproductive force seems feeblest at the angle of the lower jaw, and in the coronoid and condyloid process; and this may be accounted for in the first and second of the sites mentioned, by the periosteal covering being replaced by the insertion of muscles. Where the outer thickness of the bone is restored, there is absence of the inferior dental canal.

Necrosis of the inferior maxilla, though it may occur at any point, appears oftenest in the middle third of the horizontal portion of the bone: viz., in the part subjacent to the molar teeth. As the disease advances, the teeth above may fall out, and the dead bone be exposed to touch and site; and then the necrosed bone lies, as it were, in a trough, of which the bottom and sides consist of the normal bone thickened by new structure. Instead of opening into the mouth, the suppurative process may perforate the floor of the mouth and appear near the margin of the lower jaw; and the outlet is often near the angle of the jaw.

Such external opening lasts indefinitely long, and soon becomes bounded by an uplifted fringe-like border of granulative tissue; and if it be explored with a sound, the instrument will detect dead bone at the bottom of the fistulous sinus.

Such necrosis is the special appanage of childhood; and frequently dates from the advent of second dentition; yet no age is exempt from it. The following may be mentioned as the chief causal agencies in its production: (1) Dental caries, and irregular development of the roots of the teeth; and such irregularity may consist in a mal-position, in which, the root deviating from its normal site, encroaches on the maxillary structure; and such encroachment can arise from both the radical and coronal portion of the teeth. Also, it is probable that from abnormal closeness of the developing teeth, the inter-dental alveolar structure may die from the compression. (2) Dental caries may arise from mercury and phosphorus; and it has been claimed that arsenical fumes can cause maxillary necrosis. The grinder of pearl-shell has been observed to become the victim of such necrosis. The necrosis arising from phosphorus will be treated of in another chapter. (3) Certain constitutional diseases may have maxillary necrosis as a complication; thus it may arise from syphilis, scrofula, scorbutus, rheumatism, measles, smallpox, scarlet fever and typhoid fever. The writer has seen cases of maxillary necrosis from syphilis; this is rarer in the lower than in the upper jaw. As a remote sequel of measles and scarlet fever, the writer has observed a few cases. (4) Some inflammatory affection of the mouth of a gangrenous character may cause necrosis; thus from noma the writer has seen the death of the cheek reach into and implicate the adjacent jaw; in such cases, death usually relieves the surgeon of attention to the necrosis.

Necrosis, on a large scale, occurs much oftener in the lower than in the upper jaw; and this is explicable from the fact that the position of the lower jaw is such that it favors the lodgment on, and gravitation into its structure of morbific materials.

Cotemporaneous with the appearance of suppuration, the affected part becomes larger; and this, primarily, is due to thickening of the periosteum; and subsequently, to the production of bone on the inner face of the affected periosteum; and hence such swelling with suppuration becomes one of the surest signs of the necrosis; and the nature of this disease is clearly established when a fistulous opening forms through which a probe can be passed to the dead bone.

The duration of maxillary necrosis varies according to the part of the bone which is affected. When the necrosis is located in, and limited to, the alveolar process, the course is a brief one; death and detachment of the part affected can occur within a few months. And where the causal agency is some exanthematous disease, the course is a rapid one; here the immediate cause is, probably, an embolic closure of the nutrient vessel of the part; and a portion of bone, being thus deprived of nutrition, it quickly dies. In all cases, in which there is death of the entire thickness of the bone, the work of separation and detachment of the dead segment is a most tedious process, and, for final completion, one may reckon on a period lasting from one and a half to two years.

Prognosis.—Maxillary necrosis does not endanger the patient's life; yet it may be reckoned as a most serious annoyance, since the function of the jaw is seriously impaired. The condition in which the pus has escaped through an external opening, is a more fortunate one than that in which the purulent material and osseous detritus enter the oral cavity, and are swallowed, or, what is yet more deleterious, some of this material descends into the lungs and affects the pulmonary tissue; in the latter case, life is so seriously compromised that death has occurred; and in the other case, the matter, being swallowed and absorbed, impairs general nutrition.

Treatment.—The treatment consists in maintaining a convenient outlet for the purulent matter until the dead structure has become detached from the living bone; and finally, the necrosed bone must be removed.

As soon as there is evidence of the existence of pus, one or more openings must be made through which the purulent material can have ready escape; and such opening should, if possible, be through the soft structures near the lower border of the jaw. If the decaying bone be of large dimensions, such orifice of escape must be kept patent until the dead bone is loose within the ensheathing new structure.

When the sequestrum has become loose within its envelope of new bone, it should be extracted; and for this work there are two routes, viz., external and intra-oral. If the destructive process be limited to the alveolar portion of the jaw, the sequestrum can be reached and extracted through the mouth; but if the lower border be the affected part, then it is better to remove it from the outside, and this can best be done by enlarging a fistu-

lous opening, if such exist. Where the horizontal portion is extensively necrosed, and fistulæ exist through which the purulent detritus escapes, an incision connecting two or more of these openings should be made, and then through the incision the bone can be examined and the dead portion removed through an orifice in the new bone; and if this orifice be too small, it may be enlarged to the necessary extent. In case the sequestrum be long and conoidal in shape, then it should be extracted by its base rather than by its smaller end, for if the attempt be made to extract the reverse of this, the sequestrum will become wedged in the conical canal and immovably fastened there. The experience of the writer furnishes this suggestion.

The work of extraction may often be facilitated by dividing the sequestrum at its middle, and then removing each fragment separately. Such division can be done with a pair of small-bladed cutting forceps.

During the preliminary sequestration of the dead bone, as well as after it has been removed, the buccal cavity should be rinsed out with mint-water, tar-water, chlorinated water, alcoholized water, camphor water or other detersive antiseptic solution.

The fistulæ which accompany maxillary necrosis, and open intra-orally or extra-orally, will soon heal after removal of the sequestrum; and this closure will be accelerated if the granulative tissue which lines the canal be removed; and this may be done with scissors and curette.

If this work be done prior to the appearance of the second teeth, there is danger of destroying the germs of the latter, unless the portions of the alveolar process containing these germs can be left intact; and, as far as it is possible, the operator should spare these portions. Besides this, it is equally important that the necrosed bone should not be removed until the whole of it can be extracted; and this time is usually cotemporaneous with the development and completed formation of the new bone, which replaces the original maxillary structure.

In case of a considerable portion of the inferior maxilla being lost, the replacing material, even when toothless, has enabled the patient to masticate food which was not very hard; and if its use in this respect is unsatisfactory to the patient, he is at least in a condition to wear an artificial set of teeth, since such prothetic substitute is more readily maintained in position on the lower than on the upper jaw.

Phosphorus-Necrosis.—The industrial occupations of civilized man have widened the bounds of surgical pathology and surgical practice; and this applies to those who manufacture the lucifer match, for to this occupation, as causal agency, is referred a form of maxillary necrosis. As this industry has flourished, especially on German soil, one finds that the first study of the subject was made in Germany: to the pen of Lorinser, of Vienna, and afterwards to Heyfelder are due the original descriptions of the disease. The observation was early made that necrosis of the jaws often occurred among the laborers of the match factory.

Lorinser, pioneer in the study of the subject, claimed that the disease was due to the inhalation of fumes of phosphorus. This was contested by others, who urge that the maxillary disease is due to exposure of the laborer to currents of cold air. Others again claim that the subjects of such necrosis were already laboring under affection of the teeth, the gums or the alveolar process, and that without exposure to fumes of phosphorus these same persons would have developed necrosis.

But, despite the opinion of a few dissenters, who, here as elsewhere, seek to ply their barks against the current of common opinion, until the force of that current overwhelms them, general observation agrees that phosphorus is the cause of the maxillary disease, and in its action there is an analogy with that of mercury. As is known, mercury introduced into the organism in large amount finally induces salivation and inflammation of the gingival tissues, and the alveolar processes; in some way cognate to mercurial action, phosphorus exercises its destructive action on the dental and alveolar structure; yet in what form the metalloid acts, whether as an acid, a salt, or as pure phosphorus, remains for determination by the pathological chemist. Decayed teeth and a diseased condition of the soft parts around the teeth seem to prepare the way for the action of the phosphorus; and if these conditions are absent, the disease does not appear. That it is not frequent among laborers who are exposed to phosphorus is shown by the observation of Meyer, that among twelve hundred laborers during a period of thirteen years, there occurred but three cases of maxillary necrosis. The disease attacks both the upper and the lower jaws; yet is much oftener seen in the inferior one, since the position of the latter favors the lodgment and action of morbific agents. Von Bibra and Geist have instituted experiment on rabbits in which the animals were exposed to the fumes of phosphorus; and they found that the animals were not affected

unless their teeth and jaws had previously been subjected to some injury.

The disease commences as an alveolo-dental inflammation; the gingival tissues are swollen and spongy, and suppuration occurs around the teeth; and at this stage, should the laborer cease his occupation, the disease is arrested; and though the teeth loosen and drop out, yet necrosis does not occur in the jaw; but if the exposure is continued, sub-periosteal abscesses develop, and the maxillary body is next attacked and dies in continuity, or in different sections. These abscesses rupturing into the mouth, leave ulcer-like fistulous openings. The teeth fall from the affected part, the subjacent bone dies, and new bone, in regular or irregular outline, is developed around the central sequestrum.

Meantime the jaw is swollen and there may be tumefaction of the adjacent soft parts; and the pus thence resulting may perforate the containing wall, and appear externally. Pain in the teeth is the initial symptom, and this may be fixed in one point, or it may shift erratically and be felt in the ear, temple, or even in the shoulder. The pain may be bilateral and slight, or it may be intense and concentrated in one point of the face, similar to neuralgia. When pus has formed and a free discharge established, the pain lessens and may quite vanish.

As the disease progresses, the new osseous production, designated osteophytic, presents itself in two forms. The one which is denominated phosphoric osteophyte, remains fastened to the dead bone and the surface of the latter; and this consists of fine lamellæ which intercross and are mingled in an irregular manner; and these, in mass, resemble the structure of spongy platinum, or pumice stone. In the other kind of production, the new osseous growth, in stratified layers, is adherent to the periosteum, and this may be eburnated, or of spongy texture. The so-called phosphoric osteophyte occupies the deeper portions of the new osseous production; while that of lamellated structure, and which is of periosteal origin, is situated more externally. In this abnormal osteogony the process of rarefaction exceeds that of eburnation or condensation. And each of these conditions is favorable to, or permits death or regressive action in the new-formed bone; in the dense form there may die isolated tracts through insufficient blood supply; and in the rarefied species the enlarged vessels which traverse it may cause absorption. This new osseous growth, examined chemically and microscopically, conforms to the structure of new bone arising elsewhere.

The sequestrum formed has an irregular surface; it is porous and of a dirty grayish color; and, in its porous structure, it resembles somewhat the new growth of bone which is developed around it; and again, at another point, the dead bone may be dense and ivory-like. The process of inflammation, suppuration, destruction and repair of the maxillary structures differs but little from the same process which attends necrosis arising from other causes; if that from phosphorus has any special characteristic, it is its obstinate persistence.

The necrosed maxillary structure tends usually to make its exit by way of the mouth; the way is opened and remains so, in this direction, in consequence of the slight reproduction of bone which occurs here; this applies to the alveolar processes of the upper and lower jaw: but in the body of the lower one, the sequestrum is so inclosed by the new structure, that usually surgical aid is needed to permit its escape.

Besides the upper and lower jaws, the proximal facial bones may become implicated in the necrosis; this action is not primary, but is consecutive to that beginning in the maxillæ. Such secondary invasion has been seen in the malar, palatal and the turbinated bones; also in the vomer and the ethmoid; and sometimes, by remote propagation, the disease has attacked the frontal, the temporal, the sphenoid, and even the occipital bones.

The manner in which the new bone is produced is similar to that occurring in maxillary necrosis from other causes. Such restoration is never complete and the reproduction takes place much oftener in the lower than in the upper jaw. The incompleteness of the new structure is partly due to abnormal development; and also to the fact that the new-formed bone is usually liable to be lessened by subsequent absorption of some of the new-formed layers of bone. According to Salter, the regeneration of the inferior maxilla, even in the best form which such regrowth presents, is very far from normal maxillary type; and even though the arch be fairly restored, after some years, the bone becomes greatly reduced in size. Such atrophic process may continue eight or ten years. Osseous reproduction has rarely been seen in case of phosphorus-necrosis of the upper jaw.

Visceral complication concurrent with phosphorus-necrosis has been observed in a few cases. Haltenhoff reports amyloid degeneration of the liver, spleen and kidneys; also renal inflammation has been seen. Bucquoy reports the autopsy of a woman who died from phosphorus-necrosis, in which the manifestations of

general poisoning from phosphorus were present, viz., fatty degeneration of the heart, liver, kidneys and the muscles. Inasmuch as few die from phosphorus-necrosis, there have been but few opportunites for the determination of visceral complication; such complication is probably rare, else indications of it would show themselves in the living patient.

When the subjective phenomena are studied, the patients may be divided into two groups. In one class, described by Lailler, the patient's general health is so little impaired that he does not discontinue his occupation; he remains at his work, thinking but little of his ailment until the sequestrum loosens, and, perhaps, escapes into his mouth; especially if the disease be in the upper jaw. And in others, the patient is so little disturbed by his affection, that he does not seek surgical aid until the disease is well advanced; the bone is dead and fistulæ open to it. In another class, the disease is more severe; there is extensive swelling, with violent pain and general fever. When suppuration occurs, the patients become pale, feeble and emaciated; albumen appears in the urine; and the vital forces being consumed, death, after a long period, occurs from exhaustion.

The prognosis is more unfavorable than in any other form of maxillary necrosis. According to Trélat, when both upper and lower jaws are the site of phosphorus-necrosis, one-half of the cases die; if the upper jaw only is affected, one-third of the cases die; but if the lower jaw is the seat, one-fourth of the patients die. At Zürich, Billroth observed four deaths in twenty-four cases. Yet in the history of the fatal cases, death generally resulted from some accidental complication; so that it may be concluded that those who are otherwise in robust health, rarely die from phosphorus-necrosis.

Treatment.—The patient should, at once, be removed from the causal agency of his disease; he must abandon his occupation in the match manufactory.

Internal medication has been advised, and benefit from the use of iodide of potassium has been claimed. The excreta from the necrosing bone should be removed from the buccal cavity through irrigation with alcoholized water, mint-water, dilute claret wine; or a weak solution of borax or chlorate of potash may be used. As mastication is trammeled by the affected teeth, care must be taken that the patient shall have an ample nourishment from semi-liquid food.

In respect to the management of the necrosing bone, two

plans of treatment, opposite in character, have their emulous advocates; in one, the practice is to extirpate the dead bone at an early period; in the other, the removal is deferred to a late period.

Early intervention is advocated by Billroth, who counsels, in cases in which the disease threatens to run a course of a year or more, to intervene long before there is a furrow of separation between the dead and the living bone, and to remove the diseased part; for, thus doing, one diminishes or arrests the suppurative stream at its source, and its exhausting consequences are averted. It is true that such early interference is not followed by a complete cure; two or three subsequent operations may, perhaps, be necessary. The subsequent necrosis which occurs, is not to be referred to the operation; it is merely the natural course of the disease; and the disposal of the bone which is already dead places the patient in a better condition to endure that which follows. The section of the dead from the living bone, Billroth thinks, enables the latter to better resist the process of necrosis. In the single case in which the disease is limited to the surface of the alveolar process, he would wait for the bone to become loose, before extracting it.

Another ground, on which an early removal is advocated, is that, thus doing, the conditions are favored for new osseous production; for the prolonged presence of the necrosed bone promotes absorptive action of the newly-regenerated structure; in fact, the new bone has sometimes nearly vanished from this cause.

Hence those who counsel early intervention would operate at the end of six or eight months; at that time the dead and living bone can be distinguished from each other.

Lorinser advises to interfere at a late period; and this practice is also followed by Trélat. Lorinser would only operate at an early period on those patients in which the pain is excessive, or the suppuration is exhausting the strength. As principles which should serve for guidance in operative work, Trélat has formulated the following: as long as the sequestrum remains immovable, one should not attempt its extraction; one should never attack with the resecting instruments parts which are sound; but when the dead part is movable, then, by division of the soft parts and section of the bone, the sequestrum may be removed. In operating early, Trélat urges that the surgeon runs the risk of doing too little, or too much; germs of the disease are left behind,

whence the inflammation is relighted; and the affection returning, may destroy life by exhaustion.

Hence, as appears, the surgeon has authority to justify either early or tardy intervention: the writer espouses the former plan, and, as advised first by Billroth, and afterwards by Maisonneuve and Verneuil, he would attack the disease in the beginning; and, by thus doing, hope to stay its progress.

The operation of sequestrotomy for the relief of phosphorus-necrosis consists of three acts: detachment of the periosteum, section of the bone, and extraction of the dead bone; and to aid in the removal, it may be necessary to divide the sequestrum into two or more parts. If the dead bone be of small size, the work may be done through the mouth; but if the sequestrum be of much magnitude, an external incision should be made, through which the removal can be done; and when thus done, it should be a cardinal rule to avoid, as far as possible, entrance into the buccal cavity; and this is best done by keeping the chisel or blunt dissector in contact with the bone, in separating the soft parts from the maxilla. After the diseased osseous structure has been removed, the remaining wound should be simply treated in accordance with rules already given for the management of operative work within the oral cavity; the chief thing to be done is to frequently cleanse the cavity, and thus avoid the swallowing of septic matters.

Growths in the Maxilla Inferior.—Maxillary tumors may be classified as benign, semi-malignant and malignant. Within the first class may be included the dental cystoma, odontoma and fibroma; in the second, epulis; and in the third, sarcoma, epithelioma and carcinoma. Of the benign and semi-malignant classes a somewhat extended description will be given; but the third class will be noticed more briefly.

Maxillo-Dental Cystic Tumors.—Guibourt, in 1845, made a study of cystic growths which develop within the maxillary bones. He finds that such growths have been seen by Petit, Cooper and Hawkins, yet the nature of the tumors was imperfectly understood by these surgeons. The subject was afterwards the matter of research by Dupuytren and Nélaton, who partially solved the problem of the nature and mode of origin of the maxillary cyst.

As a compendious history of such tumor Guibourt gives the following: the growth commences as a slightly painful and slowly developing tumor in the maxillary region, which finally crepitates and fluctuates when pressed on; and when it attains some magni-

tude, the teeth fall out, and the overlying bone disappears by absorption.

According to Nélaton it can arise in one of three ways: (1) a morbid condition of the dental vesicle, whence arise hypertrophy and an excessive secretion of liquid or semi-liquid material, which usually arrests the development of the tooth; or the tooth may develop in the cyst. (2) From mal-position of the tooth, the latter crowds on the adjacent bone, and creates a cavity in which fluid is secreted from the dental capsule. (3) From the unusual vital activities of the maxillary bones, conditions are present which favor such development.

In 1873, Magitot wrote an exhaustive monograph on maxillary cysts, from which, as well as from the writings of Broca, the writer has derived many of the facts which hereafter follow.

Every maxillary cyst is either of dental or periosteal origin. It appears normally in any portion of the alveolar process, from the symphysis in front, to the last molar tooth behind, and in such situation it occupies the position normally filled by one or more teeth. Yet, exceptionally, the cyst may be situated abnormally, viz.: it may appear in the nasal process of the upper jaw, in the orbital portion of the same, in the canine fossa, finally, in the ramus of the lower jaw. And these, like those appearing in the alveolar process, are follicular in character, and have arisen from the displacement of dental follicles.

These cysts may seem to have a compound character, which, however, is not really so, for the compound or divided form has arisen from the diseased dental follicle having encountered some hindrance, such as an inter-dental septum; or it may arise from two or more follicles having united or pressed together.

The cyst may vary in volume from the size of a pea to a much larger volume. In its development it may grow into the mouth; or it can expand, and, encroaching on the parts around it, it may push these aside. The mucous membrane which covers it, becomes vascular and injected with blood; but should it grow towards the skin, the latter remains unchanged.

When the cyst is of periosteal origin, in developing, it may awaken an inflammatory action which finally ends in suppuration; and through suppurative action the cyst may open, and discharge its contents, and afterwards fill again. Or, if there be growth without inflammation, the cyst may continue to enlarge until its osseous structure is absorbed, and the remaining wall consists only of mucous membrane. This thin wall may be invested with villi,

or it may be smooth, shining and transparent. It is not always adherent to the adjacent parts. The structure of this wall is similar to that of the dental follicle, and contiguous periosteum.

In cysts of both follicular and periosteal origin, the content is thin, clear, serous, or mucous in character in those cases in which the development has been slow; but if the growth has been rapid, the content may be discolored. Besides those with the liquid content mentioned, cysts also occur of which the content may be bloody, purulent or fat-like.

According to the time of origin, Broca classifies these cysts into those of the embryoplastic period, the odontoplastic period, and the coronary period.

The embryoplastic class corresponds to that period in the evolution of the tooth, in which the germ is contained in a sack or follicle; such cysts have liquid content in which there may be sebaceous matter. The odontoplastic class arises at the time when bony matter, or ivory, is being formed on the developing tooth; and such cysts present a liquid content in which are osseous masses. The cysts of the coronary period correspond in date to a later period in the evolution of the tooth; in such cyst is found the crown of a tooth, or an entire tooth. The last class is the most numerous.

When there is a dental cyst, as a rule, there is the absence of one or more teeth; yet this is not always so, for all the teeth may be present, and then such cyst is referable to a supernumerary dental follicle.

From the observation of one hundred cases, Magitot concludes that when it is congenital the cyst may remain undeveloped for some years. From birth until twenty-nine years of age, the follicular form is the more frequent; but after that time, the periosteal form is the more common one: to be explained, probably, on the ground that in infancy and early life the follicular dental germ is in a state of high activity, while later, the dental periosteum is the frequent subject of morbific action from the adjacent teeth. The origin of the follicular form is a matter of conjecture; while the periosteal species is referable to some agency which awakens a periosteal inflammation. In the follicular form, remnants of teeth are found; numbers varying from two to twenty dental crowns have been seen; and from this circumstance this species has been named dental coronal cyst.

In the periosteal species the mode of development is, that the periosteum becomes uplifted from the cementum, especially from

the end of the dental root; and following the periosteal detachment there is poured into the opened space a small quantity of fluid; and this is retained, since there is no outlet for its escape. The effused material augments, and finally causes decay in the root of the tooth; and this tooth becomes imperfect; and others adjacent may become implicated, and also decay. If the tooth is full-formed, then its displacement causes dragging on the nerve that is supplied to it; and thus pain arises. Later the nerve dies, and the pulp in the root of the tooth, likewise, decays; and the affected tooth then has a gray, dark or bluish appearance. The cyst thus formed can develop laterally; and encroaching on the adjoining tooth, this may be uprooted; or the cyst may form around it.

In regard to pain, the follicular dental cyst in its first stage, is painless; but, at a later period, when nerves are encroached upon, it is painful. But the periosteal cyst is painful in the beginning, so that the patient desires the removal of the tooth; and such tooth being early extracted, a small cyst will be found in the root. If the tooth is not removed, the cyst will continue to grow, until finally it attains large dimensions; and its walls may then be so thin, that they yield under pressure, giving the crackling sensation of parchment. The large follicular cyst is also compressible; but such attenuation of wall is only attained after many years of growth. In the periosteal species, if the affected tooth be extracted at an early period, further development may sometimes be prevented; sometimes, however, the opening in the alveolar process may close up, and the cyst continue its growth.

The maxillary cyst, through suppurative action may open; also, when the content is of serous character, it may rupture and discharge; and when an opening thus occurs, the breach may close, and remain so for a time.

The maxillary cyst may pulsate, and thus simulate an aneurysmal tumor; such pulsatile action is due to vessels in the wall of the tumor. Doubt as to the nature of the case would be cleared up by the use of an exploring needle.

Solid tumors, whether of osseous or other tissue, within the lower jaw, thrust the adjacent bone in every direction; but if the tumor be cystic, it extends more towards the face, that is, outwards. Should a tooth be absent in a young subject, this indicates a cyst of dental origin. A multilocular maxillary cyst, the origin of which is not traceable to either dental follicle or to

dental periosteum, has been observed. Its occurrence is exceedingly rare. This tumor presents an irregular surface, being protuberant or embossed at points; and a protruded portion may be bounded by a wall so thin that it crepitates when pressed upon. This non-dental cyst has sometimes developed very rapidly; in other cases, the growth was of long duration.

Treatment of the Maxillary Dental Cyst.—The cyst of periosteal dental origin, should be treated by removal of the tooth or teeth which are affected; and should the extraction be done before the disease has progressed far, then an immediate closure of the part may be reached, and an early cure obtained. Should, however, the disease have progressed so far as that a large cavity is formed, then the process of repair will be tedious, and the treatment will reach through a period of many months. In the species originating from the dental follicle, the volume reached in development is commonly greater than that from periosteal origin; and consequently, though the case is always curable, yet, from the writer's experience, to effect this, patient and continued effort is demanded. In two cases treated by him, the disease had evidently originated in the embryoplastic period. The operation done was to open the cavity, excise a portion of the parchment-like wall, and to remove the contents; and then the inner surface of the cystic wall was carefully curetted. The cavity which remained was then filled with lint saturated with alcoholized water. In this manner the wound was daily redressed, and after protracted attention, the cases were cured. The writer's experience has taught him that the most important part of such operation is to remove all that is possible of the outer wall of the cyst; thus done, the cavity is secured against premature closure, and a final cure is insured. Where the cyst has a favorable conformation, and is easily accessible, it might be possible to remove the outer osseous wall, and so retain its muco-periosteal investment, that this could be made to cover the remaining wall; and thus a speedy care be obtained; yet the writer's experience justifies the prediction that the attempt here indicated would usually fail, and the wound then heal by granulation and cicatrization.

Odontoma.—The odontoma is a solid tumor which has an indirect relationship to the teeth; it is composed of elements cognate to those of dental structure; and was formerly named a dental exostosis. Our present knowledge of this growth is chiefly due to the researches of Broca.

Broca finds that the odontoma originates from a hypertrophy

of the dental pulp; remaining for a time in a soft state, this afterwards ossifies, or dentifies, as Broca styles it. There primarily occurs a hypergenesis or multiplication of the inceptive dental elements; and this structure, when it has passed through a soft and vascular stage, next becomes the site of osseous or dental deposits, either within the tumor, or on its outside. When the growth is in its soft stage, it is named the non-dentified odontoma; but after ossification, it is named dentified odontoma; in the former, the soft structure is homogeneous in composition; but in assuming the dentified form, the primitive material is differentiated, and forms, remotely resembling teeth, are developed in it. These odontoid structures may be separable, or they may be crowded together into a shapeless mass.

The hypertrophic action may take place near the crown; and this form is named the coronary odontoma; and here, at the base of the crown, there occurs a lateral exostosis composed of dental ivory and enamel. Or the hypertrophy may proceed from the radical portion of the tooth: a form named radical odontoma. The radical odontoma can encroach on and imprison the roots of adjacent teeth.

The era of the development of the odontoma is during the period of second dentition; it is most common in the molar region; the coronary odontoma, however, occurs only in the region of the incisor teeth.

During development the odontoma causes pain of a neuralgic character. Its appearance is announced by swelling and pain, constant or recurrent; and later, an abscess forms, and bursting leaves fistulous openings.

It is often difficult to distinguish between the dental cyst and the odontoma; and to do so, an exploratory incision may be necessary; then, if the case is cystic, one enters a hollow cavity; but if it be an odontoma, solid structure is met. The non-eruption of adjacent teeth denotes odontoma.

Treatment.—The coronary odontoma need not be interfered with, since it causes no inconvenience. In all cases in which the growth causes no pain, non-interference should be the rule; but if pain be present, the tooth should be removed. Also, if the odontoma be contained within the maxilla and a fistulous opening lead to it, then an opening should be made through which the odontoma can be removed; and in this work it is sometimes required to remove with a chisel or forceps a portion of the containing alveolar wall.

Fibroma.—Fibroma, as a very infrequent growth, has been observed in the upper and lower jaws; it has been seen more frequently in the inferior maxilla. In site it is included, or seated within the bone; and thus it resembles the odontoma and the maxillary cystic tumor; and this analogy has led to confusion and controversy in regard to the origin of the fibroma. It is akin to the fibro-plastic species of epulis. Its development corresponds to the period of second dentition; and but little pain is caused by it unless it encroaches on a nerve. In the upper jaw it may partially obstruct a nostril, or wholly occlude the lachrymal canal. In the lower jaw the fibroma may prevent the closure of the teeth, and thus interfere with mastication. Luxation of the lower jaw has thus arisen. The teeth implanted in such tumor stand in divergent irregularity, and finally fall from their sockets.

The maxillary fibroma can attain great dimensions, and then cause extrême deformity of the face. An example of this was seen by Bauchot in which the lower jaw attained an immense volume, as is shown in the adjacent sketch of the patient. Growing towards the neck, it may encroach on the air-passages and obstruct breathing. And if it prevents closure of the mouth, it allows the saliva to escape, and thus weakens the patient. The

FIGURE 90. Showing an enormous maxillary fibroma observed by Bauchot.

mucous membrane covering it remains intact, and is pale in color. It is hard to the touch; less so than the odontoma, and more so than a cystic tumor; and it becomes of larger volume than the cyst. The adjacent glands remain unaffected. If thoroughly removed it is non-recurrent; and should it return, it would be evidence that the tumor was not a pure fibroma, but of epuloid rather than of fibroid character.

The fibroma should be removed; and the facility of doing this will vary according as the tumor is sessile, partly pedunculated, or wholly pedunculated. The tumor must be circumscribed at its attachment, and the removal be done as close as possible to the bone; for if a fragment be left, from this a new fibromatous production will probably arise. In case the growth be included within the maxillary structure, then the bone must be opened and the tumor thus extracted; and should this be in the lower jaw, the removal may require the division of the body, or a process of the bone, so that a false joint will result. But should the tumor be included in the upper jaw, the accompanying mutilation will be of less import than in the lower jaw; in the latter an attempt should be made to restore the interrupted continuity by metallic ligature. After this ligation an attempt should be made to put the part at rest by a properly devised splint; and for this purpose the surgeon may select one of the appliances employed in the treatment of fracture of the inferior maxilla.

Osteoma.—Exostosis sometimes occurs in the maxillary bones. It is round or lobulated in form, and is not adherent to the skin; and if one thrusts into it a needle, this will be arrested by the hard bony structure. In site this growth may be central or peripheral; that is, an enostosis or an exostosis. The exostosis that is subperiosteal in its site, is the more frequent one; it is oftenest in the young; and may originate in a dental non-suppurating periostitis. Such osseous growth has been seen near the inferior dental foramen. These osseous growths rarely demand treatment; but if they trammel mastication, or are an inconvenience to the patient, they should be removed; and for this purpose chisel and mallet or bone forceps, are instruments with which the work can be done.

Epulis.—This name, etymologically, refers to a growth seated on the gum of the upper or lower jaw. The term has been used somewhat vaguely, since it has been employed to represent tumors which vary in point of origin and in elementary structure.

In 1868, Fouilloux stated, as the result of his studies of epulis, that its place of origin may be one of the following points: (1) it can spring from the medullary canal of the jaw; and this form may appear as late as the thirtieth year. (2) It may arise from the periosteal covering and submucous tissue of the alveolar process near the roots of the teeth. (3) It may originate from the neuroglia, or constituent tissue of the pulp of the teeth; and here the growth is similar to a myxoma. (4) It can grow from the epithelial coating of the gums, or from that of the cheek. (5) An epulis may proceed from the numerous glands situated in the structure of the gums. Fouilloux saw cases of purely epithelial origin.

Studied histologically, epulis may be divided into two classes, viz., the fibro-plastic and the myeloid. The fibro-plastic species consists of fibroid elements, and it springs from the periosteum; or if it commences in the gum, it soon reaches to the periosteum. It is composed of elongated spindle-shaped cells; and among these, multi-nuclear round cells occur.

The myeloid species presents cells of two kinds: the round, simple nucleated cell, and the giant cell, in which the large cell may be viewed as compounded of several rounded, nucleated cells, inclosed in one common enveloping cell. In this species, as well as in the fibro-plastic, one finds but little inter-cellular material. In the myeloid species vessels are developed; and more so than in the fibro-plastic species. In a few cases observed, vessels have been formed so abundantly that pulsation was perceptible in the growth. The epulis is usually soft in texture, and of a violet color; exceptionally its structure is hard and resistant.

The epulis may be sessile or pedunculated; in the former, it occupies a larger space than in the latter, in which the growth may so project from its alveolar origin that it is movable. It appears equally, in the upper and lower jaw; and its site on the gum may primarily be on the inside, or on the outside of the teeth; and in each case it tends to grow towards the other side. It may arise between two teeth; and Dolbeau claims that the common point of origin is the osseous wall or ridge which separates two dental alveoli.

When the growth is of hard texture, and of a bright red color, it is of the fibro-plastic species; but when it is soft and of a dark red or violet hue, then it belongs to the myeloid class, and arises from the bone; and if the tumor pulsates, this is further proof that the growth belongs to the myeloid species.

The writer has seen several cases of the disease; these were always in the young subject; viz., in those between six and twenty-four years of age; and all the cases were females except one. The growth was usually in the lower jaw, and in the region of the incisor teeth. The teeth were sound, and the gums, outside of the affected portion, were also sound. The growth was first observed as a swelling of the point of the gum which lies between two teeth. This swollen tissue was of a purplish hue, softer than the normal tissue of the gum; and free from pain, even when pressed between the fingers; and pressure did not cause bleeding, as would occur in a gum affected with scurvy or other disease. No glandular enlargement was present.

Excepting this neoplasm, the health of the subject of epulis is perfect; and in consequence of this, as well as of the painlessness of the growth, the patient, if an adult, rarely applies for surgical aid until the tumor has attained such dimensions that it interferes with mastication.

Treatment.—Epulis has been classed as a semi-malignant neoplasm; and may be viewed as a growth located in the line which separates malignancy from non-malignancy, with a root springing from each field. With such nature, as thus figuratively conceived, the treatment, to be successful, must take into account this twofold character. Unless the growth be sought for and extracted from its most retired site of origin, it will soon recur.

The patient soliciting assistance, whether child or adult, usually has perfect incisor teeth; and when told that some of these must be sacrificed, not unfrequently there is a revolt against such a proposition; such has been the writer's experience; and the patient then following less radical treatment, has not only failed to be cured, but has found herself in a much worse condition; the disease, through extension, finally involving teeth which were previously unaffected.

A permanent cure can only be secured by an operation in which the affected section of the alveolar process with the teeth contained in it, is excised. This operation was practiced by Mütter, of Philadelphia, as early as 1850. His plan is to first extract a sound tooth on each side of the growth; and through the gaps thus made, a vertical cut is to be made with cutting forceps; and then, having horizontally divided the soft parts with a scalpel, the bone is to be severed with cutting forceps. Instead of forceps, the writer has used a small resection saw; and thus a smooth surface, and one more favorable to immediate healing, is

obtained. Should, however, there be doubt whether the affected part has wholly been removed, the wound may be touched with the ferrum candens, and allowed to heal by granulation.

The author, before proceeding to this mutilating process, has attempted to destroy the growth by the actual cautery; and though the cauterization was thoroughly done, gum and interdental tissue being charred by heat, yet there was invariably a recurrence; and the only advantage from it was, that it made the patient submit more contentedly to the radical excision just described.

Though one or more teeth be lost, the maxillary arch remains so that artificial teeth can be placed in the breach.

Malignant Growths.—Sarcoma, chondroma and carcinoma appear in both the upper and lower jaws. Sarcoma of an epuloid type is not infrequent; in fact, the myeloid species of epulis so closely resembles sarcoma that the two terms, as reciprocals might replace each other. There arises here, as in many sections of surgery, a temptation to reconstruct the existing nomenclature. The example of the well-planned efforts of such innovation by Piorry, Leidy and others, of which but fragmentary traces have escaped oblivion, warn the prudent writer not to waste effort in trying to check the powerful current of usage; and thus conservatively proceeding, myeloid epulis may be viewed as a species or cognate form of sarcoma.

Chondroma in the maxillary region is closely akin to the cancerous growth. It occurs oftenest in the Highmorian sinus of the upper jaw; yet it occurs also in the inferior maxilla; and here its origin may be central, the chondroma beginning within the bone; or it may start peripherally; and then it commences in the periosteum. A tumor which begins latently, and forces its way through the bone without causing ulceration, and is of tuberous outline, often containing cystic compartments, is a central chondroma. But when the tumor is of periosteal origin, its nature becomes apparent at a much earlier period. The chondroma should be extirpated; and care must be used to remove the growth in its entirety; and to be assured of this, the operator must carry the line of excision well into the contiguous sound structure.

Carcinoma.—Cancerous growth of the type of epithelioma may appear primarily in both the upper and lower jaw; or the disease may occur secondarily through propagation from neighboring parts. When it is a primitive growth, the disease commences in

the mucous surface of the gum, or in the periosteal covering of the bone. When it begins in the mucous surface, its development is similar to that of epithelioma elsewhere; thickening of surface is finally succeeded by ulceration that penetrates gradually to the bone. Such disease, from the writer's experience, often appears behind the incisors of the lower jaw, and, burrowing inwards, finally attacks the alveolar process, and exposes the roots of the teeth, which remain in place until the alveolar structure which contains them has been destroyed.

The carcinoma originating in the periosteum grows somewhat differently from that just mentioned; in the growth of the tumor, the periosteum is detached from the bone at an early period, and thus its osteo-genetic action is stimulated, and, as result, new bone is caused to grow. In this way osteophytes are produced which become a part of the tumor.

Carcinoma occurs in those who are advanced in age; the reverse of which is the case with chondroma and sarcoma. Carcinoma occurring primarily in the maxilla develops rapidly: often within six months from the commencement of the growth; it comprises within its domain the entirety of the jaw, and the adjacent parts becoming implicated, are hard in texture, increased in volume, and lose their accustomed mobility. The infiltrated structures soon ulcerate, and ichorous fluid and particles of the decaying structures are discharged. In epuloid sarcoma and chondroma, there is little or no glandular infection; but in carcinoma the neighboring glands become affected at an early period, and, in their voluminous growth, they add greatly to the tumefaction of the soft structures; this applies specially to the lymphatic glands which lie within the arch of the inferior maxilla.

As means of diagnosis, a harpoon-like instrument can be thrust into the growth, and, a fragment being withdrawn, a microscopic examination will determine the nature of the tumor. From the writer's experience, the microscope when questioned in regard to the nature of growths, frequently gives a Delphic response, one that can be interpreted as much for as against malignancy. In fact, the true nature of the growth is to be learned from a study of its clinical history; and in this inquiry, macroscopic rather than microscopic evidence should be given precedence. A hard tumor fastened to the bone, so immovable, in fact, that it simulates an exostosis; and which is usually painless until it ulcerates; and is of rapid growth, and accompanied by

early glandular infection: such are the historical elements of maxillary carcinoma: a history clearly intelligible to experience; and in such a case, the microscope would furnish confirmation, redundant rather than necessary.

Treatment.—The only possible relief for a patient of carcinoma springing from the maxillary bones lies in an excision of the affected bone; and this to be effective, must be done early. For after the glands have become largely swollen, or the soft parts are perforated by ulcerative action, the disease has obtained indisputable hold of the patient's life, and any operation, however thorough it may be done, will prove but a mutilation. An operative attempt then made, instead of ameliorating the patient's condition, will only prove an ally of the disease; and the final result will probably be an abridgment, rather than an extension of life; since, through surgical lesion, a wider field for cancerous devastation will be laid open. Hence, as a cardinal rule of treatment, remove the affected structure as soon as the disease is recognized: and this introduces the study of excision of the inferior maxilla.

Excision of the lower jaw has awakened and stimulated surgical ingenuity; and from mutual emulation to improve the methods, numerous rival procedures have arisen. As famous pioneers in the work were Gensoul, Syme, Bégin, Forget, Heyfelder and Schillbach.

The excision may be partial or total according to the extent of the disease, viz., the operation may only embrace one side; or the median or mental portion may be exsected; or the maxilla in its entirety may be removed. In the removal of the greater part, or of the whole of the lower jaw, there is encountered an unexpected difficulty, to wit, the regression or retroversion of the tongue and retraction of the structures in the maxillary cavity, whereby the patient may be suffocated; this does not occur in partial excision unless the part which is removed be the anterior median portion.

The methods which have been used for unilateral or partial excision, will first be considered. In 1842, Syme did this work through a cut described by him as follows: "The best course for incisions through the cheek is first downwards from that angle of the mouth which is opposite a sound part of the jaw, and then along the base as far as the tumor extends; and if necessary, up along the posterior ramus to the condyle. The flap thus formed having been separated from the tumor, the jaw is partially cut

through with a small saw, and then completely divided by strong cutting pliers. The surgeon then grasping the detached portion turns it outwards, and separates its connection with the muscles and membrane of the mouth. The only arteries that require to be tied are the facial and the transverse branches of the temporal." And should it be required to remove the ramus, the temporal muscle must be divided, so that the joint can be exposed; the knife is then to be "carried close around the condyle, so as to avoid the internal maxillary artery, which crosses the neck of this process on its inner surface, about a half an inch below the joint." The amount of deformity which follows excision of a greater part of the lower jaw was found by Syme to be smaller than could be conceived without actual observation; and on this account, as well as on account of the relief which it afforded the patient, "the operation may be regarded as one of the greatest improvements in modern surgery."

In 1850, Huguier advised to make a cut for excision, which should lie horizontal, below and parallel with the duct of Steno; thus flaps were made which were reflected upwards and downwards; through this cut the bone having been sawed through, half of the jaw can be removed without injury to the facial nerve.

J. F. Heyfelder and his son, Oscar, were early operators in this field; in 1857 the latter wrote on the maxillary excision a monograph, in which is found a review of the work done by his father and others. He wrote that prior to 1843, excision of the lower jaw was feared on account of the nearness of the carotid artery, and suffocation from retraction of the tongue; and to lessen the dangers where total excision was done, in 1843, Signorini removed one-half, and at a later period he ventured to remove the other. After this, total excision was done by Pitha, Heyfelder, Dumreicher, Maisonneuve and Carnochan. In 1853 Heyfelder removed the entire jaw, after having divided the bone at the symphysis. The incision of Heyfelder, similar to that of Huguier, before mentioned, commenced at the angle of the mouth and passed straight backwards, stopping two-fifths of an inch anterior to the lobule of the ear. The bone being divided in front, it is separated from the soft parts by a blunt dissector by which vessels are spared: the facial artery only need be severed. In severing the external pterygoid muscle, one must be careful to avoid the internal maxillary artery. For a time the work was done without dividing the lower lip. Instead of the high horizontal cut, Langenbeck made one along the lower margin of the

maxilla to the angle, and thence upwards to opposite the tongue. Maissonneuve also incised along the lower edge of the maxilla, yet he did not continue his cut upwards on the ramus. In the plan of Maisonneuve it is difficult to reach the summit of the ramus and divide the muscles there. Verneuil followed this plan, and, having sawed the bone through in front, he caught hold of this, and pulling violently, he severed the muscles attached to the ramus. But others condemn this mode of extraction as perilous to the vessels. Chassaignac reported a case in which the internal carotid was thus ruptured. Though the periosteum be preserved by this method, it is rare that new bone has been re-formed.

Forget, also an authority on maxillary excision, directs that special care be used in dividing the bone; the sawing should be so done that no sharp angles can pierce through the overlying soft parts. And should the lip be the site of cancer, Forget directs that this should first be removed and the flaps for closure be constructed, before the bone is severed. As soon as the divided bone has been detached from its site, extensive bleeding will occur from the sublingual region; and this bleeding, which is arterial and venous, should be controlled by ligature. To guard against and to be able to control such hæmorrhage, Dupuytren did not close the wound for at least an hour.

Schillbach, an exhaustive writer on this subject, describes the operation for partial and total excision of the maxilla inferior. For unilateral removal he advises to begin the incision in front of the ear, and carry this down to the angle, and thence along the lower margin to the symphysis; then saw through and detach the soft parts from before backwards; in this dissection spare the inferior dental nerve and artery, until the soft parts beyond are separated; lastly, sever the artery and nerve, and tie the bleeding vessels. The steps are similar where the entire bone is removed. The vertical cut should not be carried beyond the lobule of the ear; thus the facial nerve and parotid gland are left uninjured. Schillbach advises also to avoid the division of the facial vein; for if this be cut and tied, much swelling from retained blood will ensue.

The later operators counsel that in doing the operation the mucous membrane of the mouth should be opened as little as possible; and that this opening be made late in the work. As a method more conservative than any which has been mentioned, Larghi did the excision wholly through the mouth with-

out any external incision; also, Heyfelder excised in this way, in some of his later work.

Despite the encomium passed on inferior maxillary excision by Syme, it has its shadowy side; during the operation, and for some days afterwards, there is danger of suffocation from lingual retraction; also, the face is greatly deformed. These points will next be considered.

Lingual retraction after removal of the lower jaw has been the subject of study by Bégin, who thinks that the operation destroys the equilibrium of the muscles which surround the larynx and pharynx, so that these parts tend to close; and this is mainly done by the posterior muscles, which, pulling on the larynx and hyoid bone, cause their convex surface to look upwards. The effect of such action is to lift the anterior end of the glottis upwards, so that the fissure of the glottis stands vertical; and in such position the air can hardly enter it.

Asphyxia from lingual retraction, according to Bégin, may be primary or secondary; the primary takes place within forty-eight hours, while the secondary occurs at any time afterwards, until the muscles have become securely cicatrized; and this secondary retraction has occurred most unexpectedly, when the patient was considered out of danger. To guard against this accident some surgeons have passed a thread through the tongue and fastened this to the teeth. This plan is not favored by Bégin: he advises to place a wire framework, similar to a mask, around the head, and to tie the thread to this, in front. He advises not to close the wound perfectly; he would leave the lateral cuts open; exact closure in the antero-posterior direction, he claims, tends to force the tongue backwards.

Heyfelder finds that the position of the head has much to do in producing lingual retraction; he observed that it occurred when the patient lifted his head, yet that retraction disappeared when he lowered the head towards the sternum. He passed a thread through the tongue, and committed the charge of this to a nurse; meantime he placed the patient on the side.

Pitha, who made a study of this subject, thinks lingual retraction is not a mere passive act, but that it is due to a spasmodic action of the muscles; and so violent was this in one case, that the tongue could not be held by a ligature which passed through it; and to accomplish fixation a pair of bulldog forceps was used.

The lingual retraction in a case operated on by the writer was counteracted by passing a ligature through the tongue, and then

attaching this to a band which passed behind the head; and in another case, the retaining cord was tied around the ear, and then a strip of adhesive plaster was placed around the head and on the ear so that the cord was retained securely in its place.

Sprengler, in 1864, writing on total excision of the lower jaw, remarks that if the entire bone be removed, the soft parts retract backwards, until they are almost on a level with the underlying larynx. Also, considerable deformity will result if only one side of the anterior median portion be removed. Langenbeck has sought to avoid this deformity by removing the bone in sections at different times. He also tried to avoid deformity by dividing the bone that was to be excised into two parts; and then removing one portion, he left the other to supply its place. Thus, in such a case, he split the ramus into two parts, and then, having excised one of the latter, he shifted the remaining portion so that it occupied the vacant site of the body which had been removed. Though the results obtained in the case were not all that could be wished, yet from experiments on the cadaver, Langenbeck became convinced that the work could be satisfactorily done in this way.

Instead of doing the work as done by Langenbeck, others have sought to lessen the deformity following the inferior maxillary excision by introducing some artificial appliance in the site of the excised bone. Lecat, Langenbeck and others tried this plan, and mechanical devices, similar to those used by the dentist, have been tried. The material of which the appliance was made was leather, silver or vulcanite, and it was held in place by straps which encircled the neck and head. The pain and inconvenience from such substitute was so great that, in most cases, the patient would not tolerate it.

In closing this chapter on excision of the lower jaw, the writer should add that where the whole or a greater portion of the maxilla is removed, direful deformity of the face is inevitable, and the power to masticate food will be lost; in the male, a beard may somewhat mask the deformity; but the ability to chew food will be lost; and the unfortunate subject must afterwards subsist on nutrient material which is in liquid or semi-liquid form. Yet life with such impediments is always accepted by the patient, and by him, as well as by its surgical paternity, the attendant deformity is viewed with complacency.

Anchylosis of the Maxilla Inferior.—The buccal cavity is divided into two compartments by the alveolar dental arches: the one

space is contained between the arches and the cheeks and lips; the other lies within the arches, and is the proper oral cavity; the external one is easily entered, whether the jaws be opened or closed; the inner cavity can only be reached through the separation of the lower jaw from the upper one, or by a circuitous route behind the molar teeth, where the two spaces inter-communicate.

Normally the inferior maxilla is easily depressed from the upper jaw; yet the degree of separation varies in different mouths, as is evident from the observation of mouths which are opened to their utmost. The limitation to opening may depend on some tethering conditions existent in the mucous lining of the cheeks, in the muscles composing the latter, in the ligaments connecting the jaws, or in the osseous structures. And where one or more of those limiting conditions is in excess, the lower jaw may be immovable, or at least inseparable from the superior maxilla; that is, the maxilla inferior is anchylosed.

Bonnet has studied the causes of maxillary anchylosis, and finds that it can arise from an inflammation in the soft parts around the joint; or in the osseous parts composing the joint. Besides these modes of origin, a more usual one is ulceration, abscess, or some lesion of the oral cavity; and, finally, it may arise from muscular retraction and cicatricial shortening.

Schulten, of Finnland, in 1879, classified the causes of anchylosis, as follows: (1) Anchylosis from disease in the maxillo-temporal joint. (2) Myogenous anchylosis, in which immobility arises from some abnormal condition of the muscles. (3) Cicatricial contraction dependent on ulceration or wounds of the mucous lining of the oral cavity. (4) Anchylosis from some deformity of the lower jaw: a species rarely met with.

The author has seen a case in which the prime causal agency was mercurial gangrene in which the cheek was lost by sloughing, due to excessive use of calomel.

Treatment.—For practical purposes the causes of immobility may be reduced to two classes: in one, it arises from an abnormal state of the soft parts; and in the other, it depends on some abnormal condition in the osseous structures; and hence have arisen two different plans of treatment: in one forcible separation, tenotomy, myotomy, and plastic procedures are resorted to; in the other, relief is obtained through osseous division, or resection. Forcible dilatation to overcome anchylosis has been done by a double lever-like instrument, in which the blades are separated by means of a screw which traverses the blades. And afterwards, to maintain

the jaws asunder, corks may be inserted between the teeth and allowed to remain there. The advantage of this plan of treatment is that after the jaws have once been separated, the patient himself can continue the work of separation.

Among the earliest essays in this section of surgery was an operation done by Blasius, for relief in a case in which the cheeks were grown to the jaws, whereby the inferior maxilla became immovable. He made a cut backwards from each angle of the mouth, and then, having dissected the cheeks from the jaws, through the wounds made he next turned the skin inwards, and attached it by sutures to the wounded edge, so that closure of the cuts was prevented. There was thus formed a wide mouth, through which the work of depressing the lower jaw was effected; after mobility was secured, the wide mouth was reduced to normal dimensions by detaching the infolded skin, and uniting the inner mucous border to the inner mucous border, and suturing the derm above to the derm below.

Gussenbauer, in 1877, reported a case in which he operated for relief in a patient in whom the cheeks, having become adherent to the jaws, caused the latter to be immovable. The work commenced with two incisions, which began at the angle of the mouth and extended backwards to the masseter muscle; the flap thus made was folded inwards on itself, so that the derm was turned inwards, and its mucous surface outwards and united to that of the cheek, the two surfaces having been made raw. After union of the raw surfaces, the flap was severed behind, and unfolded so that its base was carried forwards, and became the commissure of the mouth. The disposition of the parts afterwards was such that the inverted derm could not cohere to the jaw, and thus the lower jaw became separable from the upper one.

The plastic procedures of Blasius and Gussenbauer did not find many imitators; on the contrary, many operations were reported in which the work was done subcutaneously, by tenotomy and myotomy. A brief review of the methods pursued in this work, will herewith follow.

In 1840, Mütter, of Philadelphia, did the work of myotomy by intra-oral submucous section of the interior portion of the masseter muscle; the same was done by Buck. Velpeau, who tried this plan in three cases, afterwards had recurrence of the anchylosis.

The muscles on which myotomy was done by those who practiced this plan, were the masseter, the temporal and the

internal pterygoid. Bonnet thinks that division of the internal pterygoid muscle is unnecessary; and that in most cases, section of the masseter is sufficient; and if not, then the temporal muscle should be cut. Bonnet advises that the masseter be divided in its upper portion, since there, the facial nerves and the duct of Stenson are not endangered by the knife; besides, if section be made lower down, the muscle there is so adherent to the bone that relief would not follow its division.

Schmidt divided the masseter in its upper part, yet he did the work inside of the mouth; he commenced at the anterior margin of the muscle, and thence cut backwards, meantime lifting the skin so as to protect it from injury.

Fergusson, also, performs myotomy of the masseter, on the inside of the mouth; he commences beneath the opening of the parotidean duct, and cuts, at first, but one-half of the muscle; fourteen days afterwards, he finishes the operation by dividing the remainder of the muscle.

Bouvier did the myotomy from the outside; after penetrating deeply, he cut towards the skin; he divided the muscle in its middle, and thus avoided the duct of Steno. Bouvier claims that the median section divides all the fibres of the muscle, which is not the case if the division be higher or lower.

In the division of the temporal muscle, Bonnet finds that the work can be done above or below the zygoma; but the lower section is more effective, since the tendon of the muscle is there more loosely surrounded by connective tissue. In the old subject, however, for example, in those over thirty years of age, the coronoid process ascends so high that the temporal tendon cannot be reached below the zygomatic arch. Also, where the upper and lower teeth glide by each other, section of the tendon cannot be made below the arch. The section above the zygoma is less effective, since the temporal muscle there is fastened to the bone by its fibres. Also, branches of the temporal artery may be wounded there, and extensive ecchymosis may ensue. Fergusson made the section from the inside of the mouth; but Bonnet did it from the outside, and cut both above and below the zygoma; and he penetrated quite to the bone, and thence cut outwards. In section above the arch the temporal artery must be shunned.

To sever the internal pterygoid, Guérin cut from the inside, internal to the ascending ramus; yet Fergusson fears that by thus doing, the internal maxillary artery and inferior dental nerve may be severed. To sever the internal pterygoid, the

writer would do the work from the outside, through a crescentic cut bordering the mandibular angle: thus with the parts open to view, the muscle can be wholly severed; and afterwards, the wound could be closed, and united primarily.

Jaesche, of Novogorod, obtained relief in an anchylosed jaw by extending the oral commissure on the affected side and forcibly opening the mouth. At a later period he closed the breach by drawing the mucous and submucous tissues from above and below and uniting them. And in this closure, the work was so done that no raw surfaces were left by which the cheek could reunite to the jaws.

Sprengler reports the cure of a case in which he divided the scar and subsequently placed corks between the jaws to maintain separation; and as aid, he also severed the masseter muscle.

In 1858, Wilms, of Berlin, reported a case of anchylosis of the lower jaw, in which, having tried ineffectually various modes of treatment, he divided the bone on the right side, one and one-half inches from the median line, and then he removed a segment of the jaw over an inch long. Thus a gap was formed which filled with fibrous tissue, and a pseudarthrosis remained. The patient's condition was so improved that he afterwards could chew with the left side of the jaw. Wilms' claim for priority in originating this method was assailed, and it was shown that Bruns had operated thus three years previously, and also that Dieffenbach had advised to form a false joint in such cases.

In 1860, Verneuil, in anchylosis of the lower jaw that could not be overcome by any other means, divided the maxilla with Liston's forceps at a point corresponding to the insertion of the masseter muscle.

In 1860, Esmarch wrote exhaustively on this subject, and he gives the credit to Dieffenbach of introducing the plan of coating with mucous membrane the raw surfaces made in the work of liberation. Esmarch reviews the methods of osteotomy which have been resorted to where the work could not be accomplished by division of the contracted soft parts. He notes that Bruns and others made an artificial joint, yet the error was usually committed by these operators of making the false joint behind instead of before the binding tissue, and hence the jaw remained afterwards as functionless as it was before.

The germinal idea of creating a pseudarthrosis for relief in cases of pseudarthrosis is referred by Verneuil to Rhea Barton.

of Philadelphia, who performed such an operation above the knee. As an early ally in the work Carnochan may be mentioned, who, in 1845, after division of the masseter, in attempting to open the jaw, fractured it, and found this an aid in the matter of movement.

In 1860, Rizzoli announced an operation in which he separated the soft parts within the mouth, and then he divided the maxilla through the site of a bicuspid tooth, or through that of the first molar; this division was made with the saw, or Liston's forceps, without sacrifice of bone, and the result obtained was satisfactory.

In 1865, Mathé reported a number of operations for relief of maxillary anchylosis. In seven cases in which there was no loss of the skin as causal agency, he simply sawed through the maxilla; of these six were cured. But in six cases in which there had been structural loss of the cheek two recovered, three died, and one was a failure. Mathé reports that after resection or division of the jaw, relapse not unfrequently occurred.

Mathé specifies the point as most proper for the division to be between the last molar and the wisdom tooth. In this operation he divided and uplifted the mucous membrane and periosteum, so that, after the bone was divided, these structures could be replaced, and the wound in the bone covered. In case some plastic work is required, this should be done some time after the artificial joint has been formed.

In 1885, Ranke, of Groningen, reported operations done by the method of Bottini: this consisted in an incision along the lower edge of the zygoma, over one inch in length, and to this a vertical cut is to be made an inch in extent. Next, detach the masseter from the zygoma, and dissect down to the condyle; then saw this through its neck and remove the condyle. And in some cases it is well to divide the coronoid process. The writer thinks this plan could be resorted to with advantage in patients in whom the causal agency is in or near the maxillo-temporal joint.

In operations for relief of maxillary anchylosis, if an anæsthetic be used, this should be carefully watched, since the tongue falling backwards may cause strangulation. Ranke says that one patient was thus lost.

In whatever way the treatment of maxillary anchylosis is pursued, the subsequent orthopedic work is highly important; and this may be done by forcing wedges between the jaws on

each side. Cork is often used for such wedge, or the dilatable double-lever before mentioned is a convenient instrument, which the patient can use after some instruction by the surgeon. The dilating appliance is more safely used between the upper and lower bicuspids and molars than between the incisors, for the latter would be in danger of being broken. And along with these instrumental means, the muscles and soft parts which are contracted should be subjected to frequent massage.

Luxation of the Maxilla Inferior.—The anatomical characteristics of the temporo-maxillary joint require some mention as an aid to a proper understanding of the luxation of the lower jaw.

The head of the condyle is separated from the temporal bone, in the glenoid fossa of which it is lodged, by an inter-articular cartilage, and the inclosing parts around are so loose that the head of the condyle and the cartilage can leave their cavity and glide forwards upon the articular eminence, which lies in front of the glenoid cavity. Such movement occurs when the mouth is widely opened or the jaw is advanced forwards. The constant pressure of the head of the condyle, aided by the occasional pressure on the cartilage, tends to perforate the central part of the cartilage. The lines which represent the long axis of the masseter muscle and that of the ramus of the lower jaw are normally nearly parallel, but when the jaw is luxated, these lines approach above, and finally touch or cross each other. This is explained by the fact that in luxation the condyle moves forwards and, as it does so, the angle below moves backwards; and hence, when the condyle is thus displaced, the contracting masseter holds both condyle and angle in their abnormal sites.

Celsus says the maxilla may be luxated forwards, and this may be unilateral or bilateral. If the luxation be unilateral, the jaw and chin are inclined to the other side; the teeth below do not correspond to their fellows above, but the canines lie underneath the incisors. If luxation be on both sides, the entire chin is advanced and depressed, and the lower teeth project beyond the superior ones. The temporal muscles appear tense. This description is so nearly like that of Hippocrates that it is probable that Celsus copied it from Hippocrates. And Hippocrates says further concerning the accident that it is rare and occurs during gaping.

Hippocrates greatly overrates the gravity of dislocation of the lower jaw; he says that if double luxation is not reduced immediately, the patient commonly succumbs within ten days

to a continued fever or a grave coma. And to guard against peril Celsus directs bleeding. These statements do not correspond with modern observation, and are surprising since the ancients rarely err in their account of fractures.

In a dissertation on maxillary luxation Beaugrand states that its true pathology was announced by Fabricius d'Aquapendente, Monro, and Delpech. Delpech says that from the inside of the mouth one can feel and verify the position of the coronoid process, which in luxation rests against the malar prominence, and he thinks that the lodgment at that point is the chief impediment to reduction.

According to Nélaton, in luxation of the inferior maxilla, the anterior wall of the articular capsule must be opened, and the condyle advanced quite beyond the anterior root of the zygoma; the external lateral ligament is rendered tense, though not severed; and the coronoid process may be thrust into the temporal muscle, and thus reduction is rendered difficult. The coronoid process can reach and rest against the malar bone.

Steinlein, of St. Gall, Switzerland, in 1852, studied the mechanism of the luxation of the inferior maxilla: he finds that in the beginning of the opening of the mouth, the lower jaw represents a one-armed lever, of which the fulcrum is the summit of the condyloid process; but as the condyle advances forwards in the movement, the axis of motion is shifted downwards, to near the insertion of the external lateral ligament; finally, the condyle reaches and stands on the summit of the articular tubercle, when the center of movement will descend downwards on the ramus, towards the angle. As soon as the jaw has reached this position, all the masticatory muscles, except the external pterygoid, will unite in drawing the condyle beyond the articular tubercle; and if the submaxillary muscles add their quota to those above, then the articular capsule will be ruptured, and luxation becomes complete.

Hippocrates says that luxation arises from separation of the lower jaw from the upper one, combined with lateral deviation.

It has occurred during violent gaping, laughing, vomiting, and other acts in which the mouth is opened greatly. Luxation has occurred during an epileptic convulsion; also in pulling teeth, and in forcing open the jaws to use the stomach tube for alimentation or vomiting. The writer has known a case caused by the dentist; and another arose during efforts made by himself to introduce the stomach tube in a case of attempted suicide. It

occurs oftener in women, in consequence of the greater laxity of the peri-articular structures in the female.

The subject of luxated inferior maxilla presents himself to the surgeon with open mouth, separated jaws, with advanced chin, and this is deviated to one side, if the luxation is uni-

FIGURE 91. Luxation of Inferior Maxilla.

lateral. The appearance is shown in Figure 91. The saliva is escaping from the mouth; articulate speech is interfered with, since the labial and mute sounds cannot be properly formed. Though the patient suffers but little pain, his usual ignorance of the nature of his case often gives him an expression of fear and anxiety. The writer has a vivid recollection of a man who called on him for treatment at a late hour of night. In answer to the question, what ailed him, after repeated efforts to make himself comprehended, he was understood to say, "I have got the lockjaw." And, literally, this was no mean description of his condition.

The prognosis is favorable; for, if seen early, no luxation is more easily reduced; and even if seen some weeks after the accident, it is commonly reducible. The dislocation may recur; and such recurrence, if often repeated, ultimately takes place so easily, that by a voluntary act the patient may luxate and again reduce the jaw. Such a patient the writer knows, who within a few seconds could luxate and again return the condyle to place. This disposition to dislocation might be avoided by proper care after

the primary accident. Anchylosis may occur where the joint remains unreduced for a long period; this, however, has rarely been observed.

Treatment.—The plan of Hippocrates has served as a model for succeeding generations of surgeons. One assistant grasps and steadies the head; the surgeon grasps with his fingers the jaw, both on the inside and the outside, near the chin; meantime, while the patient is opening the mouth as wide as possible, the surgeon, for some time, moves the jaw; and as he does this, he directs the patient to move the jaw, and yield as much as possible to the movements that are being made; then to reduce, three movements are to be made; lift the jaw towards its normal place, push it backwards, and close the mouth. After reduction, retain the chin in place by a bandage.

Celsus, following this plan somewhat, advises the surgeon to insert his thumbs into the patient's mouth after he has wrapped them in linen so that they cannot slip (he might rather have said to avoid being bitten); with the remaining fingers on the outside, the jaw is strongly grasped, and the work of reduction is then finished by shaking and depressing the chin, and then forcing the maxilla into its site. Feed the patient on a liquid diet, and let him not speak.

Fabricius d'Aquapendente advises to do the work so similarly to the above that it is probable he was a close student and follower of the Fathers of Medicine; nevertheless, Fabricius has the fame of originating the plan of reduction now in use.

The surgeon usually finds the luxated jaw tightly fixed in the abnormal situation; to overcome this, press the jaw downwards and move it, as the old authorities direct; this is more applicable where some time has elapsed since the luxation, and adhesions between surfaces have formed. Most authorities use a similar method of reduction in both unilateral and bilateral luxation. Leo, however, directs in bilateral luxation to reduce each condyle separately; he claims that in this way the reduction is more easily accomplished.

Maisonneuve, from experimental luxation of the inferior maxilla in the cadaver, found that the articular capsule is not torn; nor did he find the coronoid process entangled in the temporal muscle as taught by Nélaton. After luxation, even if the coronoid process were exsected, he did not find the reduction any easier. His plan of reduction was to gently depress the chin, and with the thumbs to press the coronoid process back-

wards. Maisonneuve's plan of reducing does not differ materially from that of Nélaton, who introduced his thumbs within the mouth, and placing them against the ascending portion of the jaw, he pressed this backwards and downwards. And the work can be done without an assistant, if the surgeon standing behind supports the patient's head, while he makes pressure on the jaw on the outside.

If seen early, as the writer has learned from experience, nothing is easier than to reduce the luxated maxilla: let the patient rest his head against a wall while the surgeon, standing in front, grasps the chin with one hand, and pushes backwards, while with the other, seizing the angles of the jaw, he pulls downwards and backwards. Should he fail to replace in this way, let a couple of pieces of wood, wedge-shaped at one end, be introduced between the upper and lower jaws behind: and with these small levers the lower molars can be separated from the upper ones; and while the jaw is being depressed behind on one or both sides, according as the luxation is unilateral or bilateral, let the chin be uplifted in front, and likewise pressed backwards; or briefly put, to reduce, first depress the jaw behind, and then lift the chin and press it backwards.

In case the patient has no molar teeth, or has teeth so decayed that they cannot bear pressure, then the wedge-shaped levers must be wrapped in cloth, or elastic rubber material, so that the gums will not be injured.

Where the luxation has existed for some time, reduction becomes more difficult; yet it has been effected after luxation has continued for three or four months; Gosselin and Michon reduced one which had existed for one hundred and thirty days. In such cases, the peri-articular structures have contracted and shrunken, similarly to what occurs in cases of unreduced luxation elsewhere, and this becomes an obstinate hindrance to reduction; hence, the first step in such cases is to break up adhesions and lengthen the contracted tissues. This may be accomplished, in some degree, by depression and lateral movements of the chin.

Complex contrivances have been devised to effect reduction; such instruments consist, in the main, of two blades which are separable by a screw which traverses them; and the whole is to be fastened to the head by horizontal and vertical straps. Instead of this complicated instrument, the work of separating the posterior teeth and depressing the jaw behind can easily be done with the double lever before mentioned: one or two should be used.

according as luxation is on one or both sides. The ends of these should be padded. That reduction has been effected will be shown by the condyloid eminence appearing in its usual place before the tragus; the chin is uplifted, the mouth can be closed, and the teeth of the lower jaw correspond to those in the upper one.

The luxation can easily recur, and care must be taken to prevent this: viz., the mouth must not be widely opened; and this precaution is the more needful after a luxation of long standing. To lessen the mobility of the jaw, the food should be taken in liquid form.

Fracture of the Lower Jaw.—The fracture of the lower jaw, according to Després, is one of the most infrequent in the general list of fractures; yet Emmert, on the contrary, says that it is of frequent occurrence. These statements show that surgeons may differ greatly in their experience. Gurlt, in a collection of two hundred and seventy-four fractures of the bones of the face, reports that one hundred and fifty-three were those of the lower jaw.

The lower jaw can be broken at any point; and the causal agency may act directly or indirectly.

Direct violence, as the kick of a horse, a blow with a club or fist, a stone hurled with the hand, or a gun-shot missile, may cause such fracture. Or the violence may act indirectly, as by pressure; and then the two branches of the maxillary arch may be forced towards each other, and cause fracture in front of, or behind, the point of pressure. Or fracture may arise from widening of the arch; and this can occur from pressure on the chin; or from explosion of powder within the mouth, the arch may be widened and fracture ensue. In experimental fracture of the lower jaw, Linhart found that the site of fracture, when the branches are forcibly pulled apart, is not at the symphysis, but at some distance behind that point.

For consideration, fractures of the inferior maxilla may be divided into those of the body, the ramus and the condyle.

Fracture of the body may be incomplete; or it may be complete, with integrity of the soft parts; or complete with laceration of the soft parts; and lastly, there may be multiple fracture.

Incomplete fracture involves but a portion of the bone; the outer plate alone may be broken. This fracture often escapes observation; it was studied by Cluzeau, who finds that it is situated oftener on the inner side of the jaw.

Incomplete fracture of the jaw may concern the alveolar process alone; and this commonly arises from a blow or fall against the teeth; and it is indicated by the displaced teeth: one or more teeth having forsaken their normal position. Such fractured portion, though attached to the jaw, is movable. Some swelling soon appears in the soft tissues at the site of injury.

In complete fracture of the body, when the soft parts are intact, the broken surface may be smooth, notched, or otherwise irregular. The line of fracture, when studied in reference to the vertical height of the body, may be nearly perpendicular; or it may run obliquely: and in the latter case, its usual direction is from above downwards and backwards. And when examined in reference to the thickness of the bone, it commonly runs from before backwards and inwards. There may be but slight displacement; and sometimes, impaction exists. This complete fracture without perforation of the soft parts occurs oftenest near the canine teeth; more rarely near the symphysis. Less solidity of the bone near the canine teeth favors fracture there. Fracture at the symphysis, mentioned by Hippocrates, has been denied by modern surgeons: but more careful observation has placed on record a number of cases. The indications of complete submucous fracture are swelling, and sometimes ecchymosis at the site of fracture; the subject is able to use his jaw in masticating, yet there may be perceived a grating or crepitating sound at the point of fracture. Also, if the patient open his mouth, and the jaw be grasped and vertical traction be made on the chin, then motion will be perceived at the site of fracture. Such movement must be cautiously made, lest the submucous injury be converted into an open wound.

In case the fracture be one in which the soft parts have been opened, the visible breach of the bone renders the diagnosis easy; and by manual movement of the part, crepitation and gaping of the fragments are produced. In case the fracture is single, there will be but slight displacement of the broken ends, but when the fracture is multiple, there is often considerable loss of normal form. If the fracture be on both sides of the chin, for example, in the vicinity of the canine or bicuspid teeth, then the front portion of the broken arch may be displaced by the sublingual muscles, while the posterior fragments can be drawn upwards by the masseter muscles. Again, if the double fracture comprise a segment of the side of the jaw, this can be displaced upwards or downwards according to its site. In case of multiple fracture, the

site is commonly near the canine tooth. The opening through the soft parts permits the escape of blood from the artery which is opened in the dental canal, a bleeding rarely great in quantity.

Whether the fracture be single or multiple, the line of the breach often lies between the roots of two teeth, so that the latter remain fixed in the jaw; or the alveolar cavity may be implicated so that one or more teeth become loosened, and then, or later, they fall out.

Fracture may have its site in the ramus, or in the condyloid or coronoid process. The fracture of the ramus is most often situated near its angle; and whether there, or higher upwards, it would be revealed by crepitation and pain in the upward and downward movement of the jaw. Bimanual pressure, made by the hands grasping the two branches, would detect mobility, and probably crepitation, in the broken side. But little displacement attends single fracture of the ramus: but if multiple, the displacement is determined by the direction of the muscular movement acting on the detached fragment.

Fracture of the condyle is seldom seen as an isolated injury; there is usually cotemporaneous fracture of the body of the jaw, and usually, both condyles share in the complicated injury. As signs of such fracture are swelling over the injured point, and pain when the jaw is opened and an attempt to masticate is made; and in this movement crepitation might be detected. Bleeding from the ear is often present.

The coronoid process is so safely entrenched behind the zygoma, that its fracture is usually accompanied by a fracture of the zygomatic arch. Great violence directly applied is necessary to produce it. The injury would be indicated by pain when the teeth were clenched: a movement calling into action the temporal muscle, and consequently, traction on the fragment.

A causal agency of fracture of the lower jaw is the bullet: and when gunshot wounds of the face are enumerated, those of the inferior maxilla are the most frequent. Such fracture may be single or multiple, and at any point. The missile may enter in front or at the side; or having entered at a point distant from the jaw, by direct or meandering route, the ball may reach and break the lower jaw. A small ball may enter and lodge in the body of the jaw. The ball may be spent, and cause a mere fissure, the simplest form of incomplete fracture; or if the impact be of greater force, a comminuted fracture may result. A small ball, moving with great velocity, may pass through the jaw with-

out severing it in its entirety: the injury being limited to the shot canal, without further fracture. Such simple injury would speedily heal; but where the fracture is comminuted, and the soft parts are extensively lacerated, recovery is tedious: necrosis and repair by callus consume many months in reaching their conclusion.

The diagnosis of the entrance and exit points of the missile is determined by the principles which have been considered in the chapter, which treats of gunshot wounds of the cranial wall.

The fracture of the lower jaw is often accompanied by other injury; for example, the violence from a fall upon the chin, is but partially expended in a fracture of the jaw: a part of the force is transmitted to the base of the skull. And thence have arisen fracture of the petrous portion of the temporal bone, injury of the middle ear, and concussion of the brain.

The prognosis depends on the condition of the soft parts covering the fracture: if opened to the broken bone, the management is difficult, the recovery tedious, and, sometimes, doubtful. In fact, Richet, from a study of the fracture, finds that it may end fatally. In a collection of thirty-six cases six terminated fatally. Even cases which primarily seemed simple, at a later time developed grave complications. And this is in accord with the author's experience. For not rarely, suppuration has appeared at some point below, and near the place of fracture, and an abscess of greater or less volume has arisen, and seriously interfered with recovery. Besides the loss of teeth, which is a frequent occurrence, necrosis of the broken ends, and more often of a separated fragment, leads to non-union, which renders the jaw nearly functionless. In case the soft parts are so open within the mouth as to lead to tedious suppuration and the escape of septic materials, which pass down the throat, then the general health may seriously suffer through pulmonary implication or perverted nutrition. Heath observes that from such fracture hæmorrhage has arisen, so severe as to demand compression of the carotid artery to arrest the escaping blood. Hence it is apparent that compound fracture of the lower jaw, though seemingly holding a subordinate place among fractures, may, in its final consequences, assume proportions of ominous gravity.

Treatment.—Hippocrates, and after him Celsus, treated this fracture by both intra-oral and external appliance. Where fracture existed without displacement, they depended chiefly on ligature of the teeth: and in this work, not one alone, but several

teeth on each side of the fracture were included and held by gold wire; or still better, with linen thread carefully tied. If displacement exists, after careful coaptation, tie the teeth together, and then apply a contentive apparatus on the outside. Hippocrates, though writing in the incomparable Greek, modestly admits the difficulty of clearly describing surgical dressing: "The reader must draw an idea as best he can from what has been written." The external appliance consisted of two strips of Carthaginian leather, about two inches broad. The one piece is fastened on the jaw by means of adhesive glue, beginning a short distance from the fracture, and it passes thence, including the chin, along the opposite cheek to the summit of the head: the other strip is similarly glued to the jaw at a point near the fracture, and is carried upwards over the head, and there the two thongs are tied. The patient must lie on the injured side. The Hippocratic method contains the germinal elements of traction and counter-traction which enter so largely into the modern treatment of fractured limbs. Fixation by means of wire including the teeth, so much in vogue in antiquity, usually loosens the included teeth: hence this contentive means is rarely resorted to by the modern surgeon: in only exceptional cases has the writer used it: cases of obstinate displacement, in which two or more teeth, on each side of the fracture, could be included in the ligature; thus distributing and lessening the ill effect of the pressure.

The treatment of the fractured lower jaw demands that attention be given to the following points: (1) Where displacement exists, the fragments must be accurately adjusted. (2) Immobilization and retention of the fragment in this corrected position. (3) Frequent cleansing and disinfection of the oral cavity.

1. Where displacement exists, adjustment is easily accomplished by grasping the two sides with the hands and lifting the two ends into normal place; and even if there be an isolated fragment, this is easily restored to place. Evidence that the fragments have been restored to normal site will be furnished by a return of the teeth to their accustomed ranks and natural relation. Such teeth must not deviate inwards nor outwards, nor stand higher nor lower than their fellows in the adjacent broken end.

2. Restitution to normal form is rarely difficult; yet maintenance of that form is difficult: so difficult that innumerable means have been devised to accomplish it. As in pertussis the

countless remedies proposed denote their fallibility and impotence, so the many appliances which have been devised for the treatment of the broken maxilla have similar signification; the perfect device has not yet been invented.

Cases in which there is no displacement of the broken ends recover through the use of any contentive appliance; any form of splint, which, slipper like, includes the chin, and which is retained in place by a bandage including chin, cheeks and summit of the head, will secure satisfactory immobilization of the fracture; and especially is this the case where the soft parts surrounding the bone are unopened. In case the soft parts are opened, a disagreeable complication that frequently arises in the course of the treatment is abscess, which may appear at some point near or subjacent to the fracture. From the writer's experience, it is an exception when such abscess does not occur; and occurring, it interferes with the contentive dressing.

In case of compound multiple fracture, in which the broken jaw consists of two or more fragments, exact maintenance of these parts in normal site is extremely difficult; in the writer's extensive experience in fractures, he has encountered no problem of which the solution has been more embarrassing, and, in its solution, the author will next briefly notice the methods which have been employed.

The appliances may be divided into two classes: those which are applied externally, and those placed within the mouth; and in many cases, internal and external appliances are combined. And in the use of whatsoever kind of appliance, coaptation must precede and accompany the contentive means.

To pass in review the numerous splints which have been devised for outward fixation, would be a tiresome enumeration of mechanical appliances, many of which, happily for the patient, repose in the lumber room of oblivion alongside of similar ones which have preceded them.

A simple splint, the invention of which is attributed to Dr. Physic, may be made of an oblong piece of felt or thick pasteboard, fifteen inches long, and five inches broad; let this be cut at its middle, half way through its breadth; thus prepared, it can be folded so that the cut edges overlap each other. Thus is formed a slipper-like trough in which the chin can rest, and the whole be retained in position by a bandage which passes under the jaw and obliquely over the summit of the head, and horizontally around the chin and behind the neck. The horizontal and

oblique turns of the bandage cross each other like a figure of eight, on each side, near the angle of the mouth. Since the bandage is easily deranged, a safer plan is to fix such a splint in place by means of a starch or gypsum bandage; and to protect the ears and hair, there must be placed beneath such bandage a stratum of cotton wadding. Instead of the felt or pasteboard, the writer has used gutta percha; of this a strip of suitable size immersed in hot water, can be molded to the fractured jaw, and retained in place by one of the bandages just mentioned.

Adjuvant appliances placed on the inside of the mouth are of three forms: one applied on the inside of the jaw, between the jaw and the tongue; another, which rests on the outer side; and a third one which, trough-like, rests on and includes the lower teeth; and sometimes it is hollow both below and above, and then it receives the upper and the lower teeth. The material from which these intra-oral splints is best made is gutta percha, or vulcanized India rubber. The last kind is the most efficient one, and this may be so constructed as to include the upper and lower teeth, and also ensheathe the lower alveolar process on the inside and outside. In its construction and application, the services of an expert dentist will materially aid the surgeon. Should a tooth be absent above or below, a corresponding opening should be made through the splint, through which a tube can pass for alimentation and irrigation. Such intra-oral appliance must be combined with an external bandage.

During the use of such a splint, the oral cavity must be washed out several times daily; and always after the use of food. Without this precaution, the cavity becomes a pest-hole of foulness. Such disinfecting irrigants are mint-water, alcoholized water, or chlorine water well diluted. Such fluid may be introduced through a tube which is carried through an interval between teeth, or through the space behind the molar teeth. As instrument for the irrigation, a flexible catheter and a flexible syringe may be employed; the latter can readily be converted into a siphon.

The patient must be nourished with liquid food, such as milk, soups and similar articles of diet. This can be introduced by means of a tube passed between or behind the teeth, as just mentioned.

In ordinary cases, consolidation occurs within a period of thirty days; but in cases in which there is laceration of the containing soft parts, with multiple or comminuted fracture entail-

ing recurrent displacement, the injury will require two or three months for recovery.

In cases in which the attendant displacement is irrepressible by any of the appliances mentioned, as an additional aid metallic suture may be resorted to. This method was first done by Baudens in 1840; it has since been done and recommended by E. S. Cooper, Kinloch, Giordano and others. The writer has resorted to it, with satisfactory result, in a few cases. Such suture is done within the mouth, by means of silver wire passed through holes drilled through the fractured ends, and knotted between the cheek or lips and the jaw. And, sometimes, even this fails to maintain accurate coaptation; and then a splint and bandages must also be used. Despite the treatment here described, recovery is sometimes attended with irregularity of form; one of the fractured ends is higher than the other; yet, in such cases, the future work of mastication will tend to reduce the teeth to a common level, and in time greatly lessen the deformity.

Finally, should non-union result, through loss of osseous structure or other cause, then the fractured ends should be exposed by dissection, and, after removal of the intermediate fibrous tissue, the ends should be united by metallic suture, and the case treated as a compound fracture.

CHAPTER XXIV

FACIAL NEURALGIA.

As synonyms of facial neuralgia are the names prosopalgia and tic douloureux; the latter is of Gallic extraction. Tic signifies a convulsive movement and refers to a spasmodic movement of the affected parts, which is often present.

Neuralgia literally signifies a painful nerve; and thus defined the term has relations with the entirety of Pathology, for the most important element in every *Pathos* is the subjective one of pain. And pain is the result of some textural change in nervous material of which the normal function is common sensation; and to awaken this, some *Nosos* or irritant is needed. And such irritant may be located within, contiguous to, or near to the nerve which responds by pain, and which, though so clearly appreciable by the subjective sufferer, may not be so to the objective observer; since in many cases, no structural change is determinable by chemical or physical test, or by means of touch or any special sense. Macroscopy failing in the search, has committed the quest to microscopy, which, though aided by its lens of immersion, has caught no glimpse of the fugitive pain. It is probable that such search will not always be in vain; and that along with the metrical appliances which have been introduced as aids in scientific exploration, an æsthiometer and odynometer will sometime be included. In such search and research, cognizance must be taken of the molecular changes which occur from the action of pain-annulling and pain-awakening agents: a most abstruse problem, in the solution of which Chemistry must lend the patient investigator its single elements, and also its compounds of double, triple and variously and diversely multiplied elements; and Physics, with its thermal, electric, luminous and spectroscopic means, will be invoked to contribute its quota of assistants.

Uspensky, who has labored on this question, refers pain to

the contact with nerve-tissue of the elements of disintegration, which are acid in nature; and that in the normal, or what may be styled the anodyne condition of the tissues, the acid compounds excreted are neutralized by the alkaline materials of the lymph and blood. Uspensky offers a few facts in confirmation of this theory. The writer would suggest that this notion might be amended by adding the work of integration to that of disintegration; or that in both progressive and regressive tissue-metamorphosis, materials may arise which by contact with sensory nerves can awaken pain. Inasmuch as neuralgia is relieved by numerous plans of treatment, some differing much from each other, it is possible that the chemical theory, here mentioned, may either directly or suggestively indicate one pathway leading to relief.

The face is the usual site of neuralgia; and a portion or the whole of the trifacial nerve may be affected there. While this nerve, by virtue of its isolated function, furnishes watchful guardianship of the special sensory apparatus, it is also the medium of intense suffering when it is the object of some morbific agency. The seventh or facial pair of nerves, stands to the fifth pair as its motor correlate, since its function, as commonly stated, is exclusively that of motion. Yet it is probable, that a few fibers pass from the fifth to the seventh pair, in the parotidean region; and to such inter-communication is due the simultaneous advent of pain and motion as the predominating symptoms of facial neuralgia.

Stromeyer claims that every manifestation of normal sensation has its correlate of motion; and that a painful sensation has its motor reflex, so sudden as to be of the nature of spasm: examples of which are seen in anal, vesical, and palpebral spasm awakened by some sensory irritant.

A characteristic of facial neuralgia is the exquisite acuteness of the pain which is present; also its inconstant nature. There are also points where the pain predominates; this fact was pointed out by Valleix; though reasoned away by writers who have no clinical communion with the disease, yet the subject of them cannot so readily do so.

The trifacial nerve beyond the Casserian ganglion divides into three branches, which diverge, and at their ending, each one has its isolated and individual peripheral field; and these fields have different bounding lines of demarcation, which are as follows: The district of innervation of the ophthalmic or superior branch has the following boundaries: draw a line from the

cranial vertex across the anterior portion of the temporal plane to the outer angle of the eye; then pass inwards through the palpebral slit to the inner angle of the eye; thence run down the nose to its point; and thence upwards to the point of departure. In this field is also included the mucous lining of the superior and middle turbinated bones, and the other intra-nasal structures corresponding to, and on a level with, these bones.

The superior maxillary branch is distributed to a field bounded as follows: Draw a line from the outer angle of the eye to the angle of the mouth; and in this field is included within the nose the inferior turbinated bones, and that portion of the intra-nasal structure which is not concerned in olfaction. This branch also supplies the teeth and the soft parts investing the upper jaw and hard palate; also, the soft palate and the choanæ have nervous supply through the superior maxillary nerve.

The inferior branch of the trifacial supplies innervation to structures which lie behind and below the districts supplied by the ophthalmic and the superior maxillary branches; behind, this field is bounded by a line drawn from the vertex of the head to the ear, and thence to the chin. Within the mouth it supplies filaments to the floor of the mouth and to the entire tongue, except that portion of the base which lies behind the papillæ circumvallatæ. It likewise supplies the lower teeth, the inferior alveolar process, the lower lip, and the mucous lining of the cheeks within the buccal cavity.

The primary terminal branches of the three divisions of the fifth nerve appear on the face in a vertical line, at the following points: the supra-orbital and infra-orbital foramina, and the mental foramen. The doctrine that neuralgic pain is especially concentrated at these points, as before stated, is contested by some authorities; the writer, however, within his professional experience, has seen cases in which the pain greatly predominated at one of these sites: especially, at the mental foramen; and the diagnosis thence drawn that the inferior maxillary branch was the site of the affection was confirmed by the relief which followed neurectomy of that nerve.

A knowledge of this abstruse disease can best be gained by a review of the literature on the subject, which the author will now compendiously present.

In 1849, Neucourt, writing on this subject, divides facial neuralgia into two groups: that which arises from pressure, and that which originates spontaneously, in which only some

remote morbid condition can be referred to as causal agency. Valleix espouses the opinion of indirect or spontaneous origin. As alleged causes of the indirect class are chorea, hysteria, rheumatism, plethora, the use of narcotics, heat, cold, miasma, syphilis and gonorrhœa. Some of these so-called causes, when examined, vanish to verbiage: names in which the realist seeks in vain for substance. Neuralgia may arise from pressure on the dental nerves through disease of the teeth; and in such cases, some swelling can be found around the tooth; or the alveolus in the aged can undergo a change, in which through slow atrophy, sometimes accompanied by pain, the root of the tooth is displaced. Neuralgia can occur in all portions of the face; and it is often situated in small spots, in which one can only find filaments derived from the facial nerve. It may disappear from one part of the face and appear at another.

Trousseau finds in the species of neuralgia, which the French name tic douloureux, an epileptiform element; in this form, pain can be awakened by some slight cause: for example, from a touch, eating, speaking, and even from an emotional thought. The attacks of pain are of extreme vehemence, and are attended by a trembling or spasmodic movement of the neighboring facial muscles. This form is difficult to cure.

In 1859, Schramm wrote on facial neuralgia, in an essay in which were detailed the observations of one hundred and ninety-five cases. In two-thirds of the cases, the affection was in the inferior branch of the trifacial. It was often associated with intermittent fever; and then the attacks occurred periodically, assuming in some a quotidian, and in others a tertian form. The periodical form, though seemingly cured, commonly recurs. In other cases, the disease was coincident with dental disease, rheumatic or gastric trouble. The use of quinine, arsenic and iron cured many of these cases.

Oppenheimer finds facial neuralgia to depend on affection of the nasal mucous membrane; or it may arise from nasal polyp; such cases were only cured through treatment of the nose.

Salter, of Guy's Hospital, published, in 1868, his investigations of facial neuralgia. He finds that it may arise directly or reflexly: it may appear in the supra-orbital or infra-orbital nerves, and the pain be felt in the temple, eye and near the summit of the head. Where the trouble has continued long, the skin is red and hot. Facial neuralgia may extend and implicate some portion of the cervical and brachial plexuses of nerves; and thus the arm may

lose its muscular power. Salter infers a connection between the trigeminus and the nerves of the arm, especially with the ulnar nerve. Spasm and weakness of the affected muscles are present. As initial causes of such nervous trouble are caries of the teeth, exposure of the dental pulp, periostitis, exostosis, and crowding of the teeth against each other. Salter cites numerous cases which support his doctrine; cases in which, concurrent with the neuralgia, were kindred affections, as trismus, torticollis, tetanus, epilepsy, neuralgia in the neck and arm, amaurosis and deafness. Salter places much stress on dental disease; he considers this the direct or indirect cause of neuralgia.

Anstie, of London, in 1868, wrote on facial neuralgia. Characteristic conditions of the affection are the tendency to exacerbate and intermit, and the disproportion between the violence of the pain and the accompanying constitutional disturbance. The pain is often confined to one branch of a nerve-trunk, and is usually unilateral; or if it be on both sides, then the pain may be symmetrical; or there may be a greater number of branches affected on one side of the face than on the other. And the pain is influenced by the condition of the body; for example, it is intensified by fatigue or other depressing causes. Under the head of ætiology, Anstie enumerates the following as causal agencies or influences: heredity, malaria, and prolonged centrifugal or centripetal irritation. As examples of such irritation are excessive use of the eye, pus in the vicinity of a nerve, or syphilitic growths encroaching on the nerve. Again, syphilis may cause a morbid change in the central nervous system. In cases in which the neuralgia has continued long, or has a high degree of intensity, then there may be present the points of pain, noticed by Valleix. There may be secondary implication of the secretory glands of the mouth and face; or through action on the vaso-motor nerves, there may be altered nutrition of the parts, and, as result, muscular paresis, and some degree of anæsthesia. Anstie is certain that there is a morbid change in the sensory nerve, or in the centre whence it arises; and finally, an interstitial atrophy may occur in the nerve, ending in degeneration of its tissue.

Benedict, in 1871, advises the division of neuralgia into two classes: in one the paroxysms may have a continuous character, though the intensity may rise and fall; and a second class in which the attacks are not continuous, but consist of momentary attacks. The second class comprises the excentric neuralgic

affections. If trigeminus neuralgia be thus divided, tic douloureux belongs to the second class. In tic douloureux, temperature is increased, the facial muscles are tense, and there is œdema of the superjacent surface. Benedict has observed in long-standing facial neuralgia a dilatation of the carotid artery; and in some cases the vessel was widened and tortuous. The dilatation seemed coincident with œdema and increased temperature. In some cases the vessel seemed narrow; and in such the parts supplied by it were cyanosed. Benedict does not refer the widening of the carotid to obstruction of the peripheral capillaries; but he deems it due to widening of these capillaries, and an extension centrally of this widening. And this dilated condition of the carotid furnishes a therapeutic hint for ligation of the vessel.

According to the writer's experience, facial neuralgia occurs much oftener in the male than in the female, and this is due to the more frequent exposure of the former to cold, or traumatic violence.

The prognosis is doubtful. The physician may promise relief by internal medication; and this relief, in most cases, is only partial and transient; exceptionally, it may be permanent. The physician has numerous medicines which he may successfully try, until he finds the one suited to the case; and along with the remedies used to cure the neuralgia, anodyne and anæsthetic means should be used to lessen the pain. A review of these means will now follow.

As internal remedies, the following may be tried: quinine in full doses; and its action will be improved by combining the quinine with morphia. Atropine may be given in doses of one-sixtieth of a grain, conjointly with morphia. Additional remedies are guarana combined with gelsemium, strychnia, aconite, colchicum and cimicifuga. Pfaff recommends the internal use of turpentine. Fowler's solution of arsenic and carbonate of iron may be tried. Phenacetin in ten-grain doses, or antipyrin in similar doses, relieves some cases. Bromide of zinc, bromide of caffein, and the oxide of zinc have given relief. In syphilitic subjects mercury in some form should first be given, and afterwards the mercury should be given with iodide of potassium. The writer saw an inveterate facial neuralgia yield to an atrocious ptyalism: the cure cost the patient his teeth.

Along with internal medicines, or subsequent to their unsuccessful trial, local remedies may be used on the sites of pain, or injected into the affected structures; of such means the following

may be tried. The external application to the painful part of Daphne mezereum has relieved; likewise inunction with an ointment composed of morphia and extract of Belladonna has given relief. Lusanna used by inunction a similar compound, viz., three grains of atropine to half an ounce of adeps; and of this he rubbed in a small portion, which contained about one-eighth of a grain of atropine. Lombard advises the inhalation of fumes arising from burning a mixture of opium, benzoin and sugar.

Morphia and cocaine may be used parenchymatously; of either one, from three to six minims of a five per cent solution may be injected into the painful part; and such injection would contain, in the one case, one-eighth of a grain, and in the other, one-fourth of a grain.

As additional remedial agencies the following have been used and commended. In 1792, Parry advised the compression of the carotid artery to relieve facial neuralgia. Later this treatment was commended by Liston, Preston, Trousseau, Malapart and Türck. In 1850, Türck published the account of cases of facial neuralgia which were thus successfully treated. Türck's explanation of the mode of action of compression is, that it acts through pressure made on branches of the vagus and sympathetic nerves. As far as possible, the internal jugular vein should be avoided.

Desterne claims to have cured facial neuralgia by touching the membrana tympani.

Electricity has been found beneficial in some cases; Benedict, especially, commends galvano-therapy: he applies the positive pole to the mastoid process, and passes the current upwards. Many others have verified the efficacy of the electrical treatment.

André reports the cure of obstinate cases of facial neuralgia by surrounding the site of the pain with fenestrated adhesive plaster, and then cauterizing the exposed part with caustic potash: and as soon as the eschar was detached, the cauterization was repeated until the bone was reached.

In 1850, Malgaigne reported the successful treatment of facial neuralgia, as well as neuralgia elsewhere, by cauterization of the external ear: in eighteen cases thus treated, six were cured. According to the author's experience, such cauterization applied directly on the seat of pain, often gives relief. As thermal agents which he has tried are the galvanic or simple thermal cautery, burning sealing wax and melted diachylon.

Numerous operative procedures have been resorted to for relief of facial neuralgia; prominent among these are ligation of the afferent artery, the simple division of the nerve, and exsection of a portion of the affected nerve.

Ligation of the carotid artery, by which the blood is diverted from the affected structures, has been done in a few cases, and relief thus obtained. In a case of violent facial neuralgia, seen by the writer in 1866, the common carotid was tied, and the neuralgia permanently relieved. No cerebral or nervous complication followed the work, but, as this sometimes occurs, it would be prudent to reserve this radical procedure for last resort: medication, cauterization and electricity having failed, should it then be found that compression of the carotid artery removes the pain, as a means of permanent compression, the writer would ligate the carotid in the lower part of its course.

Some of the primary essays in neurectomy were made by an ignorant tinker, who lived in an obscure corner of Paris. Richet records that this man, for thirty years, had relieved patients of dental neuralgia by a cut on the side of the face near the ear. Richet, who did not disdain to learn from so humble a source, learned and performed his operation, which was done as follows: introduce a bistoury through the skin between the tragus and the condyle of the lower jaw, to the depth of three lines. In such an incision, the knife would meet the auriculo-temporal branch of the inferior maxillary nerve; and the temporary relief which often follows such incision must be due to incision of this nerve.

Neurectomy often falls short of its purpose: the relief from it is but temporary; the divided nerve reunites, and the neuralgia returns: and to render the work more effective, neurectomy, or removal of a portion of the trunk of the nerve, has superseded simple division.

The pioneer in the work of neurectomy was Bérard, who, in 1836, announced an operation of this kind; and he was followed by Roux, who, in 1854, reported numerous neurectomies. This work of Roux is reviewed by Beau, who, finding that many of the operations had not resulted satisfactorily, refers the failure to the fact that in the resection too small a portion of the nerve had been excised. To guard against reunion of the ends of the severed nerve, Beau advises that a section of it, an inch and a half long, should be removed from the trunk of the affected nerve; and he approves of the counsel of Malgaigne and others to remove the nerve as deep as possible.

In a dissertation published in 1858, Schuh offered some general notions concerning facial neuralgia and neurectomy; and he likewise indicated the routes by which the branches of the trifacial can be reached for their division.

Schuh claims that the operation is not dangerous, and that some relief, if not a perfect cure, is always obtained by it. It is difficult to locate the site of a pseudoplasm, which by pressure is the causal agency. If the cause be deep, the pain radiates peripherally; but if the cause be more external, the pain pursues a central course. Pressure, friction and muscular movements aid in determining the chief site of pain.

In the sections of the excised nerve which Schuh examined microscopically, he failed to discover any structural changes: yet he found in the sheath of the nerve neoplasms and osseous changes, which he regarded as causes of the neuralgia.

The following indications are given by Schuh for the operation, viz.: where the neuralgia depends on a superficial scar; where it becomes chronic, very intense, and medicines fail to relieve. It should be done, also, in cases in which but one sensitive branch, or but few branches of one trunk are affected, and the latter is anatomically accessible. To decide that a nerve is really affected, there must be a fixed point of pain in the structures supplied by the nerve; and also a point whence the pain radiates. And even in cases in which such point of pain was absent, neurectomy gave relief for some months.

To operate on the frontal and supra-trochlear nerves, Schuh incises along the supra-orbital margin to the bone: the periosteum is then reflected downwards, and the eye pushed downwards. The frontal nerve will be perceived glistening through the reflected periosteum: divide it as far backwards as possible, and remove a section of the nerve. Through the same cut the supra-trochlear nerve can be found and divided.

To resect the infra-orbital nerve make an incision along the lower edge of the orbit, and, entering the orbit, lift up the eye with a spatula, and then sever the nerve as far back as possible in its canal. This division is done with scissors, and both artery and nerve are severed. In this division, the instrument should not enter the antrum. Next, reflect the soft parts downwards, until the infra-orbital foramen is found; and when the nerve is seen, draw it out from the canal, and cut off the part withdrawn. Should a portion of bone be found encroaching on the nerve, the bone should be exsected; and in this work care

must be taken not to let any fragments of bone drop into the antrum.

Schuh reached the subcutaneous malæ through a cut by which the outer half of the floor of the orbit is opened, and the nerve being found there is divided as far back as possible. To reach the posterior branches of the superior maxillary, let the mouth be elongated laterally, so that the tuberosity of the upper jaw can be reached, and its mucous membrane divided and so turned aside that the nervous filaments which lie there can be reached and severed. The division of the nerve is best done with a chisel. In two cases Schuh destroyed the nerves with a hot iron.

The temporal nerve can be reached through a vertical cut in front of the tragus, and being separated from the artery, the nerve may be divided.

Schuh sought the lingual nerve by a cut in the floor of the mouth, made near the posterior teeth; this route for finding the nerve is less mutilating than that of Roser, who by incision, elongated laterally the commissure of the mouth. Michel divides the lingual nerve through a cut in the floor of the mouth, next to the molar teeth; and as aid in the operation, the tongue was drawn outwards towards the other side.

Paravicini sought and reached the inferior dental nerve through an incision in the back of the mouth, in which he pierced and opened the internal pterygoid muscle; through this opening he forced his finger and found the dental foramen and the nerve entering it; from the nerve thus found, a section was cut out. Some bleeding accompanied the operation.

Bratsch, in 1863, reported ninety-eight cases of neurectomy done for the relief of neuralgia; these operations were mostly performed by Nussbaum of Munich. Of these operations, almost an average of six were done on the same person, so that the actual number of patients treated was about sixteen. Almost all of the branches of the trifacial were operated on. The occipital was also divided.

The general result obtained by these operations was a favorable one; and the fact that relapse ensued in several of the patients, Nussbaum thinks was no objection to the work, since the patients always demanded to be operated on again. The relapses occurred in from six to fourteen months.

In several of these cases, in which the pain seemed located in one branch of the trifacial, the division of this branch did not remove the pain; relief was only obtained by the removal of all

three branches of the trifacial. And where this radical exsection failed, relief was finally obtained through the ligation of the carotid.

Roser, who has operated several times for the relief of facial neuralgia, gives the following directions for finding the lingual nerve. An incision is made through the cheek opposite the base of the tongue, and through this cut the tongue is reached, and the nerve, being found, is exsected on the base of the tongue, below the insertion of the stylo-glossus muscle. For the division of the inferior dental nerve, Roser divided the masseter muscle, and having laid bare the ramus of the inferior maxilla, a trephine crown was placed on this midway between the coronoid process and the lower margin of the angle of the jaw; the outer portion of the jaw was removed, and the nerve, being found, was exsected. Michel in a case of neuralgia seated near the angle of the mouth, concluded that the affection was in the buccal nerve; and this supposition was verified by division of the nerve, which was done by a cut made along the anterior border of the masseter muscle, when a finger inside of the mouth uplifted the nerve, and brought it into position for division.

An examination of the published results of several operators reveals the fact that neurectomy does not always accomplish its intended purpose; for in some of the patients the operation has partially failed, and in a few it has been wholly unsuccessful. A search for the cause of this has led to the conclusion that, in such cases, the nerve had not been attacked deeply enough. This was the notion of Goux, of Strassburg, who wrote on the causes of relapse, and concluded that it is due to the causal agency existing on the proximal side of the site operated on; or it may arise from the pain traveling from the branches of a trunk which has not been divided into the branches of the trunk already divided. In such a case the branches of the cut and uncut nerves anastomose; that is, there is propagation in a manner which the writer would denominate anastomatic radiation.

To insure success in neurectomy, Goux recommends to divide, in rebellious cases, all the branches of the trifacial nerve.

To destroy the nerve as deeply as possible, after neurectomy, the central stump has been cauterized by some surgeons by means of a heated wire, which was thrust into the stump. Such cauterization has chiefly been done in the case of neurectomy of the infra-orbital nerve.

In patients in whom neurectomy, as above described, failed

to cure, indicating that the causal agency was more deeply located, surgical enterprise has passed the boundaries which the prudent conservatism of the past had fixed as the Ultima Thule for the surgical explorer; and the intrepid feats here done seem cognate to the daring depicted by the classic Mantuan, in which the Promethean race launched their barks upon and crossed forbidden seas. Indeed, by means of the Promethean light with which Anatomy illumines the way of the scalpel, old boundaries have recoiled, and the surgeon now penetrates to the base of the skull, and there divides the middle and inferior branches of the trigeminus; and recently even the cranial wall has been opened, and the trifacial branches divided close to their encephalic origin.

In the work of deep extra-cranial neurectomy, the name of J. M. Carnochan, of New York, merits special mention. His operation, done in 1855, was on the superior maxillary nerve, which he severed near the foramen rotundum; and in the operation, the spheno-palatine ganglion was also excised. Carnochan placed much stress on the removal of this ganglion. The operation began by the formation of a triangular flap on the cheek, which being uplifted, the front wall of the antrum as well as the infra-orbital foramen were exposed. This wall was now excised and the antrum freely opened. Afterwards, the posterior wall was perforated, so that the spheno-palatine fossa was opened to view. The superior maxillary nerve will there be seen prior to its entering the infra-orbital foramen; and also the spheno-palatine (Meckel's) ganglion. A segment of this nerve together with the ganglion is to be excised. The pioneer case thus operated on was seen by the writer a few days after the operation; also the segment of nerve which had been removed. The ganglion was unusually large, as well as the trunk of the nerve. The breach in the man's face was a great one: since the work was done previous to the time when the cosmetic element began to share in the surgeon's operative work on the face. The patient seemed delighted with his mutilation, since in exchange for it, he was wholly freed from his neuralgic torture.

The operation of Carnochan might be so modified as to avoid much of the deformity which was left by the work: namely, the anterior wall of the antrum might be uplifted in connection with the soft parts, and afterwards replaced.

The bold procedure of Carnochan has given his name an enduring place in operative surgery. In works on surgery, no

matter in what language written, in the chapter upon neurectomy, one finds a mention of this operation.

In 1872, Woodbury reported that Pancoast, of Philadelphia, performed an operation, somewhat analogous to that of Carnochan, for the relief of neuralgia seated in the inferior maxillary nerve. This was done as follows: A pedunculated flap was made over the ramus of the inferior maxilla; this flap was detached above and allowed to hang attached below. Thus he reached the coronoid process, and resected the same; then arresting the hæmorrhage by means of Pagliari's styptic, he reached and tied the internal maxillary artery. The next step was to pluck out the fatty tissue, and detach the external pterygoid muscle from its attachment to the sphenoid bone; and finally, the foramen ovale being reached, exsection was made of the inferior maxillary nerve.

Through the same route, Pancoast proposed to reach the foramen rotundum, and then, having thrown a ligature around the superior maxillary nerve, pull it out and excise a portion of it. And if one desired to remove a large portion of the nerve, he could lay bare the infra-orbital foramen, and having seized the nerve there, it could be pulled out, and thus removed.

In exsection of the inferior maxillary, at the foramen ovale, Pancoast found that the sense of taste was lost on the corresponding side of the tongue.

The deforming mutilation caused by the operation of Pancoast, and the interference with mastication which it entails, are serious objections to it. Nevertheless, the pain of facial neuralgia is so intense, in many cases, that the patient is willing to be quit of it at any cost; yet, before undertaking an operation so deforming as either of the operations mentioned, the surgeon should be very certain in his diagnosis that the patient will not afterwards have a revolting deformity added to his uncured neuralgia.

The undismayed foot-tread of surgical audacity, not content with reaching the cranial base, has recently overleaped that barrier and attacked the sensory trunk of the trifacial near its emergence from the pons Varolii. Surgical enterprise failing to subdue the enemy by an attack on the outworks, has, adopting the maxim, *Flectere si nequeo superos, Acheronta movebo*, penetrated within the citadel of life. Dieffenbach and Stromeyer were so inimical to neurectomy as done in their time, that they declined to give a description of the operation in their works on surgery; had they foreseen that the Casserian ganglion some day would

be the objective aim of the excising instrument, their hostility would doubtless have swollen with a higher tide of indignation.

This operation is now in the experimental and expectant stage, and whether the hand of critical adjudication, which is now adjusting the scales, will turn them towards the side of acceptance or rejection, remains for decision in the future; nevertheless, in the meantime, one must admire the boldness of the work done here by Rose, Andrews, Hartley and Horsley.

Rose has lately published five operations of this kind, done for relief of neuralgia seated in the superior and inferior maxillary nerves.

The fifth nerve resembles a spinal nerve in this, that it consists of a sensory and a motor portion; and in the sensory portion, similar to the posterior root of a spinal nerve, there exists the Casserian ganglion. Rose's operation removes this ganglion, which lies outside of the dura mater on the upper face of the petrous bone, near the inner end of the bone; and the work is done as follows: the eye is closed by stitching the lids together, in order to protect this organ, which by the operation will be deprived of its normal sensibility; and, in consequence of this, the eye will be unduly exposed to injury from the contact of foreign bodies. Next, an incision is made along the lower border of the zygoma, terminating at its posterior end; now this incision, reaching only through the skin, is carried downwards to the angle of the lower jaw, and then forward along the lower margin of the jaw to the facial artery. The flap thus outlined is next dissected forwards, without wounding the facial artery, nerve or Stenson's duct. The zygoma is next divided and uplifted and turned forwards, carrying with it the masseter muscle. The coronoid process is next divided and shifted upwards with the attached temporal muscle; and, in later operations, Rose removed the process. The internal maxillary is next ligated, and then divided. The external pterygoid muscle is then separated from the sphenoid bone and the external pterygoid plate. Next, a trephine, of half inch diameter, is made to penetrate the cranial wall, just anterior to and outside of the foramen. The trunk of the inferior maxillary nerve served as a guide in the act of trephining, and likewise in the subsequent search for the Casserian ganglion. After Rose had thus reached the ganglion, he excised it with curved hooks, taking care in the division not to open the neighboring cavernous sinus. The result of these operations was satisfactory.

Horsley penetrated yet deeper, and having removed a part of

the squamous portion of the temporal bone and lifted up the brain, he severed the trifacial at its emergence from the pons Varolii; the patient died a few hours afterwards.

The temptation inspired by *l' envie des autres rivaux* has led surgery onward until it has now reached the ultimate of operative effort, unless some one ambitious of mention within the lists of unjustifiable temerity, should lay bare the medulla oblongata, and, penetrating alongside of the vital point of Flourens, should reach and destroy the nuclear origin of the trigeminus; and the bold hand who would do this would add another name to operative nomenclature, viz., *nuclearectomy*. But if the prudent voice of conservatism be listened to, one hears the chiding remonstrance that there is a limit beyond which it is not allowed, paraphrasing the words of the Muscovite potentate, for even surgical heroes to pass.

To conclude this chapter on facial neuralgia, the writer will add his experience in reference to neurectomy. In eight patients, the subjects of facial neuralgia which had resisted all other plans of treatment, exsection of the nerve was resorted to; in six of the cases, the superior maxillary and inferior dental nerves were operated on; and in two patients, along with these two nerves, the supra-orbital nerve was also exsected. The subjects were all males, and were over forty years of age, except one, who was twenty-five years old. The neuralgia was seated on the right side of the face in the majority of the cases.

The methods pursued in reaching the nerve were as follows: To divide the inferior dental, a crescentic cut was made around and close to the angle of the lower jaw; the insertion of the external pterygoid muscle was separated from the jaw by means of a chisel. Into the opening thus formed the finger can be passed, and the dental foramen found by means of the process of Spix, a spike-like prominence of bone surmounting the lower edge of the foramen. The nerve and accompanying artery can now be caught with a blunt hook and torn asunder. In another case, after a proper incision was made, and the soft parts detached on the outside, a trephine was used, and the bone which lies opposite the foramen was removed, and the nerve thus reached was sundered with forceps. This method of approaching the nerve directly from the outside is more deforming than the preceding method, just mentioned.

The middle branch of the trifacial was reached by the method of Schuh, Wagner and others. An incision is made along the

infra-orbital margin, the inner end of the cut terminating two lines outside of the lachrymal sack. This incision must penetrate to the bone; and the lower edge of the incision having been pulled downwards so as to display the infra-orbital foramen, the upper lip of the wound is next lifted up, and the dissection continued backwards along the floor of the orbit. This work is best done with a blunt dissector, by which the periosteum is separated from the orbital floor; and done thus, bleeding will be minimized, the peri-orbital fatty couch will not be injured, and can easily be lifted up; but if the periosteum be fenestrated, the adipose tissue will pout through the openings. This separation is to be continued until the inferior orbital fissure is reached. The infra-orbital nerve is readily traced backwards; for, with a good light, the nerve can be seen beneath the thin stratum of bone which lies over it. The orbital floor is so thin and fragile in the aged that it can easily be broken; in fact, it was so thin in one case that in the work it was ruptured, and a fragment of sponge catching in the breach, escaped into the antrum. Knowing that sponge will float in water, the writer filled the cavity with water, when the sponge floated to the top and was removed. As aids in this work were a small gilded spoon, and direct illumination with sunlight. The nerve and attendant vessels were caught at their entrance into the canal with a small pair of forceps, and severed with scissors in front of the forceps. The central end held by the forceps was pulled and twisted, so that the nerve was acted on much beyond the point of division. The nerve was next seized at the infra-orbital foramen, and the portion within the canal was extracted. The wound, cleansed with alcoholized water, was next closed with fine wire sutures; and to maintain drainage, a small tube was used in the early operations; later, instead of this, a silken thread was substituted, and answered equally well. Recovery ensued with a scar, which, in the subject over fifty years, was almost imperceptible after six months.

The frontal nerve was reached through a cut made along the inner half of the supra-orbital margin; the nerve and artery were seized, and divided; and on the central end traction and torsion were made. If this cut be made near the palpebral fold it will afterwards be scarcely visible. After section of the infra-orbital and frontal nerves, the wound was dressed with simple cold water; and the healing was rapid, and almost without suppuration.

The operations done within the orbit necessitated some pressure on the bulb of the eye: a circumstance which gave the writer some anxiety in his early operations; in no case, however, was the eye injured by such pressure; nor, from the violence done the nerves, has the nutrition of the parts, deprived of sensory innervation, been in any way impaired. The results obtained in the eight patients operated on have been highly favorable to neurectomy; the most of the patients were wholly relieved; and in the few in which there was a recurrence, the pain was trivial in comparison with that which existed prior to the neurectomy.

CHAPTER XXV

NECK.

General Remarks.—The neck, which connects the head with the trunk, is elliptical transversely, in its lower portion; while above, it is elliptical antero-posteriorly. It is isthmus-like, a region of transit for important structures between the head and trunk. These structures are all important, and some of them necessary to existence, and the latter become the objects of destructive attack from the hand of suicide, which desires to put a period to life; also of the hand of justice in its work of punishing malefaction.

The hand of the surgeon makes also frequent visitations to this field; and in conservative effort and operative work, surgical art offers many examples of humane intervention: instances of which are correction of abnormal position, the combating of stenosis or occlusion of the laryngo-tracheal and æsophageal canals, and the removal of growths which compress nerves concerned in respiration, or vessels which furnish blood to the head. Such are the highly important subjects which will be considered in the coming chapters of this work.

Surgical Anatomy.—At the threshold of the matter, it is necessary to notice topographically some of the anatomical components of the neck, of which an accurate knowledge is necessary to the surgeon.

The anterior surface of the neck is an elongated quadrangle, which is divided by the larynx and trachea into two lateral fields, also quadrangular in outline; and each of these lateral fields is divided by the sterno-cleido-mastoid muscle into two somewhat symmetrical triangles, which may be named the inner and outer triangles; the base of the outer one is the clavicle, while the base of the inner one lies above. And the two inner ones combined may again be conceived to be a great median triangle, of which the sides, formed by the sterno-cleido-mastoid

muscles, are equal; and the apex of this median triangle ends at the manubrium of the sternum. This space contains nearly all the vitally important structures of the neck.

The fasciæ in the anterior portion of the neck should be well known to the surgeon; these are three in number: the superficial, middle and the deep. These fascial structures vary much in strength, between extreme tenuity and one of strong resistance: sometimes so thin as scarcely to be demonstrable.

These fascial strata form partitions which bound spaces within which lie certain parts which enumerated from without inwards, are as follows: between the skin and the superficial fascia lie the platysma myoides, the fatty couch, and the branches of the superficial plexus of nerves. The adipose layer varies greatly in both infants and adults; it may be absent, or amount to an inch or more in thickness. It is thicker in subjects in whom the neck is short. This fatty couch closely concerns the operation of tracheotomy; when very thick, it becomes a serious obstacle to the operator in the work of penetrating to the trachea.

The subcutaneous fascia extends laterally from the median line, and reaching the sterno-cleido-mastoid muscles, forms a sheath for the latter; it passes thence to the anterior border of the trapezius muscle, which it also incloses, by an anterior and posterior layer. At the median line, the superficial fascia is thickened, and this is named the cervical linea alba. The fascial sheath of the sterno-cleido-mastoid is thinner below than above; thus, pus contained within this sheath may perforate the thin anterior layer below and appear under the skin. The superficial fascia is attached inferiorly to the anterior margin of the sternum.

The middle layer of fascia starts above from the hyoid bone, in common with the superficial layer; the two soon separate, and the middle passing below is inserted in the periosteum which lines the posterior face of the sternum and is attached also to the clavicle. Thus a space is left between the superficial and middle layers, which being thin above is equal to the thickness of the sternum and clavicle below. The middle layer forms sheaths for the sterno-hyoid, sterno-thyroid and omo-hyoid muscles; also a sheath for the great vessels and nerves, and passing thence outwards, it penetrates between the scalene muscles, and reaching the transverse processes of the vertebræ, it is inserted into them.

In the space between the outer and middle cervical fascia is a layer of lamellated cellulo-adipose tissue; and in this are con-

tained lymphatic glands. In this space occurs the broad phlegmon of Dupuytren, a phlegmonous abscess which may occupy the greater part of the front cervical region. Pus contained in this space forces the anterior wall forwards; and it is prevented from pressing much on the parts behind by the resistant middle layer of fascia; and through the protection given by this firm median fascia, dyspnœa and vascular obstruction are lessened or avoided.

This middle layer, which from its attachments may be named the hyo-sterno-clavicular fascia, has been assigned by the anatomist Allan Burns, the very important function of protecting the trachea during the respiratory act of respiration. For a time this notion was generally accepted; its incorrectness has, however, been shown by the fact that in numerous surgical operations, in which the fascia was opened, no such collapse of the trachea ensued. In a great number of operations performed in this region by the author, the middle cervical fascia was divided with no ill effect; and in a few cases of thyreotomy, the entirety of the cervical portion of the trachea being laid bare, breathing was not obstructed. The patency of the trachea is maintained by its cartilaginous walls; and only in cases in which the rings have been softened and weakened by pressure, will they, when laid bare, yield to the atmospheric pressure.

The relation of this middle fascial stratum to the carotid artery and jugular vein is more important than its connection with the trachea. This fascia, as stated, forms a sheath for those vessels; and in this is a partition separating the artery from the vein. The middle stratum forms ensheathment for the omo-hyoid muscle; and the latter, where it lies on the internal jugular vein, is tendinous in structure; and by virtue of this structure of unchanging volume, and its fixation in the fascia, pressure on the vessel is avoided and the venous circulation favored. At its inferior part the fascia is closely adherent to the expanded termination of the jugular vein; and since the inspiratory movement lifts the sternum forwards, the effect is to carry forwards the middle fascia, and to open the vein. Thus a suction-like action is exerted on the vein, and its blood is attracted towards the heart. This suction is exerted, in some degree, on the affluent veins which empty into the internal jugular vein; thus the afflux of blood from the head and neck to the heart is promoted. The advantage which the circulation derives from this anatomical disposition is not shared by the surgeon in his operative work on

the neck; for, if a large vein be opened, the inspiratory suction may draw air into the veins, and this, mingling with the blood, may fatally obstruct the circulation.

Allan Burns mentions a case in which the destruction of the cervical fascia in a surgical operation was followed by dyspnœa after the wound had healed; during inspiration, the trachea was compressed, and a hollow depression formed over the top of the sternum. The patient breathed with effort, which was attended by a wheezing sound. He suggests that relief might be obtained in such a condition by applying a piece of leather, covered by adhesive plaster, over the affected part of the neck; and to fix it more surely, sealing wax dissolved in alcohol, might be applied to the edges of the leather, which. thus fastened, would become a substitute for the lost fascia.

The third layer of fascia, from its position, may be named the prævertebral; and this stratum extending between the transverse processes, covers the longus colli and other muscles situated in front of the cervical vertebræ; it forms a sheath for the anterior scalene muscles.

In the third inter-fascial space contained between the middle and deep fasciæ lie the important structures of the neck, viz., the carotid artery, jugular vein, the air-passage, the œsophagus and the nerves which form the brachial plexus. In the lower part of this space lie also the subclavian artery and vein. It contains, likewise, a loose cellular tissue. This space is connected with that of the posterior mediastinum by means of the trachea and œsophagus; and pus forming in the space may descend along these tubes into the thorax; or it may follow the trunks of the brachial plexus and appear in the axilla. The strength and resistance of the middle stratum are such that tumors forming in the third space are forced backwards and laterally, and can cause perilous compression of vessels and nerves.

The fourth space which lies behind the prævertebral stratum is filled with the muscles situated there; the only other structure of importance found there is the sympathetic nerve; and to this may be added the vertebral artery and vein which traverse the transverse vertebral processes.

Besides the blood-vessels contained in the third interfascial space, there lie there also, lymphatic glands and their vessels; and likewise, the termination of the chylo-lymph trunks, which end on both sides in the vessels formed by the union of the internal

jugular and subclavian veins. These terminal trunks should be remembered in estimating the gravity of wounds which penetrate these regions.

The glands lie chiefly in the space between the second and third fascial strata; and a number, which have a special surgical importance, lie along the course of the carotid artery and internal jugular vein; and those in contact with the vein are especially to be borne in mind, since when the glands inflame, they can become so adherent to the vein that their removal by the surgeon imperils the venous wall; or their suppurative action may weaken and open the vein. Again, the diseased glands encroaching on the vein may occlude it through the formation of a thrombus which, growing upwards or downwards, may imperil life.

As stated, the antero-lateral region of the neck is a field which offers numberless opportunities to surgery for operative intervention; and the facility or difficulty of such intervention is determined by the form of the neck; if the neck be short and thick, incision, excision, subcision, ligation and other technical procedures become inconceivably difficult; but if the field is long, spacious and accessible, the knife has freedom to do its best work. And these methods have a bearing, commonly unnoticed, on surgical statistics.

Torticollis.—As synonyms of torticollis are caput obstipum and wry-neck.

In torticollis the head, instead of being erect, is deviated to one side; and this arises from a distortion or inclination of the neck in the same direction. The neck not only leans towards one side, but it is also twisted on its vertical axis, so that the face is turned towards the side opposite to that of the cervical inclination: that is, the head leans towards one side, while the face is turned towards the other side, and the chin is uplifted. The head is sometimes so fixed that the patient cannot move it, or only slightly.

As classification of the directions in which the head may be inclined, that of Duval is a convenient one, viz., anterior, posterior, anterior oblique towards the right or left, and posterior oblique towards the right or left.

The affection may appear as a congenital deformity; or it may arise after birth.

The head is oftener flexed towards the right side; and from the author's observation, torticollis occurs oftener in the male sex.

If viewed in reference to the anatomical structure which is

affected, torticollis may be designated cutaneous, osseous, muscular or musculo-nervous. Cuignet of Lille adds another species, viz., ocular torticollis, which arises from photophobia or diplopia.

Congenital torticollis studied in reference to ætiology, has been explained in three ways: (1) Mechanical, in which the origin of it is referred to abnormal pressure on the fœtal head before birth. This was the theory of Hippocrates and Dieffenbach. (2) Musculo-nervous, which refers the origin to some pathological condition of the muscles dependent on some lesion or defect of the nervous centers. (3) Arrest of development, in which one side of the head outstrips the other in growth.

Von Ammon, who has made a careful study of torticollis, finds a connection between the greater frequency of the deformity on the right side, and the position of the fœtus in utero: viz., in three-fourths of the cases, the fœtal head is turned towards the left side of the mother. And this may explain the fact that the affection seems to be inherited in some families. He also observed that parts of the fœtus which are developed early in utero are the most liable to congenital deformity.

The deformity was seen by Von Ammon to occur soon after birth; and in such children there was an abnormal hardness and density of the contracted muscle which caused the deviation.

The author has seen cases which arose at the time of birth, and were due to some manual or instrumental manipulation used in the delivery of the fœtus, viz., version, or the use of the forceps. In some of these children, the violence done the neck in delivery caused swelling and suppuration of the injured muscle. Duval has seen torticollis arise in the infant from a glandular affection on one side of the neck, which causes the child to incline the head towards the other side; thus, from habit, lateral deviation of the head and neck can arise. But if the muscles be affected with rheumatism, the head will incline towards the affected side.

The site of torticollis may be in the derm, the cervical muscles and fasciæ, or in the cervical vertebræ: or the site may be in two, or in all of these structures.

The removal of a large portion of the skin of the neck may be followed by a torticollis; also a burn, followed by a contractile or keloid cicatrix, may deflect the head. That arising from the skin, which has been wounded or removed by a surgical incision, is rarely permanent. After such operation the writer has

seen a tendency to wry-neck; and so great was this tendency in a few cases that it was necessary to use an orthopedic correcting appliance. The surgeon may lessen cicatricial deflection, if in his operative work he so plans the incisions or wounds made that their closure can be done by vertical lines, rather than by transverse ones.

Torticollis from musculo-fascial contraction occurs much oftener than from any other cause. The muscles which are implicated are, when named in their anatomical order, the platysma myoides, the sterno-cleido-mastoideus, the scaleni, the trapezius, the prævertebral and the retro-vertebral muscles. Of these muscles, the one which is oftenest the causal agent through its shortening, is the sterno-cleido-mastoid, together with its fascial sheath.

As may be inferred from what has been stated, the shortening of the muscle is commonly due to some lesion, or inflammatory affection of its tissue; and where such direct agency is not discoverable, some recondite nervous disturbance of central, intermediate or peripheral location, has been sought for.

Long continuance of the contracted state, eventually induces changes in the muscular structure; thus, as the writer has seen, the tissue of the sterno-cleido-mastoid has become changed into dense tendon-like structures; and this change implicated the muscle's fascial envelope, as well as the overlying skin. This shortening was accompanied by incurvation, so that the retracted structures were adherent to the cervical vessels.

The third site in which the causal agency may be situated is in the superior cervical vertebræ. Some writers do not include under the head of torticollis cervical deviation which originates in spinal affection; Malgaigne, however, in his chapter on torticollis, gives this mode of causation a prominent place. He finds that torticollis may arise from a disease of the joint connecting the axis and atlas; and of the articulation which unites the occipital bone with the atlas. In such cases, the site of the disease can often be discovered by an examination of the pharynx. A swelling is thus detected, in which pus sometimes is found. The osseous disintegration may proceed so far that sub-luxation can occur, and death ensue; as a rule, however, the vertebral displacement is so limited that it is tolerated. If the atlas be displaced on the axis, the luxation is commonly forwards; if the displacement is lateral, then the odontoid process ceases to be the center of motion, and what motion there is, is accomplished through the medium

of the adjoining sound vertebræ. Or if the displacement between the atlas and axis be on one side, then the rotation may be accomplished through the non-luxated side.

In cases in which there is a doubt whether the affection is one of inflammation of the joint, or of osseous disease, it is safe to decide that in severe cases, the bone is the site of trouble, and that disintegration is present or impending; and such disease is usually in tubercular subjects. In such patients, the spinous processes of the region should be examined; and if undue prominence be found, this denotes osseous disease.

In cases of sub-luxation, Malgaigne thinks that the danger from an attempt to effect reduction is not so great as is commonly taught.

As accompaniments of torticollis, the following are often present: the face is asymmetrical, arising from the imperfect or arrested development of the side on which the distortion exists. The nose is small, the cheeks are unlike, the eyes of unequal size: all the parts of the face on the inclined side are smaller than those of the other. And the cranium participates in the malformation; it has an oblique, oval form; and this is due to the half on the affected side being smaller than the other. The cerebral hemisphere on the affected side is smaller than the other. From this lessened cerebral form, the opposite side of the body is slightly retarded in its development. Broca finds, also, an impairment of intelligence in the subjects of congenital torticollis.

This impaired development is caused by the pressure on the carotid artery on the affected side: thence arising a lessened blood supply to all the parts on that side of the head. Bouvier has verified, by the necropsy of such cases, the lessened calibre of the carotid on the distorted side.

As functional symptoms are the following: the patient can only make limited movement of the head. When at repose, the patient experiences no pain; but when an effort is made to erect the head, pain is caused. A shifting of the head from the normal position may cause double vision. The movements of the larynx are hampered; and phonation in some of its acts is restricted. The œsophagus may be disturbed in form and function. The temperature is often slightly lowered on the affected side.

Paralysis of one sterno-cleido-mastoid, or of other muscles on one side, leads to inclination on the sound side; in such cases, the patient is unable to move the head on the paralyzed side.

There is a form of torticollis which is intermittent or spasmodic in its manifestation. The affection is the result of involuntary contractions of the cervical muscles, viz., of the sterno-cleido-mastoid, the trapezius and splenius. The subjects of this are affected differently; in one case, it appears only when the patient stands; in another, it appears when he walks; and in a third class, it arises when the patient makes movements peculiar to his occupation. In a case of spasmodic torticollis treated by the writer, the spasmodic deviation of the head was awakened by any rotatory movement of the head; and the contractile action was on the left side, and the head was drawn obliquely downwards and forwards. This spasmodic act was not continuous, but was marked by momentary, slight remissions; and these cessations were not long enough to allow the head to assume its erect position.

Torticollis, again, may arise under some moral influence, as anger, fear or depression. It has been seen to appear at the catamenial period. And it has arisen so periodically, that its cause has been referred to malarial poison. Boyer saw a case in which the attacks came on when the patient began dinner; and even if the dining hour was changed, the attacks came on as previously.

In these cases of intermittent torticollis, the attacks do not appear when the patient is asleep. As a rule, the spasmodic action is unilateral; yet it may attack simultaneously both sides, as was seen by Steudel in one case.

In conclusion, the attacks of spasmodic torticollis are, as a rule, irregular in their occurrence; in some cases, the recurrence has been at long intervals. And the attacks are commonly transient in duration.

Treatment.—Torticollis is often amenable to medical treatment; and when causal conditions are present which indicate that the patient can thus be cured, appropriate remedies should first be tried, and when these have failed, some orthopedic or operative measure must be resorted to.

In all cases of a grave or obstinate character, as a diagnostic means to test the extent and persistence of the distortion, the patient should be subjected to complete anæsthetic narcosis; and the degree of the contraction being thus determined, the surgeon is enabled to decide whether he should make a preliminary trial of non-operative treatment, or resort at once to the knife. If, for example, he finds that the shortened muscles easily relax, then a

non-operative course may be pursued; and, as means comprised under this head, are electricity, manipulation, and orthopedic appliances; and in spasmodic and periodically recurring cases, internal medication must be employed.

Electricity was employed by Duchenne and Remak: the former using the interrupted current, while Remak preferred the continuous one. The continuous current, generated by a limited number of galvanic elements, should be made to pass from the spine to the lengthened muscle; and this is done by placing the positive pole on the spine, and the negative one on the muscle. The electric current in all cases, should act on the convex or elongated side of the neck; it should not be continued over twenty minutes, nor be repeated oftener than three times a day. This treatment promises most in torticollis of spasmodic character and, also, in those of a paretic, or paralytic nature: the electricity being applied to the palsied muscles.

A number of authorities have reported excellent results from manual manipulation; among these may be cited Seguin and Delore, who, with the passive movement, have in some cases combined volitional movements of the patient.

The plan of Delore is to deeply anæsthetize the patient, when, the trunk being held, and the shoulders depressed by an assistant, the surgeon grasping the head moves it in a direction which is the opposite of the deviation. These movements are made in the sense of flexion and rotation; and, at first mild, they are to be gradually increased in force, until the head is restored to rectitude. This can be done in from ten to fifteen minutes. During these movements the contracted parts are felt to yield with a crackling sound. When the neck is restored to normal position, it is to be retained so by means of a silicated immobilizing apparatus, between which and the patient, a thick layer of cotton is to be placed. This retentive dressing remains in place a month, when it is to be removed, and another applied, if a cure has not been accomplished.

Instead of the silicated apparatus, other surgeons, after having broken the adhesions and relieved the distortion, use an appliance of fixation which can occasionally be removed; and they claim that, by so doing, there is less danger of sloughs from undue pressure, since the apparatus can easily be removed and applied, as exigency may demand.

Internal medication must be resorted to in cases of a spasmodic or periodic character, and especially in those in whom

there is a suspicion of malarial infection. In such cases, quinine in full doses should be administered. Fowler's solution of arsenic may also be given. In those in whom there are rheumatic symptoms, colchicum and cimicifuga may be given. An additional remedy that may be tried is salicylic acid.

The armory of electric, mechanical and medical means having been exhausted with fruitless result, the knife remains as the ultimate resort: and this opens the subject of tenotomy and myotomy of the cervical muscles, for the relief of torticollis.

Tenotomy, or, more properly, myotomy, was first done for the relief of torticollis by Ronhuysen, in 1670; he divided the sterno-cleido-mastoid by first opening the skin and then severing the muscle from within outwards, with a bistoury. Afterwards, the division of the muscle was done with scissors by Florianus; and Minnius divided the muscle, after he had exposed it by the aid of an escharotic which destroyed the superjacent skin. This pioneer work found but little imitation: in fact, it was decried, until the two master surgeons Dupuytren and Dieffenbach, who flourished during the first third of the nineteenth century, gave the operation its proper place in operative surgery; and priority in this work is assigned to Dupuytren by Von Ammon, a German authority.

Though the operation is a simple one and free from ill consequences in most cases, yet this is not the universal report; ill results, and even death, have followed it. Such ill results have been from wound of the internal jugular vein, injury to nerves, and occasionally, troublesome suppuration.

The internal jugular has often been wounded; even those whose instruments were guarded with accurate anatomical knowledge have unwittingly strayed from the protective landmarks, and have pierced the internal jugular. The writer once saw this happen in an operation done by one who was reputed to be the most skillful operator among those who speak the English tongue. The famous surgeon had just premised the work by a few words in which he dwelt on the danger attendant on the subcutaneous section of the sterno-cleido-mastoid; "that though one might safely cross a bridge many times, yet if he approached too near the edge, he might fall into the river;" and having said this, he inserted his tenotome, and the gush of blood which instantly flooded the parts, showed that he had wandered off the "Waterloo bridge," and fallen into the river.

Bonnet claims that a puncture of the internal jugular vein is

free from danger; yet Guérin and Vallin teach the contrary, and advise to scrupulously avoid the vessels. In one case, death resulted from a wound of the internal jugular.

Philippe, in 1847, wrote on the operation, and announced that he had seen ill effects follow myotomy in the neck. He has collected five cases in which the injury to certain unimportant nerves caused paralysis of parts. In one case, Philippe divided subcutaneously the clavicular portion of the sterno-cleido-mastoid, and in the operation some small nerves were cut, whence a neuritis was awakened, that extended to adjacent nerves, and produced palsy of the arm. This palsy finally extended to the facial nerve. The writer cannot refrain from remarking that the tenotome here may inadvertently have wandered from the route appointed for it, and encroached on structures of which an injury is punished with fatal forfeit.

A third ill result of myotomy and tenotomy is suppuration; it is probable, however, that careful asepticism will strike this out from the list of accidents which may follow these operations.

Upon the point whether cases may be cured without an operation, Dieffenbach admits that they can; yet, that when the non-operative course is pursued, the treatment is more tedious and prolonged, and relapses are not infrequent. In fact, where only orthopedic means have been used, Dieffenbach has seen the muscles rebel and contract still more than they were before.

As a guiding rule on this subject, Guérin says that while the muscle is yet in the condition of mere contracture, a cure can be effected mechanically; but when the muscle has reached the stage of permanent contraction, orthopedic appliances fail, unless the muscle be divided; and the reason of this is, that in the former, the muscle is in a normal state, and can easily be extended; but when the muscle has passed into permanent contraction, it has undergone a fibrous change that does not permit of elongation.

The section may be done at an early age, as was verified by Dieffenbach, who operated on two infants which were only six months old.

The sterno-cleido-mastoideus is the muscle usually contracted in torticollis; and, as a rule, the sterno-mastoid is the portion affected; so that, in many cases, the operation is limited to this portion; but in cases which have continued for years, in which fibrous change has occurred, it is generally necessary to divide both portions of the muscle.

The point at which section is made lies in the lowermost portion of the muscle, viz., from a half inch to an inch above the sternal and clavicular endings. The section was, sometimes, done higher by Malgaigne. In the high division, the spinal accessory nerve should be borne in mind.

Where the skin is contracted into a fibrous cord, Dieffenbach first removed the contracted portion, and then closed the wound; some weeks afterwards, he divided the shortened muscle subcutaneously, and thus effected a cure. In a normal case of contracted sterno-cleido-mastoid, he divided the muscle, at once, as follows: if the contraction were on the right side, having seized and lifted up the muscle with the left hand, then, with the right hand, he pushed the tenotome between the trachea and muscle, underneath the latter, and thus severed the muscle from beneath towards the skin. As he cut, he pressed the skin and tendon with the thumb of the hand. Having divided the sternal portion he next passed the knife in the fossa beneath the clavicular portion, and divided this.

In some cases operated on by Bonnet, after dividing the sternal and clavicular portions of the muscle below, at a later period, he divided the body of the muscle an inch and a half higher up.

There has been a controversy whether the cutting should be done from before, backwards, or reversely; and also whether the knife should enter on the inner or outer side of the muscle. Bonnet thinks it is unimportant which way the work is done. When he divided the muscle in its body, he cut from behind forwards; but when he cut but one portion, he severed from before, backwards. After the division, should it appear that certain fibres are unsevered, or that the sheath has not been included in the division, then a blunt knife may be passed behind these parts, and their division effected. In the young subject, however, the sheath may be allowed to remain unsevered; thus doing, one obtains better reunion of the divided muscle.

As soon as the division is done, the site of puncture should be compressed so as to check any bleeding which may follow. Should a re-division of the muscle be necessary, Duval counsels not to repeat the cutting in the same place; he cuts at a new point, and thus there is less danger of wounding the vessel that has become attached to the muscle through the previous cutting.

Dieffenbach, who operated a countless number of times, found the seat of the trouble in most cases, to be in the sternal portion

of the sterno-cleido-mastoid muscle; he divided this a half inch above the sternum. Should it be necessary to sever both portions, he thrusts his tenotome on the inner side of the inner portion, and on the outer side of the outer portion; and cuts both portions from behind, forwards.

The site of the muscular contraction has been found to exist in the platysma myoides; also in the scalene muscles, lateral portion of the trapezius and in the muscles behind the neck; of the retro-cervical muscles, the trapezius and complexus are the ones oftenest at fault. In whatever muscle the contraction exists, this, in most cases, may be divided subcutaneously; should, however, the muscle not be safely accessible in this way, as, for example, the deep-seated scalenus, then the muscle should be displayed by an open incision, and divided to the extent required. The more superficial muscles, as the platysma myoides and the trapezius, may be severed subcutaneously; yet the latter, if the operator has not recently verified the site of the spinal accessory nerve, is more safely divided by open incision. And the depth of the scalene muscles is such that they can only be reached and divided by an open incision, as Bauer did.

In cases of spasmodic and periodic torticollis which have resisted internal medication, a resort may be had to neurectomy of the spinal accessory nerve, and the branches of the superficial cervical plexus.

The spinal accessory lies above in a four-sided figure, of which the boundaries are as follows: draw a horizontal line from the angle of the jaw backwards, and a second one on a level with the upper boundary of the thyroid cartilage, then draw two other lines, one in front of and another behind the sterno-cleido-mastoid; then a diagonal line, drawn from the upper and inner angle of this figure to the lower and outer angle, will lie over the nerve. It usually pierces the sterno-cleido-mastoideus; yet the writer has found exceptions to this in his dissections. The branches of the superficial cervical plexus escape from the posterior border of the muscle, near the union of the upper and the middle thirds of the muscle.

Campbell de Morgan having failed to cure a case of torticollis by myotomy, afterwards exsected a portion of the spinal accessory nerve, with successful result. The writer treated a case of obstinate spasmodic torticollis, which was unilateral, and which was not benefited by myotomy; the patient was finally cured by neurectomy of the spinal accessory nerve and all the branches of the superficial cervical plexus.

In recent times (1885) Volkmann has done this work by open incision; and having the parts exposed fully to view, he divided freely the parts necessary to rectify the head; this plan is analogous to that of Price, who, having made an opening, passed a grooved director under the muscle, and divided it.

After the myotomy was done, Eulenberg's practice was to forcibly restore the head to normal position; and after breaking up any adhesions which opposed this—the head was then allowed to resume its abnormal position, and to remain thus for three days; then it was straightened and maintained erect by mechanical appliances.

After myotomy, Petrali advises, before the application of a mechanical support, to bring the shoulders to a horizontal position, and having lifted the head to an erect posture, let it be moved in the arc of a circle which is the opposite of the ill position; and lastly, any secondary curves of the spine lower down, must be corrected; and thus rectified, the parts must be maintained in place by orthopedic apparatus.

Inventive genius has given the surgeon mechanical appliances of diversified models, to maintain the parts in rectitude after division of the contracted muscles; and it is through the judicious selection and proper use of these means, that the cure is finally obtained; for, from the writer's observation, there is no thing which is more strongly impressed on the surgeon through his experience than that, however much his knife may aid him in this work, it is through the slow plodding effort of well-devised orthopedic appliance that the ultimate link in the cure of torticollis is reached; the tenotome is merely the key that opens the gate of the field in which lies his chief work.

The orthopedic appliances used in the treatment of torticollis may be classed in the following groups: (1) A simple cravat. (2) A cravat with apparatus for fixing the head. (3) An apparatus for fixing the head in rectitude which is attached to one fastened about the upper part of the trunk.

In mild cases, or those of recent origin, after the tenotomy of the sterno-cleido-mastoid muscle, the cure may be acccomplished by the use of a stiff cravat, which will prevent the head from resuming the former false position. Such an appliance can be made of felt, pasteboard, leather, gutta percha, or of metal.

In the second group, the cravat is combined with some appliance fastened about the head; and the latter may be a simple ring, to which straps are fastened which are attached to the

cravat at points which will permit traction to be made in such directions as will best maintain the normal rectitude of the head. Or these straps may be fastened to padded rings through which the arms pass; and these rings rest on the shoulders. Either of these orthopedic apparatuses, though it restores the head to proper position, may act faultily by lifting the shoulder abnormally high; that is, when the head is brought to proper position, the structures, which are abnormally short on the affected side, lift the shoulders upwards. And in a cure thus obtained, the correction would consist in an exchange of a distortion of the neck for one of the shoulders. Bonnet has invented an apparatus in which, besides the thoracic portion, there is a neatly fitting, well-padded cravat, and there ascend from the shoulders two uprights, to which are fixed rods which press pads against the face. The pads can be fixed at different points, and by their pressure, the head can be made erect and rotated, and the face turned towards the sound side. The apparatus of Bonnet is shown in Figure 92, from which its mode of action can be understood.

FIGURE 92. Apparatus of Bonnet for correcting torticollis.

An apparatus has been devised by Bigg, of London, which is light in construction, and is composed of the following parts: a light pelvic girdle to which a dorsal stem is fastened; to this is attached above another light girdle, which encircles the chest and passes close to the arms in the axillary spaces; and to the dorsal upright stem there is fastened a vertical piece which divides above into two branches, of which the parts pass respectively to

the right and left sides of the face. These latter branches are fastened to pads which rest against the sides of the face, and through them graduated compression can be made. The two branches are so arranged that the head can be fixed in any position which is desired.

Malgaigne, as appliance, used a corset to which were fastened axillary crutches, and a dorsal upright staff to which retentive head-pieces were fastened. The head-gearing contained an attachment for support, similar to what is known as the "jury mast." Orthopedic appliances have recently been devised, analogous to those described, by which continuous traction is maintained by means of elastic cords or straps. From the writer's experience the advantages claimed for these straps are less than their inventors assert; they soon wear out, or become weak, and demand constant renewal.

Among means to restore to normal position, after division of the contracted structures, should be mentioned traction and counter-traction made on the head and trunk. This method is strongly advised by Stromeyer. For this work special beds have been constructed, of a complicated character. Since the introduction of the weight and pulley to maintain traction, the work is simplified by converting the bed into an inclined plane, and making attachment of the pulley to the head of the bed, and fastening the tractile appliance to the head. Despite the eminent authority of Stromeyer, his extension plan has not met with general acceptance; in fact, Malgaigne utterly discards it; and South disapproves of it.

From the writer's observation, there are cases of torticollis in which, after preparatory myotomy, the surgeon will find it impossible to return the head, neck and shoulders in proper place by the use of any of the ordinary orthopedic appliances. In such a case, treated by the author, in which the usual instruments did not effect the desired correction, a satisfactory result was obtained through the application of a gypsum apparatus, applied as follows: the patient sitting on a stool with the head, neck and shoulders brought into proper position, must have these parts well enveloped in cotton wadding, and firmly held in place while the plaster dressing is being applied. For this maintenance in position three assistants are necessary: viz., one to hold each arm, and a third to fix the head. In spite of this care, there may be some error in position found after the dressing has been applied. Such error may be that the chin is too high, and deviates from

the median line; and that the shoulders do not stand on a level; such were the faults of position which the author found difficult to avoid; and it was only after repeated applications that such faulty position was avoided. The gypsum bandage must encircle the chest, shoulders, neck and head, crossing in a figure of eight manner. The ears should not be covered, and the arms only so covered as to immobilize the shoulder joints. Such a cast should be worn for three months; and if the deformity be great and of long standing, a longer period will be required. During its use the patient can be allowed to walk and use the limbs not included in the cast. And, for the continuance of the correction which has thus been obtained, some one of the numerous orthopedic appliances in vogue may be selected, and worn for from six to twelve months.

In cases of many years' standing, though the faulty position may be greatly amended by treatment, yet it is impossible to completely restore the subject to normal position and natural figure. The long continuance of the lateral deviation has altered the forms of the cervical vertebræ; the lessened supply of blood to the affected structure has rendered those parts smaller; so that though the head be rectified in position, yet one side of the face, one eye, and one-half of the skull will remain somewhat dwarfed, or malformed. And, for a time, vision is often disturbed after rectification of the head; but the diplopia or obliquity of vision, thence arising, finally disappears.

A method of corrective fixation, in cases in which the hair is long enough, is to make two braids of this, and tie these around the shoulder of the elongated side. The lawlessness, falsely named liberty, indoctrinated into the modern child, was evidently left out of account by the writer who advised this trichopedic procedure.

In cases of torticollis in which the causal agency consists of an affection of some of the cervical vertebræ, it is seldom that tenotomy need be resorted to. The shortened muscle or muscles are in a condition of simple contracture, which readily yields, if the spinal column be rectified. A most troublesome task, however, is often encountered in the effort to straighten the spine; and this is still more aggravated if there be added the complication of an abscess arising from tubercular disease. In such cases, an apparatus, so devised as to remove the most of the weight from the spinal column, must be applied and worn. The consideration of the method here referred to belongs rather to the

subject of special deformity; and in the chapter devoted to this, the matter will be briefly considered by the writer.

The chapter will conclude with a mention of a form of torticollis which originates in some lesion of the soft parts of the neck, and may be called cicatricial.

In the removal of neoplasms from the neck, in which a large tract of derm is sacrificed, and the wound is allowed to heal by granulation, the head becomes drawn towards the affected side. Such lesion may be a burn, by which the skin being destroyed, a slow-healing wound remains. The scar there formed is thick and contractile, and of the nature of the semi-malignant structure named keloid. In all such cases, in which an agency exists disposing to distortion of the neck, the tendency to deviation should be opposed by a supporting and restraining apparatus. Such an appliance may consist of a simple cap fastened to the head, and from which straps or cords may pass to a girdle around the upper portion of the chest.

Sometimes these cases only apply for surgical relief after the scar has been formed; especially is this seen where burns on the neck have healed badly, or, perchance, have not healed at all. In such a case the writer has seen the head flexed forwards, so that the chin almost rested against the upper end of the sternum. In this deformity, relief may be obtained by dissecting out the cicatricial structure, and replacement by sound skin borrowed from the contiguous surface, if sound derm exists there. Such restoring material should consist of one or more pedunculated flaps, which are carried into place by circumduction; and afterwards the remaining wounds are to be closed by suture. Such replacing flaps should be taken from sites where their loss will cause the least possible tension. And during the time of healing, the head should be immobilized by means of a head-dress provided with straps, which are fastened to it at such points as will secure antagonism to the tendency to deviation. In cases in which closure by dermal flaps is not practicable, the process of Thiersch may be resorted to, in which large epidermal grafts obtained from the femoral or humeral region, are transplanted to the wounded surface.

CHAPTER XXVI.

CONGENITAL CLEFTS OR FISTULÆ IN THE NECK.

THESE clefts which are of congenital origin, are related to, and arise from, incomplete closure of the primitive branchial fissures, which are present in the development of the embryo.

In the upper part of the anterior face of the embryo, in its early development, Dzondi discovered certain openings, which he named tracheal fistulæ. Afterwards Heusinger, of Marbourg, made a careful study of these congenital clefts, of which he collected forty-eight cases in German medical literature; and Heusinger attributed them to an arrest of the normal embryonic fissures.

For the comprehension of this matter, a short rehearsal of the embryological constituents of the face and neck should precede; and, briefly enumerated, these are as follows: there are four arches, and three clefts lie between these. The first arch is the budding point of the future structures of the face. The second arch contains the germinal elements of the styloid process, and a part of the hyoid bone; and the cleft between these becomes the future tympanic cavity, and the Eustachian tube. The third arch forms the body of the hyoid bone and the epiglottis; and the cleft between this arch and the preceding is afterwards obliterated. The fourth arch forms the future structures of the neck; and the cleft between the third and fourth arches is afterwards closed.

In its primary period of growth, the embryo presents above, on the side towards which the head is turned, a cavity which may be named the pharyngeal, bounded by arch-like processes, which are analogous to the costal arches which inclose the thorax. The spaces between the arches above vanish during the process of development, except some vestiges, which remain in the structure of the auditory apparatus. Should the branchial arches not proceed to complete development, then some fissure will remain; and, as verified by observation, this occurs, and happens oftenest in the

site of the second and third arches. In this way the existence of congenital clefts in the anterior surface of the cervical region can be explained.

This cervical defect has only recently been observed, or if observed, the observation has seldom been recorded. Duplay and Gillette have collected a list of nearly seventy cases; of these, the greater part were observed in Germany.

The causal agency which leads to an interruption in the completion of the branchial arches has not been explained; it lies perhaps in the domain of those obscure, recondite, and probably undiscoverable agencies, which presided over the animal body in its previous phases of evolution; and which, beginning with the embryonic form that primordially is similar in all vertebrates, pursues such diverse paths to reach the adult stage.

Though the direct and immediate causes are unknown, yet observation has noted certain indirect or contingent agencies, which seem to influence such congenital defect; and prominent among these is heredity or kindred. During three generations in one family such defect was noticed eight times; and in one family, of eight children, five were the subjects of the fissure. Other collateral defects often coëxist with them, especially defects of the ear and face.

Duplay divides such defects into those which are congenital, or exist at birth, and those which appear afterwards; the latter class is rare.

The branchial fistula may be complete or incomplete; the former having an inner and outer opening, while the incomplete may be a blind canal, which opens on the inside, or on the outside.

The complete fistula has a dermal outlet, and it opens into the pharynx. This form is, according to Cusset, often associated with imperfect pulmonary development. The opening outside may be situated at any point from the thyroid cartilage to the sterno-clavicular articulation. The higher the dermal opening is, the more it approaches the median line. This opening may be fine and on a level with the skin, or somewhat uplifted on a reddish papilla; and sometimes, the outlet has a valve-like fold of skin as a covering. Instead of a fine opening, the outlet may be much larger, viz., two or three lines in diameter; this, however, is exceptional, and the outlet may be so attenuated that a fine probe can not enter it. When the opening is large enough for inspection, one finds it invested with a coating similar to that

of mucous membrane. The canal between the outlets varies in caliber; and may be uniform in dimensions, or with one or more dilatations. It may be straight or sinuous. The internal orifice opens into the pharyngeal cavity; and this may be above and near the greater cornu of the hyoid bone; or it may be near the palato-pharyngeus muscle; and this inlet may be small and difficult to discover; or it may be a pocket-like opening, in which mucous or alimentary materials may lodge.

The external fistula, which is incomplete, may end at a variable distance from the cutaneous surface; this canal points towards the hyoid bone, and is dilated at its blind ending.

There has been some contest concerning the incomplete fistula, which, opening in the inner mucous surface, descends thence towards the skin. Some claim that such fistula originates through a hernial protrusion outwards of the mucous membrane.

There have been observed, located somewhere near the inner end of the branchial canal, fragmentary plates of cartilage, or of cartilage and bone; and these lodged on the wall may vary from a line to an inch or more in length. Such cartilaginous lamella is movable, and is not adherent to the skin. And Duplay has seen similar plates of cartilage in the structures of the front of the neck where no fistulous opening existed. And such cartilage has been seen so prominent that it was a source of inconvenience, and its removal demanded.

A fistulous canal similar to those described has appeared some time after birth. Duplay has called attention to this species, and his explanation of it is as follows: A fistula which opens internally at birth, may be covered with a film-like epidermal coat; afterwards, materials entering the canal, the outer terminal covering may be abraded and opened; and thus an incomplete canal becomes a complete one. Such cases are extremely rare.

Besides the anatomical characteristics of the branchial fistula which have been pointed out, its leading clinical characteristics are the discharge of material from its external outlet, when the latter exists; also, the collection and temporary sojourn of such matters within the canal itself, and finally, the irritation which such materials may cause while lodged in the canal, or after their escape from it.

The canal is painless unless a sound be passed into it; this act awakens an unpleasant sensation, or even pain of a pricking or burning character. In a case in which the author was consulted, the passage of a probe was painful to the patient. This

fistula ended blindly; hence the irritation awakened by the probe did not arise from its contact with the inner surface of the mucous passages.

To make an accurate diagnosis of the nature of such a fistula, colored fluid must be injected into the outer end; and for this purpose, milk is one of the most harmless that can be selected. If the canal have no opening inwards, the injected fluid would regurgitate to the surface again; but if it be complete, it would enter the air-passage and produce cough. The previous history would show whether the fistulous canal may have arisen from a ruptured bursa in the hyoid region, or from a gland that has suppurated, and opening on the surface, has left an unhealing sinus. Such fistulous canal might occupy the usual site of a branchial fistula; yet the attendant phenomena of the former, and the character of the discharge, would clearly distinguish the former from a branchial orifice. The branchial fistula is often associated with disturbrnce of the functions of respiration and deglutition. Sarazin who has collected facts bearing on this matter, finds that in fifty cases, ten of them had some pulmonary trouble, such as catarrh, emphysoma, tuberculosis or pneumonia. Such fistula rarely disappears spontaneously; still Duplay saw a case which did thus close.

Treatment.—The majority of surgeons oppose operative intervention in the complete fistula; or they limit the work to merely an attempt to convert the complete canal into an incomplete one which only opens externally.

As means used in the treatment of branchial fistula are the following: irritant injections, thermal cauterization and excision.

Injections, which have a destructive or escharotic action on the lining of the canal, have been commended; and as such may be tried, the tincture of iodine, a strong solution of nitrate of silver, or one of chloride of zinc. Such means could not be safely used, in case the fistula be incomplete; for the entrance of the irritant fluid into the air-passages must act injuriously. Hence, such treatment should be reserved for the incomplete canal.

The thermal cautery, in the form of the heated galvanic wire, or an iron wire or probe that has been heated to a red heat, may be used; and such cauterization may be employed, not only in the incomplete fistula, but in that which is complete, since differing from the escharotic injection, the heat can have no ill action on the air-passage, or alimentary canal.

The methods mentioned are tedious and less direct than an

immediate attack with the knife. Sarazin, Weinlechner and Broca have practiced excision of the walls of the fistula, and have effected cures. Sarazin's method was to introduce an elastic sound into the canal, and cut this off on a level with the skin. Then by a circumscribing cut the walls of the canal were dissected wholly out, along with the sound. Or the canal might be distended by injecting melted wax into it, and then excision be done.

As such fistula causes but slight inconvenience, non-intervention is the wiser counsel to the patient. Such was the course pursued in a case which consulted the writer; in this patient, the incomplete external fistula opened about midway between the angle of the lower jaw and the sterno-clavicular joint. This course is still further justified by the fact that, after the closure of such branchial fistula, the patient has found that the site of the healed canal is the seat of unpleasant sensations greater than before it was interfered with.

THYROID GLAND, AND ITS AFFECTIONS.

Surgical Anatomy.—The thyroid gland, according to Allan Burns, lies a little below the cricoid cartilage, its upper margin being generally parallel to the second ring of the trachea. It is generally composed of two lobes, which are joined to each other by a slip which crosses the trachea, a few lines below the cricoid cartilage. In one case Burns saw this isthmus placed between the trachea and œsophagus; a peculiarity, he says, at all times to be much dreaded.

This description, given by an eminent pioneer, will here receive some supplementary completion by material furnished by Marchant, in his essay upon the thyroid gland.

Viewed as a whole, the gland is in the form of a crescent, of which the convexity is directed downwards, and the branches point upwards. This convex border has a notched depression in it. The gland has an anterior and a posterior face, an upper and lower and lateral borders, and a median portion, named the isthmus. The posterior surface contains an excavation or semi-canal, in which the air-passage and œsophagus lie; and the isthmian band lies on two or three of the upper tracheal rings. The recurrent laryngeal nerve lies close to the posterior face. The upper border, as a rule, lies close to the cricoid cartilage. The inferior border is thick, short, and is often concave; and from this border pass the thyroid veins. This inferior bor-

der in the adult, lies nearly one inch above the superior margin of the sternum; and in the infant, the distance is somewhat over a half inch. If, however, the head be well retro-flexed, then the distance between the sternum and gland is increased nearly a half inch. The lateral borders which are inclined backwards, are thick, and each one presents a furrow in which lies the primitive carotid artery. The inner edge of this furrow corresponds to the œsophagus, while the outer one forms a slight separation between the carotid artery and internal jugular vein.

The gland is included in a thin capsule of fibro-cellular tissue, which comes to the aid of the operator in the work of enucleating the gland. This capsular envelope seems to accompany the superior thyroid artery, and, when it reaches the gland, it expands and forms the investing capsule.

There is often seen a divergence from normal form; and the diversity or variation may concern the lobes, the isthmus, or the accessory portion, named the pyramid.

The lobes may ascend to unequal heights; one of them may rise to the middle of the thyroid cartilage, while the other nearly reaches the lower border of the cartilage. The lobes may be developed unsymmetrically or irregularly. They may also be replaced by lobules or fragmentary portions which are loosely connected together. And the thyroid gland thus lobulated, may, according to Madelung, who has carefully studied this abnormal form, assume various forms. Hence, as seen, the lobes may vary in site, direction and in the disposition of the component lobules.

The isthmian portion may be thick, or merely a thin band; or narrow, or broad. And in height, it may vary from a half inch to almost two inches in elevation; or it may not exceed two or three lines in height.

From the upper border of the gland there often ascends a pyramid-like portion; and this is so constant that the anatomists, Meckel and Morgagni, rarely saw it absent. This process may arise from the middle of the isthmus; or from the connection of the isthmus with a lateral lobe; or it may proceed from the lobe itself. And according as it rises from the median line, or has lateral origin, so it will stand vertical or oblique in direction. The pyramid terminates in a fibrous cord, which extends upwards and is fastened to some portion of the thyroid cartilage; or it may reach to the hyoid bone.

Very exceptionally, the thyroid gland consists of a right and left portion unconnected by the normal isthmian bridge.

The arteries which supply the gland are the superior and inferior thyroid arteries; and, in about ten per cent of cases, there exists a vessel, entering from below, named the middle thyroid artery, and which springs from the arteria innominata; this vessel is named the artery of Neubauer. The superior thyroid arteries are given off near the commencement of the external carotid arteries; and, at their beginning, lie superficial in a triangle formed by the sterno-cleido-mastoid, digastric and omo-hyoid muscles; the inferior thyroid arteries, at their origin from the subclavian arteries, lie deep; and each passes behind the corresponding primitive carotid and the sympathetic nerve; and a ganglion of the nerve is named thyroid from its position on the inferior thyroid artery. The thyroid arteries are normally of quaternary magnitude; but in goitre they may acquire the diameter of a finger, as was seen by Burns.

Goitre.—The thyroid gland, or body, as it is often denominated, may be the site of wounds and inflammatory action; it is, however, remarkable as the seat of a growth named bronchocele; more commonly called goitre. In Derbyshire, in England, the affection is so frequent that it is known there as Derbyshire neck. The Germans wrongly name this affection struma. The name goitre has been borrowed from the French, and was originally derived from the Latin word *guttur*, signifying throat.

Goitre is an affection of the thyroid gland in which there is an enlargement of its structure; and the latter may be solid or liquid. Or, as Celsus puts it, "there is a tumor, which the Greeks name bronchocele, that grows between the skin and the trachea, and which sometimes is composed of torpid flesh; and again, it may include some liquid similar to water or honey; and sometimes it contains hair mingled with bones."

This growth may comprise in its development the entire gland; or the tumor may be confined to one lobe, as the isthmus, or the pyramidal portion, or to two or more of these parts. It may vary in volume from a small nodule that is almost undiscoverable, to one so large that it may occupy all the space from the chin to the sternum; and if Fischer and Mittermayer are to be credited, such tumor has become pendulous and reached beyond the umbilicus. The writer does not insist on the reader believing this; yet he would record that he has seen a case in which a goitrous tumor depended to the middle point of the sternum. When the tumor is symmetrically developed, there is a median depression between the lateral lobes. In deglutition, the goitrous

growth makes excursions upwards and downwards; and when the tumor is not large, in the act of swallowing, there will be observed a well-marked fossa in the middle line of the neck. This hollow will be less in proportion to the development of the isthmus. When the goitre is developed laterally, it carries the carotid artery forwards and laterally; indeed, in such a case, the artery will be found lying under the skin, a long distance from the median line. This lateral displacement of the vessels is an anatomical fact of the utmost importance in the surgical treatment of goitre; and it must not be forgotten in the operation of thyrotomy.

In this lateral shifting of vascular location the internal jugular vein also shares. In one case, however, seen by the writer, the carotid artery was not displaced, but the internal jugular vein was uplifted and lay flattened as a blue ribbon over the goitrous tumor, which had developed from the left lobe of the gland and grown only towards the left, carrying the vein with it; a perilous anomaly.

In the development of the goitre, its anatomical structure will be determined by the element which predominates in the growth: thus according as the fibrous, vascular, or glandular tissue is predominantly developed, so the goitre is distinguished as fibrous, vascular, cystic, or follicular goitre. Ecker, who has made a study of goitre, published, in 1845, the following classification: vascular, cystic and glandular.

The vascular species arises from congestive hyperæmia of the gland, often due in the female to parturient effort: also such congestion may be due to the changes which attend puberty; and such afflux may arise from menstruation and pregnancy. From this congestion, the capillaries and smaller arteries dilate and become varicosed, and ultimately rupturing, blood is effused into the parenchyma of the gland. This extravasated blood becomes the starting-point of the cyst; and in the formation of the cyst the colored cells perish and become absorbed, or are converted into other forms of organic matter, which may be crystalline or amorphous. Or if the blood be considerable in quantity, then its fibrinous content may be deposited on the containing wall, and thus a cyst is formed.

The vessels sometimes undergo calcification, and this change favors rupture of the walls; and some even claim that such calcification precedes and occasions hyperæmia. The calcified material may form calcareous concretions. The chalky matter

may be precipitated in stratified form; and also other exuded matter may be arranged in layers. The calcareous material for such calcification is thought to be derived from the lime-containing water used by the subject. In the third species, named glandular, since all the constituents of the gland concur in its formation, the tumor is found filled with gelatinous, or albumin-like material. If such goitrous structure be incised, it presents a yellow stroma in which bluish, diaphanous masses are seen; and these pellucid masses may have any volume from that of a pin's head to that of a child's head. The content resembles boiled sago. When such content is in large amount, it crowds on and renders denser the surrounding glandular structure; and this compression may be such as to quite obliterate all traces of the true structure. Ecker's explanation of the origin of this colloid or gelatinous tumor is, that the efferent lymphatic vessels fail to remove the matter formed in the glandular vessels; and he compares it to a cyst from retention. The vessels remaining after such a tumor has formed, lacking their normal support, burst and add blood to the colloid content.

Rokitansky, the veteran pathologist of Vienna, whose study of disease as revealed in the *dead-house* has been surpassed by no individual, claims that the different kinds of goitre are derived from, and referable to, one common genus, viz., the vascular. From this common class, according to the course followed in the evolution of the tumor, it may be named exogenous or endogenous. In the exogenous class are comprised those forms in which the development is excentric, or from within outwards. In the endogenous type, the cells or compartments grow through the development of smaller growths within the primary one. If a tumor of this type be opened, the secondary growths can be seen adhering to the parent wall. In this form vessels can be seen passing from the primary wall to the secondary endogen. And when such a growth has reached full maturity, it becomes sterile; and then neither nucleated nor glandular elements can be found within it. This stage is the terminal one of the goitre; and such a growth corresponds in character to cysts in other regions of the body.

Returning from this morphological history of goitre, and utilizing the facts here learned, a practical and compendious division of the subject is into two classes: solid and liquid or semi-liquid.

In the solid species the constituents are both multiplied and enlarged. Such a tumor has the solid feel of muscular tissue; it

is slightly elastic, yet on percussion, it yields no impulse of fluctuation. It is painless; and even when strongly compressed there is awakened only a dull pain, or unpleasant feeling. When the tumor is displaced, its connection with the air-passages is shown in this, that the air canal obeys the movements of the goitre. The overlying skin is of natural hue, and has but little or no attachment to the goitre. If the solid goitrous growth be split open, an appearance akin to that of the normal glandular structure will be presented to the eye; and such section on pressure will yield glandular elements, viz., vesicles and a syrup-like fluid Sometimes in such tumors, alteration of tissue will be found which denotes the transition to the cystic formation.

In the second general form, the constituent elements on examination are found multiplied and enlarged. Vesicles differing in volume will be discovered; and these contain a content which is liquid, or gelatinous in character. Such a goitre presents analogy to the multilocular cyst of the ovary. If the examination be made at a later period of development, larger cavities containing cystic material will be found, which have arisen from the confluent fusion of a number of smaller cavities. And by a continuation of growth, degeneration and fusion, the multilocular subcysts are transformed into one large cystic cavity. Or instead of one, the tumor may contain two or more separate cystic compartments.

The content of the goitrous cyst presents several varieties. In a few cases seen by the writer, it was a transparent fluid of remarkable clearness; more often, however, such content is turbid, and on the walls of the cavity there will be found a detritus, which is the remnant of clotted blood. And when shaken up, the liquid content is similar to the lees of wine. Again, the content may resemble semi-liquid gelatine, discolored with pigmentary matter, and this may be of different degrees of fluidity. Sometimes a steatomatous or adipose material is found in the cyst. During the development of the cyst, the blood-vessels in the distending walls may be ruptured; and thus blood is added to the cystic content; or one of the compartments may be quite filled with blood, of which the coagulum remains and becomes a permanent constituent.

Besides the content mentioned, sometimes there are found osseous or calcareous concretions, either alone or along with liquid content.

A form of goitre not very unusual is that in which the exces-

sive development concerns the vessels; the arteries enlarge enormously, so that they constitute the chief component of the tumor; and in such a case, the tumor consists of a mass of aneurysmal varices. If this tumor be grasped in the hand, there will be felt in it a pulsating thrill, a movement and expansion synchronous with the pulse. The aneurysmal goitre, though it attains less dimensions than the cystic form, yet the former through its vibratile motion and buzzing sound, becomes a source of great annoyance to the patient.

Maunoir, of Geneva, claims that frequently the so-called goitrous cyst is not of thyroid origin; and he names them hydrocele of the neck. Tillaux concedes that this may be so, exceptionally, viz., that it may arise in the bursæ of the præ-laryngeal muscles; also a lymphatic gland of similar site may simulate goitre; yet Tillaux has found in his dissections that in doubtful cases there could be traced a connection between the thyroid gland and the tumor; and such connection was often in the form of a narrow, elongated pedicle. And he formulates as an anatomical axiom, that in those cases in which a tumor located in the sub-hyoid region ascends and descends during the movements of deglutition, it almost always originates in the thyroid gland.

Trained digital palpation can often recognize the nature of the goitrous content; yet, to arrive at absolute certainty, the hypodermic syringe should be used, and some of the content withdrawn. The determination of the nature of the goitrous content, if interesting in surgical pathology, is yet more so to the practical surgeon, since it indicates the course to be pursued in the treatment of the disease.

The goitrous tumor when small, and seated high in the neck, gives the patient but little inconvenience; yet when it becomes voluminous, and even when diminutive, if seated near the sternum, it gives trouble through compression.

Bilz, in 1850, studied the changes of form and position of the trachea which such pressure can produce, and found that the trachea might be misplaced laterally; also the tracheal canal may be flattened, or converted into a triangular, prismoidal form.

Compression acts most deleteriously when the tumor grows inwards rather than outwards; or when it is deep-seated and rests closely on the important structures which traverse the neck. Such pressure can narrow the tracheal and æsophageal canals, and can disturb the function of the recurrent, sympathetic, pneumogastric and phrenic nerves.

Bonnet, who has studied the functional disturbance resulting from the mechanical action of such tumors on contiguous structures, finds that a small goitrous growth seated at the junction of the neck and thorax, can cause dyspnœa, numbness in the arms, and aphonia or impaired voice. And such compression is augmented when the tumor glides behind the clavicle, or the sternum. When the trachea is thus narrowed, the entering air expands the trachea above the constriction; and the air returning from the lungs, being obstructed in its exit, causes abnormal expansion of the air-passages below the constriction; and then, as Bilz has found, an emphysematous condition of the lungs is induced. In some cases, the sterno-cleido-mastoid muscle, when uplifted or stretched by the goitre, may be the chief factor in the pressure; so much so that Bonnet, to get relief, severed the muscle.

Rose, in the *Archiv fur Klinische Chirurgie*, in 1878, published his observations of the mechanical effects of goitre on the trachea. He finds that alteration occurs about the first tracheal ring. Patients unconsciously correct this curve or inflection; but when the subject is anæsthetized, the inflection returns, and respiration may thus be seriously interrupted. Rose found cases in which the trachea was maintained patent through the goitre surrounding it on all sides; in such cases, the removal of the tumor should be preceded by tracheotomy.

Kaufmann, in 1883, describes a form of goitre, which from its situation he names the retro-pharyngeal and retro-œsophageal goitre, and which interferes with voice, breathing, and swallowing. The goitre may be unilateral or bilateral; and in the former case, it can only be moved towards one side. The remedy in such a case is extirpation.

In 1887, Heise reported three cases of goitrous tumor within the air-passages; the growth was attached to the posterior wall of the larynx and trachea, and was not connected with the thyroid gland. The subjects were young, and the tumor caused dyspnœa. The growths were removed by laryngo-tracheotomy. Streckeisen saw such a growth seated higher, within the arch of the hyoid bone.

Having concluded the description of the anatomical characteristics and the symptomatic phenomena of goitre, a consideration of its causation is next in order: this subject has occupied the pens of many theorists and also many practical observers. It is a polenical field beset with diverse and antagonistic opinions, in which the only points settled beyond contest are that

goitre has its favorite topographical habitats, and in most cases occurs in the female; and further that it is in some way associated with the generative function.

In the south of Europe there is a popular belief that the sexual act enlarges the previous virginal neck ; and allusion to this is in the line of Catullus; *non hesterno poterit collum circumdare filo.* And Malgaigne mentions that the watchful matron tests the moral character of girls between fifteen and twenty years of age by placing the two ends of a measuring cord between the incisor teeth, and then passing the loop over the head; such a close-fitting loop can contain the neck of the intact; but it will not include the neck of the other class. In these admeasurements the male's neck seems to have been forgotten.

The straining efforts of the female in parturient labor act especially on the thyroid gland, which becomes for the occasion a reservoir in which the blood takes temporary refuge; and there finally results a permanent enlargement of the part; the writer has known several cases of goitre which arose in this way. As a rule, goitre of puerperal origin is bilateral, and does not attain large dimensions. Suppression of the menses is sometimes coincident with development of the thyroid gland.

Heredity is a disposing agency. And the disease has developed in the fœtus; and to such dimensions that it caused suffocation of the new-born.

The disease often appears in the subject of fair complexion and lymphatic temperament. The scrofulous subject is likewise disposed to goitre. And this is so usual, that it has influenced the nomenclature of goitre: since goitre is universally designated struma by the German writer. That this name is appropriate, the writer will not concede; though it may be somewhat justified, when a writer of such eminence as Bazin says that, in nearly all cases of goitre, he has found other symptoms of the scrofulous constitution. Hypertrophy of the thyroid body seems to be cognate to scrofula, in the same manner as the hypertrophy of the thymus gland is related to syphilis.

Occupation in which there is laborious and continued muscular effort, favors thyroid hypertrophy.

Besides the agencies enumerated which figure in the causation of goitre, there are others of a more obscure nature, which have claimants among surgical and medical writers.

The fact that the disease is endemic, in fact, pandemic in some geographical regions, has led to a search in those places, for

the disposing cause. The countries in which goitre prevails are Derbyshire, in England, the warm countries of the Tyrol, the Alps, and especially the Alpine region of Isère, Savoy and Piedmont, in southeastern France. In the vicinity of Uriage, in the southeast of France, visited by the writer, there is a village in which goitre and cretinism in amicable sovereignty have absolute control; a region in which nature, having placed her sublimest pictures, afterwards, in mocking irony, formed humanity dwarfed, deformed and imbecile.

The cause of this endemic goitre has been sought for in the air, water, and food on which the inhabitants subsist. The use of water from the melted snow has been assigned as a cause; also, the presence of dissolved magnesian limestone in the water has been urged as the cause; and much proof in favor of this agency has been brought forward. Bromine, lithium and, recently, fluorine have been given place as causal agencies. A dog fed by Maumoné on fluoride of sodium for four months, developed a general tumefaction of the neck. The intemperate use of ice-water has been offered as one of the causes of goitre.

Chatin, in 1852, announced a new theory in regard to the origin of the disease; he referred the origin of goitre to the absence of iodine in the air, water and food used by the subject. To confirm this hypothesis he made a long journey in the Jura Alps, Lombardy and other regions in which the affection was prevalent, and examined the air, water and food chemically. Though he found in Lombardy facts which were in discord with his doctrine, yet these seemed insufficient to alter his opinion that, where goitre prevails, it is due to the absence of iodine; and his inference is that in non-goitrous countries, the inhabitants continually use enough iodine to counteract the development of the disease. Chatin's doctrine is accepted by Moleschott, in his noted work entitled the "Circulation of Life." The author has observed facts at variance with Chatin's theory; on the Isthmus of Panama, on the western coast of Nicaragua and Mexico, he has observed cases of goitre in persons who had always breathed the air from the ocean, impregnated with iodine. A similar observation has been made among the inhabitants of California, among whom the writer has seen several cases of the disease, in both males and females. Hence the theory of Chatin is untenable; or if it contains a grain of truth, the most that can be granted to it is to hold a conjectural place among the causal agencies of goitre.

In a search for the causation of goitre, some claim that there exists a mutual relation between the parotid and thyroid gland; viz., that where the parotis remains in a state of inertia from non-use, as in the case of shepherds who chew but little, and consequently there is but slight excretion of saliva, the thyroid gland enlarges; but on the contrary, those who live on vegetable food, and hence masticate freely, are exempt from goitre. Hence, for prophylaxis and cure, Grynfelt advises the use of food that demands active use of the muscles of mastication. The author has had under his observation two cases which militate against this theory, viz., two persons who in infancy through cicatricial contraction of the structures of the side of the face lost the power of using the lower jaw; in these cases there was no thyroid enlargement observable.

In 1860 Collin reported an epidemic of goitre which occurred in a body of French troops stationed at Briançon, and in another body stationed at Clermont. At Briançon, the disease appeared suddenly in a number of men. Collin, who had the surgical care of these soldiers, referred the origin of the disease to the slight elevation of the place above the level of the ocean, in consequence of which the air was rarefied, and produced difficulty of breathing; thus, he claimed that congestion of the gland arose, and that this was promoted by the soldiers' uniform, which caused constriction of the neck and chest. The exercise of carrying burdens up the hill, also, contributed to such congestion.

In the regions of the Alps where the disease is pandemic, that the disease depends on some local cause or causes is indisputable from the fact that, besides man, numerous domestic animals become also the subjects of the disease. Thus, Baellarger saw goitre in the horse, the dog, the cow, the sheep, the goat, the hog, and especially in the mule. And in such regions persons unaffected with the disease, coming and sojourning, may become the subjects of goitre; and also in those in whom the disease has commenced to appear, should they leave the locality, the disease recedes.

In those regions in which goitre prevails, especially in certain mountainous districts of Switzerland, there also prevails a constitutional disease denominated cretinism; and in many cases goitre and cretinism occur in the same individual.

Cretinism is a disease in which there is a general arrest of development of the subject. There is cranial deformity in which the frontal and parietal eminences are unusually prominent,

and ossification is retarded, or imperfect. The teeth are irregular in formation and position, and second dentition is wanting, or imperfect. The muscles, tendons and aponeurotic fasciæ are ill formed; and as result, the subject is liable to hernia. The functions of digestion and assimilation are imperfectly performed, and there may be pyrosis, ill appetite or inordinate voracity. The pulse is often small, and too frequent. The patient is emaciated, the skin loose and flabby, and the tissues are œdematous. The generative faculty is feeble, perverted, or lost. Melancholy, hysteria, mania and dementia are present. The intellect is clouded, narrowed or nullified to complete idiocy, so that the mentality of the cretin is reduced to a few fragmentary traces which might be designated instinctive rather than rational. And this dwarfed human parody may have as an additional touch of degeneration, a goitrous neck; and so often is this true, that there must be an intimate consanguinity between the causal agencies of cretinism and goitre.

Perhaps the goitrous enlargement,encroaching on the adjacent vessels and nerves,may arrest the growth of the brain and disturb the functions of the heart and lungs; and in the child such deranging influence would promote general corporeal degeneration, viz., cretinism, or something akin to it.

Treatment.—This may be placed under three heads: prophylactic and restraining, medical and surgical treatment.

A precaution of great prophylactic value, when practicable, is the removal of the patient from the region in which he is exposed to the external influences which promote the goitrous growth. Kneading and rubbing the tumor should be practiced so as to awaken a counter-action to the morbid processes occurring in the gland; thus, a healthy cell-metabolism and return to normal structure will be promoted; and though the goitrous tissue may not be made to disappear, or even recede, yet further progress in the direction of glandular degeneration may thus be arrested.

As a means of restraining growth, a cravat or bandage about the neck has been used. Such a compressive bandage might be made of elastic material. There is a serious objection to this repressive treatment, since, thereby,the growth is crowded against the cervical vessels, and thus congestion of the head is maintained; and a further fault is that a growth which is compressed backwards is caused to grow in that direction, and to deform the tracheal canal, and also to insinuate itself between the windpipe

and the œsophagus; or else to include and to encircle these passages.

Medical Treatment.—In 1820 Coindet announced the successful treatment of goitre by means of iodine. Other medicinal agents have since been advised; yet none have yielded the satisfactory results which have been obtained from iodine. This agent may be used externally, parenchymatously, or it may be given by the mouth.

When externally employed, iodine may be in the form of the simple tincture of iodine, or the compound tincture; or the simple or compound ointment of iodine may be used. The solution of iodine in glycerine or collodion has been employed. The simple or compound tincture of iodine is applied by means of a brush; a number of coats are to be applied daily. When the scarf-skin is loosened, this must be removed, and the painting renewed on the freshened surface. This treatment to be effective, must be continued for a long period: many months, at least. And as the favorable result is so slowly obtained that it is nearly imperceptible, the patient and surgeon, in most cases, finally lose hope of reaching a cure in this way; and the former is hastened to such a conclusion by the pain with which he is harassed by the irritating action of the iodine. Instead of using the tincture of iodine, the writer prefers a solution in collodion; thus the action is hastened, and the compressive action of the collodion is added to the specific action of the iodine. For this purpose let the following compound be used:—

℞. Collodii.... ....ʒij
Iodi puri. ... .gr. xij
Potassii. Iodidi..... .. ..ʒss
Misce.

Let a number of coats be painted on and around the goitrous enlargement. The collodion forms a constricting capsule about the tumor; and the included derm is irritated or vesiccated, so that the iodine penetrates the tissues. After this crust, including the epiderm, has become loosened, it should be detached and a new coat applied. To render this application less painful, the fresh surface can be cocainized.

Iodine in combination with mercury, has been used in the form of an ointment, which is made as follows:—

℞. Hydrarg. Biniodidi. ....ʒi
Adipis... .. ..grs. xxx
Misce.

A portion of this is to be rubbed daily on the tumor, for some minutes, and then the part must be exposed to the rays of the sun. This treatment was introduced by a layman in the East Indies, and afterwards, adopted and used in some thousands of cases of goitre, with beneficial effect.

By a long use of the iodine externally applied in one of the ways mentioned, the goitrous affection may be checked in its growth, and, perhaps, made to recede; yet the employment of the remedy hypodermically is less circumstantial, and is more prompt and more effective in action. The hypodermic use of iodine in the treatment of goitre was announced in 1853 by Woerner, whose observations were made on cases treated in the surgical clinic of Tübingen. These cases were of the cystic form, and the work was done as follows: by means of a trocar the liquid content was evacuated, and then, into the emptied sack there was injected from one to two drachms of pure tincture of iodine, which was permitted to remain. About one-half of the cases were cured, while the others remained uncured. After the injection, a burning feeling was experienced in the sack; the latter soon refilled, but in a month or two, the tumor began to lessen, and continued to do so until a cure was effected. In 1867, Luton published a paper on the same subject, in which he claimed to have taken the initiative. He injected the tincture: and according to the volume of the tumor, and the number of its lobes, more or less was employed; and the amount thus used varied from one scruple to four scruples. The injection was followed by a burning pain, and if a lateral lobe was the part attacked, then the pain extended upwards towards the side of the head, and downwards to the shoulder. The injected part swelled, and it remained swollen and painful for some days. The patient perceives the taste of iodine in his mouth, and the agent can be detected in the urine. After this the tumor begins to diminish, yet the curative results are not fully realized until after the lapse of some months. Hence, Luton says, the injections need not be often repeated. After each injection, one should wait until its action has become exhausted. The induration arising results from the coagulation of the albumen from contact with the iodine.

This interstitial treatment gave the best results in the soft and diffused species. The polycystic species is also thus curable; and Luton and Monod found that it was not necessary to first empty the sack; the cystic content serves as an excellent medium

by which the iodine is brought in contact with the walls of the goitre. Large goitres can thus be treated with a fair probability that the volume will be diminished, though the tumor will not wholly vanish. In the multilocular species, the injection into one section has caused general lessening; yet in such it is better to attack several lobes. This interstitial treatment is not suited to the aneurysmal species of goitre.

Luton reports forty-eight cases of goitre thus treated; of these thirty-two were completely cured; twelve were made better, and in the remainder, no benefit was derived from the treatment. Subsequent work done by this plan of treatment has further demonstrated its utility. Where ill results followed the use of iodine thus employed, they were not more severe than those which occur after the use of the agent, when given by the mouth. The instrument used for this work was the syringe of Pravaz, or that employed for the ordinary subcutaneous injection.

In 1872, Schwalbe reported in Virchow's Archives one thousand cases of goitre treated by the interstitial injection of remedies. He uses the hypodermic syringe as a diagnostic aid to determine whether the tumor be cystic, vascular, glandular or fibrous; from the cystic, liquid content escapes; from the glandular and fibrous, nothing escapes; while blood escapes from the vascular. He used a syringe somewhat larger than that of Pravaz; and a point that is conical is better than one which is ground down on one side, since the latter can bend or break.

The treatment is not free from danger; in one case, after an injection, the patient complained of prickling in the arm and leg; convulsions soon followed, ending in death. In many cases pain radiated along the course of the adjacent nerves.

Schwalbe, for a time, used the tincture of iodine; later, believing that alcohol was the chief agent in the work, he used this alone, and obtained satisfactory result. The quantity used was from ten drops to a drachm. The injections were repeated at intervals of from three to eight days. Along with these injections, fifteen grains of iodide of potassium were taken daily, by the mouth. To be sure that a blood-vessel was not penetrated, Schwalbe, after inserting the point, let it remain a short time, in order to determine whether blood would escape.

Instead of the tincture of iodine, Fowler's solution of arsenic has been used. In 1882, Grünmach reported the treatment of nearly one hundred cases, by the subcutaneous injection of the tincture of iodine. He diluted the remedy with an equal amount

of water, and of this he injected a half Pravaz syringeful, two or three times a week.

A third mode of treatment is the administration of remedies by the mouth; thus iodine, arsenic and the muriate of lime may be given. Yet such indirect route of reaching the tumor should not wholly be trusted to; it should be combined with the endermic or interstitial use of one of the anti-goitrous remedies; thus an attack being made from within and without, the treatment becomes more effective.

Electrolysis as an anti-goitrous treatment has its advocates; the writer has observed cases in which the use of the constant current not only retarded the growth but caused diminution of the existing volume; and since this method commends itself by its painlessness and simplicity, it may be tried. Both the constant and interrupted currents may be employed; yet the galvanic or constant current has, from experience, received greater sanction.

Should the means of treatment which have been enumerated prove unsuccessful, then a resort may be had to some operative procedures; that is, one may adopt as a guide the Hippocratic axiom, *Quod medicina non sanat, ferrum sanat:* What medicine cures not, the blade cures.

The treatment advised by Celsus is first to attempt to destroy the goitrous tunic by escharoties; and when the tumor is thus opened, the content will flow out if it be thin; but if it be thick, it should be pulled out with the fingers; and then the ulcer which remains is to be healed by proper dressings. But Celsus says a cure with the scalpel is speedier; and for this, the tumor is to be incised in the median line, and the tunic exposed; then with the finger the cyst is to be separated from the sound structures, and removed, with its contents. The wound is now to be cleaned with vinegar to which salt or nitre has been added; and its lips are next to be closed by means of sutures, and dressed in the manner pursued in other wounds.

This description of the Celsian treatment shows that the Roman surgeon managed the goitre intelligently and dextrously; and one finds in it the elements of the operative treatment of the present time.

Goitre has been treated operatively by the following procedures: the seton, simple incision, incision and suture maintaining the wound open, strangulation by circumscribing ligature, ligation of vessels, and enucleation.

The treatment by seton originated with Reid and O. Beirne, and should be limited to the cystic species; it has been recommended by Nagel and Hamburger. The plan of Hamburger was to so introduce a tube that it would afford drainage at the most dependent portion of the tumor; the lower opening was made larger than the tube. The seton caused much reaction. Adelmann advises the seton in the goitrous cyst of thin walls. The author treated a case by the use of the seton in 1869; this was a large cystic goitre, and the treatment reached through a period of many months. Though a cure was thus obtained, the writer would not adopt this plan again.

The method of treatment by incision is suited only for the cystic species, and in this way Adelmann cured some cases. In 1867 Patruban treated by incising the goitrous cyst freely; and then having uplifted the bottom, this was transfixed with threads, and these were then fastened to the neck outside, so that the cavity was nearly obliterated. No serious reaction followed, and a cure in six weeks was obtained. After making a free incision, and the content having been evacuated, the inner wall of the cyst may be brushed with a strong solution of iodine; and then the cavity may be filled with iodoform gauze, and redressed as required.

The method by strangulating ligature is adapted to the solid species of goitre. It was used by E. S. Cooper, of San Francisco, in a case observed by the writer. As the operation was done in the suppurative age of surgery, the unsatisfactory result which followed the work, was not a fair test of this plan of treatment. It is probable that subcutaneous circumscription of the vascular or glandular form of goitre, done aseptically, would effect a cure.

Goitre has been treated by ligation of the nutrient arteries; this has been chiefly done in the vascular species. In 1829 Langenbeck tied the superior thyroid artery on the right side; and in another case he tied the common carotid artery. Soon afterwards Chelius performed ligation of the superior thyroid arteries in four cases, with success. And in 1852, Porta tied the superior and inferior thyroid arteries for the cure of goitre. This plan of treatment has been pursued by but few surgeons. When it is done, it would serve a better purpose were it the preliminary act in the work of enucleation.

A more satisfactory treatment is to remove the growth at once by the plan known as enucleation. Wölfler, in his monograph on the surgical treatment of goitre, says that in 1771, Vogel

partially excised the goitrous tumor after having tied the vessels. In 1791 Desault removed one-half of the diseased thyroid gland. The gland was first systematically removed by Hedenus, in 1800; he separated the muscles from the gland, and tied all the vessels. In 1817 Von Walter tied the superior thyroid arteries with the intention of inducing atrophy of the gland. Galen noticed that the recurrent nerve might be impaired in the removal of the gland. Zang, in modern times, observed that loss of the voice might result from removal of the thyroid gland. Jobert, in 1843, advised electro-puncture; and later, extirpation was done by the galvano-caustic process.

In 1842, Sédillot published an account of the extirpation of a large goitre; his incision was made along the border of the sterno-cleido-mastoid muscle; twenty vessels were tied, some of which were as large as the little finger.

Dieffenbach, for the cure of goitrous tumor, advises to extirpate the glandular species; to treat the vascular by ligation, and the cystic form by the seton.

Woerner, who wrote in 1853, would treat the cystic form by incision, but the solid species by extirpation. Extirpation, which he pronounces a perilous operation, is to be done by a long incision, in which the tumor is laid bare and dissected out with the fingers, the handle of the scalpel, closed scissors and forceps. When large vessels are brought into view, then a pair of curved scissors should be carried under them, and along this an aneurismal needle, carrying two threads, so that the vessel can be tied at two points, and then divided between the ligatures. Large veins which swell up during the dissection, should be tied, and then severed. Thus, step by step, the operation is so done that the surgeon works almost in non-bleeding tissue. If large processes pass underneath the sternum, Woerner divides them with the ecraseur. One of the risks attending this extirpation was secondary bleeding; and from this some patients were lost.

In 1872, Warren Greene, an American surgeon, reported cases of extirpation of goitre, done as follows: lay bare the tumor by a straight incision, in which the capsule must not be opened. When the tumor is thus well displayed, its capsule is to be opened and the contents enucleated and removed with the fingers and handle of the scalpel; and he advises to do this rapidly and regardless of the hæmorrhage; the aim of the operator being to reach the thyroid arteries as soon as possible, and to tie them. When the inferior attachment or pedicle is reached, it is to be

transfixed with a blunt needle and each half securely tied, and section then made above the ligature.

Kocher, in 1874, wrote on the treatment of goitre; his method was similar to that of Luecke; he treated the hyperplastic form by injections of tincture of iodine. This injection, in the cystic form with thick walls, will not cure; indeed, such injection only thickens the walls. The cystic species is better suited for treatment by incision. But in the gelatinous, vascular, hæmorrhagic and soft follicular species, as well as in the fibrous form, the best treatment is enucleation of the tumor. The proper method of doing this is to divide the skin over the growth, open the fibrous capsule, and tie all the vessels which are met. Next proceed with the enucleation, and when large vessels are found in the peduncular part of the growth, they are to be ligated. Where the growth is firmly attached to the trachea, the mass must be included in a ligature, severed, and the remaining stump cauterized with carbolic acid. The edges of the remaining capsule are to be drawn outwards, and sutured to the skin. In cases of gelatinous material, Kocher opens the growth and clears out the content with his fingers, and temporarily fills the cavity with sponge; after the bleeding is thus arrested, he fills the cavity with carbolized lint, which is changed from time to time.

In 1879, Wölfler reported on the extirpation of goitre as pursued in the surgical clinic of Billroth. Instead of a T or V-incision, the tumor was laid bare by a vertical cut which was median in position, or along the border of the sterno-cleido-mastoid muscle. The capsule was opened on a grooved director, and to control bleeding, the forceps of Péan was used. The recurrent nerve must be carefully guarded, as there is danger of injuring it. In eighteen months he operated fifteen times; and only in one case was it necessary to perform tracheotomy. The removal was done under the thymol spray. In four of the cases, the recurrent nerve was partially palsied, yet, afterwards, its function returned. Garré, of Basel, describes and commends the method pursued by Socin in the removal of goitre; he laid bare the capsule of the growth, and then removed the component nodules with his fingers (the plan of Celsus). The hæmorrhage was not great, and was controlled by clasp forceps.

Between the years 1877 and 1896 the author has performed enucleation in eighteen cases of goitre; many years prior to this, in 1858, the writer, when a junior member of the surgical corps of the United States Navy, removed a goitre of moderate dimensions

from a woman in Chinandega, a city of Nicaragua. Of the eighteen, fifteen recovered, and three died. One death was from secondary bleeding; this patient, a mulatto, was neglected by the nurse and allowed to bleed nearly to death before the medical attendant, who had been intrusted with the case, was notified. Another died from collapse of the trachea after the tumor had been removed and the wound closed. After the wound had been closed, syncope ensued, which was thought due to the large amount of blood that was lost during the operation. Artificial respiration by Silvester's mode was resorted to; also inversion of the body and bandaging the limbs to force the blood to the brain; and, as last resort, the wound was reopened, when the trachea was found so collapsed that it was probable that in the movements of artificial respiration, but little air had entered the lungs. Though the trachea was opened, and a tube inserted and air blown in, yet the patient did not rally. Death in this patient was clearly due to the collapse of the trachea, of which the walls had lost their powers of resistance through the continued pressure of the tumor. In the third fatal case, there arose, soon after the operation was completed, a tumultuous action of the heart, the pulse beating over one hundred and forty times a minute. This inordinate cardiac action continued until death, which occurred on the fifth day after the operation. The heart, being exhausted from over-action, ceased to beat. An explanation, which may be offered of the disturbance of the heart in this case, is that, in the enucleation, the cardiac branches of the sympathetic nerve were wounded; those nerves, which regulate or inhibit excessive action, were deprived of their controlling influence. During the five days which this patient lived, the wound healed rapidly; in fact, there was almost complete closure without suppuration.

The operation as done by the author consists in making an incision by which the tumor is brought into view; and such incision should be made vertically in the median line of the derm covering the goitre. The first operation done by the writer was performed prior to the era of "antiseptic surgery," and before the introduction of the hæmostatic forceps, which has given the surgeon such perfect and speedy control of bleeding. This operation was performed on a woman in Chinandega, Nicaragua, in 1859; and as aids were a German and an American physician, residents of that city. As it was thought possible that the woman might die during the operation, the priestly official with his tapers and other appanage in use there in the death ceremonial,

stood near by to perform the last offices, should the knife render them necessary. The patio of the Spanish house, and the street in front, were crowded with curious spectators of the bloody drama which was to be enacted: a scene in which the operator and patient played parts as interesting to that motley company of witnesses, as did the gladiators of old to the Roman corona, which once filled the Coliseum. The operation was a very bloody one, and midway in the work, the bleeding was so profuse that one of the assistants was seized with panic, and begged that the work should cease there. These remonstrances were not heeded; the patient could not have run more risk from concluding the work than from leaving the half-enucleated tumor in her neck. By the careful ligation of vessels, and dissection of the growth from the parts to which it was attached, the work of removal was brought to a fortunate issue. The patient soon recovered, and was amply repaid for the risk of submitting to an operation which had rarely been done: risks here augmented through submitting to a knife which had been disciplined by but little experience.

In subsequent operations done by the writer, after the skin was divided, the muscles which lie on the goitre were uplifted

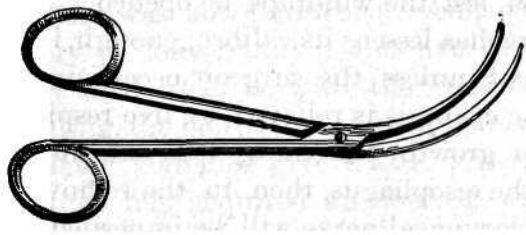

FIGURE 93. Representing the transfixor used by the writer in the enucleation of goitre.

and turned aside, and held so by large blunt retractors; thus the capsule was divided, and if the growth were cystic or cystoid in structure, it was enucleated, and the vessels which entered it were doubly tied and divided between the ligatures. If the tumor be of the vascular or glandular species, then the work is much more difficult than if the development is cystic; a great number of ligatures must be tied; every artery and vein must be carefully secured. And to accomplish this safely, the writer practices a method that may be named interstitial transfixion. For this purpose he uses an instrument which from its use may be called a transfixor. This instrument, as seen from the drawing, is an extremely curved forceps, of which the points are somewhat blunt, yet are sharp enough to permit of the instrument being

thrust through the structure underneath vessels. When the transfixor is thrust through a section of the tumor, the points are opened, and two ligatures are caught and drawn through. The material used for ligature was silken thread which had been carbolized or saturated with alcohol. The two threads were tied, leaving an interval between them, which was divided with blunt scissors. Thus proceeding, section by section containing vessels may be tied and severed. In his recent operations the writer has used catgut ligatures.

If large vessels be met, these should be isolated from the neighboring tissues as much as possible, and ligated. The writer has not seen that large development of the arteries which some surgeons report to have met in this operation. The veins, in number and calibre, exceed the arteries; and these vessels are also to be tied doubly, and severed between the ligatures. Thus done, there will be lost but little blood, and the danger of intravenous aspiration is avoided.

When the tumor is of the glandular species and the isthmus with one or both lobes is enlarged, then the growth is closely adherent to the trachea, and separation of the two demands cautious dissection, lest the windpipe be opened. Also, the traction made on the trachea lessens its calibre; enough, in fact, to asphyxiate the patient, unless the surgeon occasionally suspends the work until the cyanosis is relieved by free respiration. In cases in which the growth penetrates into the niche between the trachea and the œsophagus, then in the removal of the tumor, the recurrent laryngeal nerve will be imperiled; especially so, if the growth is seated on the left side. With due care, the nerve can be spared; and though partial or complete aphonia may follow the operation, yet, as a rule, this will finally disappear. If, however, the nerve on both sides be severed, the voice will be permanently lost; if the division be only on one side, then the voice will be reduced to a species of falsetto which will remain permanent. And as these aphonic accidents cannot always be foreseen, the surgeon should apprise his patient of the possibility that the voice may be injured or lost by the operation. In no patient operated on by the writer has aphonia been produced; yet in the majority of patients there has been some temporary change in tone of the voice.

Jankowski, in 1885, wrote on the aphonia which sometimes follows the removal of goitre; he finds in six hundred and twenty operations that aphonic conditions occurred eighty-seven

times; that is, in fourteen per cent of the cases. Richelot, who wrote on this subject, says such aphonia might arise from pressure of the tumor prior to the operation; or it can arise from lesion of the nerve during the extirpation; and finally, from subsequent cicatricial contraction, the nerve may be compressed, and aphonia thus arise.

For a few days following the operation, the patient experiences great difficulty in swallowing food. He should be fed on liquid diet, which should be introduced in small quantities; thus the movement of the parts is reduced to a minimum, in deglutition. A drainage tube should be inserted and retained in the wound for a few days; and an alcoholized dressing should be applied on the wound. During the treatment, to permit the escape of the excreta, the patient should lie on the side, much of the time.

In 1883, Kocher reported two hundred and forty extirpations of non-malignant goitre, of which twenty-eight died; that is eleven and six-tenths per cent.

Rotter of Würzburg, in 1885, wrote on the mortality which follows the removal of goitre. He finds that of fifty-four cases operated on before 1850, seventeen died; from 1850 to 1876, of one hundred and fifty-four cases operated on, thirty-one died, and the result in five cases was not published. And since the era of antiseptic surgery of four hundred and five cases collected by Rotter, fifty-two died; that is, with the improvement in the method of operating, the mortality has been reduced to near eight per cent; and later statistics give a still lower mortality; so that the operation has acquired an abiding place in surgery among those procedures which lessen human suffering and prolong life.

Recent experience has revealed the fact that the removal of the goitre is not always an unalloyed blessing to the patient. In 1883 J. L. and A. Reverdin, famous for the introduction of skin-grafting, observed that the entire removal of the thyroid gland was followed by loss of appetite, irregular gait, paleness of the skin and dementia; that is, a species of idiocy was induced; and the conditions present are similar to a disease described and named by Sir William Gull, myxœdema. The Reverdins claim that the loss of the thyroid gland leads to a deposit of mucin in the tissues, and causes a disturbance in the central system of the sympathetic nerve. They advise that the gland should not be wholly removed. In the same year Kocher announced that in

eighteen cases in which the gland was wholly removed, there were two in whom the health was impaired; while in sixteen there was a disturbance of the general health, and a degeneration of the patient's physical and mental powers. The limbs were weak, heavy and easily tired, and there was transient or permanent œdema of the skin. Kocher names this condition cachexia strumipriva, and he regards it as akin to dementia or idiocy. In 1884 Credé reported fourteen cases of total extirpation of the gland, and the strumiprivous cachexia did not occur in any of the cases. About the same time, Schiff and Zesas experimented on cats and dogs, in which the thyroid gland was removed. Schiff found that dogs thus treated died within a month. Zesas thinks the gland regulates the circulation of the brain. And to compensate the loss of the thyroid gland in man, it has been recommended to introduce portions of the gland derived from the sheep into the structures of the connective tissue, or into the abdominal cavity.

About this period, a new disease hitherto unknown was noticed, described and named myxœdema: a morbid state in which there are conditions present similar to some which exist in cretinism, and, also, are very analogous to those which follow total removal of the thyroid body: an analogy, in fact, so close that it is permitted to infer that cachexia strumipriva and myxœdema are cognate or identical, and should be amenable to similar treatment. And as a remedy, the fluid extracted from the thyroid gland of some animal, as the ox or sheep, suggests itself as a rational remedy to be used by the mouth, or by interstitial injection.

In 1887 there were additional contributions to the literature of this subject by Bruns and Hoffa, who claim that the entire thyroid body cannot be removed with impunity: the cachexia strumipriva will certainly supervene; and that when such cachexia has not followed thyroid extirpation, it was because the gland had not been entirely removed, or that a portion of it had been reproduced. Again, the absence of cachexia strumipriva can be explained by the coëxistence of an accessory thyroid gland; the existence of such supernumerary thyroid has been verified by the researches of Gruber, Streckeisen, Zuckerkandl and Madelung, who have found that such an anomaly is not infrequent.

Bruns advises to remove but one-half of a bilateral goitre: thus proceeding the cachexy will always be avoided. Bruns announces that he has operated on forty-eight cases of goitre,

leaving a portion of the gland in each; and in no case did the cachexy appear.

In his recent thyroidectomies the writer has pursued the plan here suggested; where the entire thyroid body was goitrous, a fragmentary portion of it was left, with favorable result. In one case, the fragment which was left enlarged so as to cause some trouble; yet this enlargement was arrested and caused to recede by the hypodermic injection of the tincture of iodine; and by the occasional use of such injection during a period of four months, the patient was permanently relieved.

Many reports have been made of total extirpation of the thyroid gland, and yet no ill consequence resulted to the patient; and in some of the writer's first work, prior to his knowledge of cachexia strumipriva and its associate myxœdema, he believed that he extirpated the part totally and still no trouble followed. It is possible, however, that here the removal was not complete, and that some fragmentary portion, fortunately for the subject, was left behind.

In conclusion, then, a rule in the performance of thyroidectomy should be, to leave behind a portion of the gland; and this should be the least affected part of the gland; and its site, if possible, should be lateral and not median; and should this remaining part become the seat of goitrous degeneration, it should be treated by the hypodermic injections of iodine, as has been described.

Exophthalmic Goitre.—In the field in which Surgery and Internal Medicine have possessory rights, the actual claims of each being undetermined, lies a disease akin to goitre, and which from one of its symptomatic features is named, Exophthalmic Goitre. And, as is usual in the cure of disease which has been noticed by a number of cotemporaneous observers, a number of other names have been applied to it; and among these are the names of two of the original observers: to wit, it is sometimes known as Grave's disease; also Basedow's disease. Another name less objectionable than the latter two, may be constructed from its leading symptoms, viz., goitrous ophthalmic tachycardia.

Basedow was more fortunate than other students of the disease in observing that three affections are here united in one, viz., of the eye, thyroid body and the heart.

The symptoms of the disease are as follows: the subject, usually a female, is generally chlorotic, anæmic and hysterical; she complains of cardiac palpitation, throbbing in the præcordial

region, and an upheaval of the chest-wall in front of and below the region of the heart; the cervical vessels beat and swell; and finally the thyroid gland becomes enlarged, and is the seat of a fremitus and blowing impulse and sound. Respiration is disturbed, and cough is easily excited. Along with these phenomena the eye becomes more prominent, and the exposure of an unusual amount of the surface of the sclerotica gives the eye a striking appearance. This ocular prominence is referred by Fano to abnormal development of the vessels of the orbits; especially of the veins. The adipose structure within the orbit is also developed beyond its usual dimensions; and this contributes to ocular prominence. And Neumann has observed that the globe itself is sometimes enlarged. Visual acuity is seldom impaired.

The sympathetic nerve in its cervical portion has frequently been found in an abnormal condition. And this may, the writer would suggest, act on those longitudinal muscular fibers in the lid, discovered by Müller, which have the function of dilating the palpebral slit. Rudolf Wagner verified such action by applying electricity to the divided nerve in the neck of a criminal whose head had just been decapitated.

Of the trio of symptomatic phænomena which are present, much attention has been given to the enlargement of the thyroid body. This hypertrophy never reaches the voluminous dimensions which are often seen in cases of common goitre. The development is usually uniform and bilateral; though exceptionally, it is limited to one side. The changes in the gland are limited chiefly to the vascular constituent, and the anatomical condition is similar to that of erectile tissue. The dilated arteries have numerous intercommunications; and their walls are often the site of atheromatous change. The veins are also altered; they may be obliterated into fibrous cords; or they may be dilated, and present varicose pouches. The proper glandular tissue may be unchanged; yet it is, sometimes, somewhat hypertrophied.

Alterations have also been noted in the heart; the organ is hypertrophied; the ventricles are passively dilated, and there is valvular imperfection, fatty degeneration of the cardiac tissue, and atheromatous changes in the aorta.

Females are predisposed to the disease; the writer has not seen it in the male. Withuisen, who has collected fifty cases of exophthalmic goitre, found that of these only eight were in men. The affection occurs oftenest between the ages of twenty and forty years; yet Stokes and Fischer have each seen a patient much older.

The symptoms which have been enumerated indicate the nature of the affection with sufficient definiteness to enable the surgeon not to confound exophthalmic goitre with ordinary goitre; a matter of much importance, since the treatment of the former is medical and seldom surgical. Should, however, there be doubt as to the true nature of the case, it is better for a time to subject the patient to a course of internal medication. The patient must be placed in the best possible hygienic conditions. There should be a change of residence from inland to the seaside or the reverse, according as the patient belongs to one or the other location. Hydrotherapy is specially praised in the management of such cases. Ice-cold compresses over the region of the heart are commended.

As internal remedies, iron and arsenic may be used; also digitalis. Iodine, so valuable in ordinary goitre, usually fails to bring relief in the exophthalmic form.

If, in spite of the means here indicated, the patient should become the subject of a large goitrous development, then it would be proper to attack the growth by some of the means described in the previous chapter.

Malignant Disease of the Thyroid Gland.—Malignant disease of the sarcomatous and carcinomatous form appears in the thyroid gland. Sarcoma is said to occur here more often than carcinoma.

The writer has seen but one case, which was that of carcinoma, which appeared in the thyroid gland of a man who was fifty years of age. When first seen, the growth, somewhat globular in outline, occupied the entire site of the gland, and was somewhat more than three inches in diameter. It was closely adherent to the air-passages, and of dense structure, unyielding to pressure. The overlying skin was slightly puckered or plicated, and so inseparably adherent to the growth that it seemed to be a part of the latter. The tumor had become slightly painful, and from its connections with the trachea and œsophagus, it interfered somewhat with breathing and swallowing.

An attempt was made to remove this growth, yet the task was a difficult one; and the adhesions to the trachea were such that it was impossible to thoroughly remove the growth without opening the windpipe; and since this would have left an unhealing breach there, it was deemed prudent to leave the tracheal canal intact, which was accomplished by removing the tumor in cuneiform sections. The cancerous tissue was similar to the cicatrized scirrhus occurring in the mammary gland. It was non-vascular, so that the work was done with but little loss of blood.

The result of the operation was some temporary relief to the patient; the latter, however, survived but a few months; and would probably have lived as long if the tumor had not been interfered with.

From the experience in this case, should a similar one present itself, instead of extirpation, the writer would make trial of the parenchymatous injection of an arsenical solution, viz., Fowler's solution, of which there should first be injected five drops; and should this not cause much irritation, the dose injected may gradually be increased in amount. Thus beginning with a few drops, the author has found that by slowly increasing the quantity, finally the patient will tolerate, without dangerous reaction, thirty drops of Fowler's solution, injected at different points in the malignant growth. The tolerance of so large a dose is probably due to imperfect development of the absorbents in the neoplasm.

Wounds of the Thyroid Gland.—Traumatic lesions of the gland named in the order of their frequency are the contused, incised, and penetrating. The gravity of such wound is less in the sound gland than in that which is goitrous.

The contused wound may accompany an attempt at strangulation done by the patient himself; or it may be inflicted by the hands of others. The prominent symptom is the ecchymosis of blood due to rupture of the thyroid vessels; and this may be slight or so extensive as to permeate the tissues from the chin to the sternum. The overlying skin is livid or purple, and there is tumefaction proportionate to the effused blood. Difficulty of breathing and swallowing may be present, due to pressure.

If such contused wound is limited to the thyroid gland, recovery may be expected; but if the larynx or trachea be fractured or torn, then life is imperiled; in the former case, the treatment should be that employed in a simple contusion, local means which will favor absorption of the effused blood. But if the contusion be associated with additional injury of the air-passage, then the patient's chances of recovery will be increased by an early performance of tracheotomy, in which the canula must be inserted below the injured gland. Should suppuration ensue, the pus should be given escape by an early incision. Where the contusion has destroyed the thyroid structure, so that the patient is similar to one from whom the gland has been removed, then symptoms of cachexia strumipriva may occur, as happened in a case seen by Guerlon-Dudon; the gland here had been destroyed by the passage of a wheel over the neck.

The incised wound is generally from an attempt at suicide, in which the wound is made with a razor, or other knife-like instrument; or such wound may be made by the surgeon in the operation of tracheotomy. In such wound, the first duty of the surgeon is to arrest and control the bleeding; and means to do this are ligation of the vessels in the open wound, or by transfixion; and should the rapid escape of blood not permit this, then plugging the wound with the first material at hand, should be resorted to. Styptics, so often used, are not trustworthy, since through the destruction of tissue which they cause, secondary hæmorrhage can ensue. Transfixion and inclusion of masses of the vascular structure in ligatures would be one of the safest and speediest ways of controlling the bleeding.

In the performance of tracheotomy, bleeding is avoided by careful dissection, and likewise, by seizing and twisting the vessels which may accidentally be opened. The proposal to seek for the thyroid arteries and ligate them in such cases, is ill advice; for it is probable that before the operator had fully displayed the quadrangle containing the four vessels, his patient would scarcely require further attention.

The penetrating wound is rare in the normal gland; but as a means of treatment in the goitrous gland it is frequent; and as a rule, such wound is harmless; yet exceptionally, it has proved fatal. Lücke, Demme, Schmidt and Schwalbe have seen death soon result from suffocation, after injections into the goitrous gland. Severe, and even fatal bleeding has resulted from such slight penetrating wound. Suppuration thus arising has caused the patient's death.

Thyroiditis.—Inflammation of the thyroid gland may be acute or chronic; the acute form is that in which surgical aid is oftenest sought.

It occurs somewhat oftener in females; and a goitrous condition predisposes to such inflammation. It is announced by a chill, and a rise in pulse and temperature. There are pain and a sense of oppressive tension about the neck. The tumefaction may be unilateral, or on both sides. The writer saw a case in which the swelling was uniform, both on the sides and on the front of the neck.

There may be headache, ringing in the ears, and in the severest cases, delirium. The tumor obeys the movements of the larynx, rising and falling in deglutition; yet it may be so extensive as to prevent such movement; and then, according to Gosselin,

such immobilization of the air-passage disappears in the same ratio as the agglutinative tumefaction vanishes.

By palpation, the hard and tense structure of the swollen gland can be traced out; and if lateral, the tumor will be felt above, passing under the sterno-cleido-mastoid muscle; while below, it may dip underneath the clavicle and sternum, and, also, be felt on the outside of the sterno-cleido-mastoid muscle.

Such tumor, from pressure on the windpipe, may obstruct breathing; it may also obstruct swelling; and, from pressure on the recurrent nerve, coughing and hoarseness may arise. And great pressure on the vagus nerve has caused sudden death.

Thyroiditis may terminate by resolution, induration, suppuration or gangrene; and, as stated, speedy death may arise through pressure causing suffocation.

In the cases which disappear by resolution, the swelling appearing on the second day, increases till the fourth or fifth day, or even later in severe cases; then it remains stationary for a variable time, and finally disappears at the end of two or three weeks. This normal, or desirable course, may be varied by accessions, remissions, cessations and other variations, which are determined by the morbid elements present in the case. The rapidity of disappearance is dependent on the condition of the venous and absorbent routes through which the redundant elements composing the structure may find escape. Such resolution may be incomplete, and then the gland remains enlarged, and the condition becomes one of indurated goitre.

In cases of more intense action, the event may be suppuration; here chills, increase of volume, pain and other functional disturbance are present. There is œdematous tumefaction of the integument; and this may reach from the chin to the sternum, and even extend down on the chest-wall. Fluctuation is slow to appear, and the usual evidences of pus are absent. The tumefied structures are dense, tense and unyielding to pressure; and if the forming pus is deep-seated, it may remain undiscovered for a time, and in the interim, the pus may migrate laterally, or penetrate deeper. In the graver cases, the imprisoned pus may erode the subjacent tracheal or laryngeal cartilages; or penetrating the interstices between these structures, it may enter the windpipe. In a patient seen by the writer, in which the inflammation extended beyond its primary site, the deep-seated pus penetrated the larynx, and finally destroyed the woman's life.

The pus has perforated the œsophagus; and this has occurred

during the act of vomiting, in which the thin intervening wall was ruptured.

By gravitation the pus has descended to, and entered the pleural cavity; and such event is a most unfavorable one, since, in the cases reported, death through exhaustion generally occurred.

Gangrene, resulting from suppurative thyroiditis, has not unfrequently been observed. In the case cited by the author, there was gangrene of the overlying derm; and this destructive process implicated the subcutaneous fatty tissue. In seven cases of this kind collected by Lebert, there were four recoveries.

From an attempt to calculate the mortality of thyroiditis, Lebert finds eleven deaths in thirty-two cases; that is, one-third of the cases died. These figures of fatality are manifestly too high. The complication of goitre in the patient adds much to the gravity of the disease; and where this is absent, thyroiditis may be considered nearly free from danger.

In the treatment of the disease, an attempt should be made to remove the congestion of the affected structure; and this may be directly affected by the application of leeches to the part. Or this may be done by scarification, in which slight penetrating wounds are made into the swollen gland; and though there might be risk of wounding arteries, yet the bleeding that thence might arise could be controlled by temporary pressure. After this, the inflamed surface should be painted frequently with tincture of iodine. The free circulation of blood through the neck must be promoted by proper position. As a resolvent, mercurial ointment may be applied in the later stage of the inflammation.

Should the means mentioned not arrest the inflammation, and there be indications of the formation of pus, there should be no delay in making one or more incisions to give the pus exit. Such incision is at the risk of opening a vein or artery; this risk, however, is slight, if one determines beforehand the presence of pus by a small hollow needle. The purulent material should be washed out, and its site well irrigated with some antiseptic fluid. The treatment may then end by the application of poultices or antiseptic compresses.

Phlegmon and Abscess of the Neck.—Phlegmonous inflammation of the neck may be rapid or acute in course; or it may be chronic; and it may be generally diffused; or the action may be limited to a small part of the surface of the neck. When circumscribed, the affection may be limited by the anatomical components of the neck; and then it may lie above, or below the hyoid bone; in

fact, it may be situated at any point on the front surface of the neck; or the back of the neck may be the isolated site of the phlegmon. This classification of site is that of Gillette, who refers the inflammation to local and general causes.

As local causes are those of a traumatic character; and these comprise the various lesions of the neck which may arise from some external agency; even wounds made by the surgeon himself have awakened a widespread phlegmon on the neck. Lesion of the mucous membrane of the oral and buccal cavity has, through the lymphatic channels, awakened inflammation in the neighboring glands of the neck; and the latter have transmitted the same to the adjacent connective tissue. Eruptions of the skin of the face or neck may light up a morbid action of the cervical glands, and thence suppuration may arise. Disease in the pharynx and larynx has extended from its primary site, and appeared in the cervical glands.

The fracture of the lower jaw, in cases in which the gingival structure is opened, may cause abscess in the supra-hoidean region; and such pus may descend much lower on the neck. Calculus in the submaxillary gland, or in its ducts, may develop cervical phlegmon or abscess.

Adenoid disease dependent on syphilis or scrofula ending in suppuration of the glands and peri-glandular tissue, is a frequent cause of abscess; and this usually runs a tedious course. Cell-multiplication due to the dyscrasic vice is the initial phenomenon; and the superabundant cells at that stage probably act as mechanical irritants. And other diseases, as the eruptive ones of the skin, in which the organism is laden with effete detritus, besides awakening abscess elsewhere, has a special tendency to cause suppuration in the cervical structures.

The terms phlegmon and abscess, though representing morbid conditions closely cognate, differ in this respect, that phlegmon is a suppurative process in which unlimited diffusion is the characteristic feature; while in abscess, the action is isolated, and within palpable and visible bounds. Phlegmon has the accompaniment of severe constitutional disturbance, viz., general fever, and sometimes delirium; while abscess is limited to local pain, swelling and suppuration. Phlegmon produces great destruction of the tissues; in fact, it may terminate life through gangrene and general pyæmic destruction.

The phlegmonous or diffused suppuration may be superficial, or outside of the superficial cervical fascia: viz., external to that

fascia which extends from the hyoid bone to the front of the sternal manubrium and clavicle; and which laterally includes the sterno-cleido-mastoid muscles and the trapezei. Or the pus may form between the superficial and middle fasciæ; or it may be between the middle and inmost fascial structure. The power of these fasciæ to limit and prevent the passage of pus through them is overrated; these fasciæ are too thin in texture to exercise such imprisoning force in cases in which there is a large purulent collection.

The supra-hyoid structures, and those in the floor of the mouth, from their proximity to the site of infecting lesions, are the frequent site of suppurative inflammation; and such pus may perforate the skin and appear externally; but occasionally, it appears beneath the tongue, within the mouth; and in this site, the possibility of a sialolith being the causal agency, should not be forgotten. The supra-hyoidean collection of pus may point also towards the pharynx, the larynx or œsophagus; and in any of these events, there may be disturbance of the voice, breathing or swallowing.

The wisdom tooth has been the cause of such abscess; and this has appeared at the angle of the lower jaw.

Vidal and Duplay have seen cases of abscess which arose in the structures at the base of the epiglottis. Such cases are accompanied by œdematous swelling within the pharynx, and all the functional disturbances which arise from swelling there; and of these, by far the most important is the swollen condition of the aryteno-epiglottidean folds of mucous membrane, which may be so great as to fatally narrow the air-passage.

An occasional site of such inflammation and suppuration, as pointed out by Velpeau, is within the sheath of the sterno-cleido-mastoid muscle; the muscle becomes painful and contracted, and as result, the head is deviated to that side. But more frequently, this suppurative action is connected with the chain of glands which lie along the vessels and close to the muscle. The swelling, owing to the implication of the cervical plexus, is attended with much pain; and as just said, there is torticollis from contraction of the sterno-cleido-mastoid. The morbid action is of phlegmonous character in its manifestations; and the pus frequently travels downwards, or in some other direction away from its primary point of origin; sometimes, penetrating the thorax. A form of suppuration of the neck of a widely diffused character, was observed and described by Dupuytren. This abscess may

appear in proportions so great that it occupies the entirety of the region, from the mastoid process to the clavicle, and reach laterally to the trapezius muscle. The dominant feature is tumefaction, which is so great as to obscure, or blot out, the normal prominences of the neck. And the pus which forms can gravitate into the thorax, or appear on its outer wall. Dupuytren observed this affection among public criers and auctioneers.

The writer has seen two cases of that wide-opened cervical phlegmon, which was due to an adynamic form of erysipelas: both speedily ended in death. In the cases described by Dupuytren, the course was a slow one; and in the pus which infiltrated the structures subcutaneously, there was generated gas, which yielded crepitation on pressure.

These severe forms of cervical suppuration are often connected with some anginous disease in the pharynx; a septic trouble there located is transmitted through the lymphatic vessels to the cervical glands; the first morbid phenomena being lymphangitis and adenitis.

Phlegmonous inflammation may occur on the posterior side of the neck; yet the anatomical structures of the neck behind are less adapted to such morbid development than those of the anterior side; the paucity of loose connective tissue, the close adherence of the muscles, and the small number of the cervical glands, are conditions unfavorable to phlegmonous diffusion. The posterior cervical phlegmon is exceedingly painful; due to the thick, unyielding character of the overlying skin; and also to the tendon-like density of the muscles composing the nuclea.

The diffused phlegmonous abscess situated in the anterior cervical region, often requires special attention on the part of the surgeon to rescue the patient from the disastrous events or complications which may arise in the course of such disease, viz., the irruption of the pus into the thorax, the trachea, or œsophagus; and a yet more formidable event is the erosion and opening of the carotid artery or the internal jugular vein. The opening of the air-passage may necessitate the performance of tracheotomy: and the perforation of a blood-vessel would demand immediate tamponing; and the subsequent ligation of the vessel. In a patient seen by the writer in which the suppuration was of glandular origin, the suppurative action had so weakened the wall of the internal jugular that when an opening was made into the purulent collection, the internal jugular spontaneously burst into the cavity, and for a moment bled in a frightful manner. This

was controlled by a plug of sponge, and some days afterwards, when this was removed, no more bleeding occurred; yet it is probable that if aid had not been at hand, death would have occurred within a few minutes.

The unsparing pen of the surgical historian has not failed to keep in remembrance an error committed by Liston, in which this famous surgeon inadvertently mistook an aneurism on the neck for an abscess, and, against the warning of his clinical assistant, he thrust a bistoury into the tumor and caused a bleeding which ended fatally. The memory of this act, as he confessed to a friend, remained as an enduring sorrow in his heart. This case fully illustrates the need of deliberate thought accompanying, as a guiding mentor, all surgical work. Unthinking routine erelong stumbles upon danger.

Dolbeau was compelled to tie the external carotid on account of ulcerative erosion of the lingual artery. As a rule, however, according to the observations of Gross, Duplay and others, such ulcerative erosion occurs oftener in the large vessels of the neck than in the small ones.

The pus, while the overlying skin is yet intact, may perforate the air-passage, and then be expelled by coughing; and also, gravitating to the lungs, it may produce ichorous pneumonia.

As already mentioned, the pus from the cervical phlegmon may, if deep seated, pass down the plane of the prævertebral muscles and, entering the pleural cavity, it may develop pleuritis and empyema; such complication is very perilous; usually, after long continuance, ending life by exhaustion.

Deep-seated abscess of the chronic type may have its origin in vertebral disease; and such suppuration may be near the pharynx and discharge into the pharyngeal cavity, but if the disease be lower down, then the pus might open into the air-passage, or into the œsophagus, or it might gravitate into the thorax, and appear in the mediastinal space, or penetrate the pleural cavity: any of which events would be very perilous to the patient. The most fortunate event would be that the purulent material should form an opening posteriorly, since such a route of escape would be the least injurious to the structures.

Dumesthé, who wrote on cervical abscess in 1864, observed that the anatomical conditions of the neck are such that the superficial abscess will open externally, while the deep-seated tends to gravitate. As means of diagnosis of the deep-seated species he directs to press the finger down on the anterior edge of

the sterno-cleido-mastoid while those of the other hand are forced down close to the outer margin; now between the fingers thus insinuated, the fluctuation of deep-seated pus may be detected. Deep-seated abscess contiguous to a vein may receive and transmit a venous murmur. But the most important act in diagnosis is the distinction of a collection of pus from an aneurismal tumor, where the former is the seat of a movement and vibratile impulse similar to what occurs in an aneurism. If studied, there is a difference in the movements of the two: the purulent collection is lifted directly upwards by the subjacent pulsating artery; but the aneurismal tumor expands in all directions; the abscess can sometimes be displaced from the vessel, and then the impulse will vanish. And, as a crucial test, where palpation cannot solve doubt, the hypodermic needle of fine calibre may be used; if the tumor be aneurismal, arterial blood will escape through the needle; but if there be pus, a drop of this may be drawn out. Such exploratory acupuncture is harmless, whatever the content may be.

Treatment.—The cervical phlegmon and abscess have been treated by different methods; collected in general groups, these are antiphlogistic, resolvent and operative.

As antiphlogistic means are bleeding, general and local, and vesication. General bleeding would rarely be appropriate; only in the plethoric subject should it be resorted to. Depletion may be done locally by leaching and scarification; preferably by scarification. To scarify, one should use a sharp-pointed lance or bistoury, and a number of vertical stabs, reaching through the skin slightly into the subcutaneous tissue, should be made; and to promote bleeding from these wounds, the surface should be bathed with water rendered alkaline with carbonate of soda or potassa, or with aqua calcis. An antiphlogistic measure which has had numerous advocates is vesicatio volans, or the flying blister, as it is popularly styled. The action of the cantharidal vesicant for such purpose was pointed out by Dr. Physic, many years ago: Physic claimed that impending gangrene could thus be prevented. Velpeau and Quinart have recommended vesication in the cervical phlegmon. Quinart applies a blister which covers the site of the abscess, and extends some distance beyond its border. After the epiderm is thus detached, he dresses the surface with mercurial ointment. And when the surface heals, he reapplies the vesicant; and thus proceeding, Quinart claims that the course of such abscess may be greatly shortened.

As resolvent local applications, lint saturated with an alkaline solution, or with simple warm water, acts well. Or Linimentum Calcis, used in the same way, is an excellent application. As an unguent, mercurial ointment, or stramonium ointment diluted to one-fourth the officinal strength, may be used. And, finally, despite the censure and obloquy that have been cast on the poultice by fastidious criticism, it yet lives. The charge that it is dirty is due rather to the compounder than the compound itself; it assuages pain and brings ease and comfort to the inflamed part, and from the alleviation which it once brought to the writer, the linseed cataplasm has an abiding place in affectionate memory; so kindly, indeed, that he fully concurs with the agreeable eulogy which the surgeon Gibson has paid the poultice. And along with the cataplasm, some resolvent ointment may be used. And these means are often advantageously employed along with the surgical methods, which will now be considered.

Of operative means by which the cervical phlegmon or abscess may be attacked, the simplest is that of tapping, which is done with a hollow needle or trocar of small calibre: a method which was inaugurated by Voillemier and highly commended by him; and was named by him capillary puncture, or tapping. An analogous plan is that of withdrawing the pus with an aspirator; this has been pursued by Lawson Tait. Voillemier resorted to this plan in infants three or four years old, in whom abscess arose from inflamed cervical glands. With a fine trocar, he withdrew what pus would easily flow out; and this procedure was repeated on the second, third and fourth days, until no more material would escape; then for a week, some resolvent ointment or poultice was used. By such a course, the abscess was quickly cured, and scarcely a visible trace remained of the work done.

Lawson Tait used an aspirator with a small needle, and repeated the tapping until the pus ceased to reform. In aspirating, the needle must not traverse the same point twice. The needle must be inserted obliquely; and this should be done from before backwards; yet the reverse is permissible; and as to the number of times, Tait fixes no limit; in one case he aspirated fifty consecutive times, and obtained a cure.

This method is applicable to both the acute and chronic forms; yet in the chronic abscess, the tapping will have to be repeated more times, and the treatment is often protracted.

Two points of much importance should be remembered in this plan of tapping or aspirating; the surface operated on must be

well cleansed before it is opened, and no air should be allowed to enter the cavity; especially, in the chronic form; for its admission greatly aggravates the case. The advantage claimed for the method described is its simplicity; and especially, the slight scarring which arises from it; an important thing on the surface of the neck, where scars remain as a visible deformity.

A second plan of treatment is the introduction of a seton through the wall of the pus-cavity. This procedure was practiced and commended by Darby; also by Bonnafont. Cotton or silken thread was used. Wire was also used for this purpose. Crean, of Manchester, reports the treatment of twenty-eight cases of scrofulous or critical abscess, as he names it, which were treated by the introduction of silver wire introduced as a seton through the wall of the abscess.

Though a cure may be obtained by the seton, yet, as St. Germain counsels, caution should be exercised in its use; the thread or wire should not be permitted to remain in place until it causes ulceration, or the formation of granulative tissue at the entrance and exit points of the thread. As soon as such ulceration begins the seton should be removed, and the pus permitted to flow through the opening thus made; and if such opening is insufficient, then the seton might be introduced at another point.

The seton is obnoxious to two grave objections; during its use, should the pus harden and occlude the opening around the cord or wire, then an erysipelatous inflammation may be excited there, and invading the contiguous structures, spread thence indefinitely. And another objection is that the seton inevitably leaves a scar which time will not efface. Hence, as a means of treatment, the writer would discard the seton; it is less efficient and satisfactory than the following method.

Drainage.—The drainage tube was introduced by Chassaignac; and though assailed by countless arrows of its adversaries, yet these are becoming fewer; it has nearly outlived opposition, and gained an assured place in the list of surgical weapons.

The use of the drainage tube must be preceded by one or more incisions which penetrate to the pus; and these openings should be made in the long axis of the neck, so that the pus can follow the natural course of gravitation; viz., from above downwards. The drain should be made of black rubber tubing; it must be fenestrated, or have lateral openings in the portion which is to lie in the cavity. It should reach to the bottom of the cavity; and, in some cases, it is well to let the tube traverse the cavity and

reach somewhat beyond the outlet and inlet. As a rule, it is better to have one or more tubes, of which one end lies buried in the cavity, while the other rises somewhat above the surface. As the cavity closes, the tube is extruded and must be cut shorter, from time to time. If the tube is placed permanently in, and its ends tied together, then it should daily be cleansed by injecting an aseptic fluid through it; but if sections of tubing are introduced into the cavity, these should daily be removed, cleansed and replaced. The dressing should be done gently, lest the reparative process be disturbed; for violent injection may tear asunder the adhering walls; also, displace the new-formed cells, and open vessels, and cause bleeding. But if the fluid be permitted to purl through the pus cavity without pressure, then the disturbances mentioned will be avoided, and the surgeon will second the work of restoration to structural integrity. The drainage tube should not remain too long; as soon as the material discharged changes from a purulent to a serous nature, then the tube is no longer needed, and its longer retention in the wound will increase the scar, which must remain afterwards. In fact, the chief charge against the drainage tube is that it is an irritant, and always leaves some cicatricial vestiges of its use.

The usual and most important operative procedure is that of incision by which a direct outlet is formed for the pus. For this purpose, the scalpel, bistoury or other instrument in the use of which the surgeon has acquired facility, may be employed. If the case be one of circumscribed abscess, then a single opening will suffice; but if it be a diffused phlegmon, then several openings should be made, so that the purulent material may have ready escape. And these openings should be made by first dividing the skin and superficial fascia, and then boring through the remaining wall with a blunt dissector, or the finger; thus proceeding, there is but slight risk of wounding vessels. The incisions should be made in the longitudinal axis of the neck. After the pus-space has been freely opened, the purulent material should be well rinsed out with a sublimated or other aseptic fluid; and if the cavity be deep, then the drainage tube should be inserted, as before described, and detergent irrigation practiced. Lint, moistened with sublimated or alcoholized water, should be placed over the affected part, and daily changed.

The time when the opening should be made is a matter of

controversy: some urge early opening; others advise delay until the pus has reached the skin; most surgeons adopt the former plan; and this is the practice of the writer, who opens the skin and adipose stratum with a short-handled scalpel, and then continues the penetration with some blunt instrument. If the phlegmon be extensively diffused, then two or more openings should be made and, through short tubes inserted into each, irrigation should daily be done. By this proceeding at an early period, the destruction of the connective tissue will be lessened; and the extravasating wandering of the ichorous pus will be avoided, or greatly curtailed.

There is a form of phlegmonous disease which was described, in 1845, by Metzler, which, differing from the species above described, has been reserved as an appendix to this chapter.

Metzler finds traces of its history in the works of Gregory, Frank and Ludwig; and he thinks it may be regarded as an anomalous form of typhus, with a tendency to special localization. Associated with general symptoms of typhus, there is deposited a yellowish, gray, fat-like matter in the subcutaneous tissue of the neck; and this tumefaction is usually unilateral, and commonly seated near the parotid gland, or lower jaw; it is not red or painful, and the overlying skin is movable. In about ten days, gangrene commences, with an increase of the constitutional symptoms.

This affection has been seen both in the acute and chronic forms; in the former, death may ensue in ten or twelve days; but in the chronic form this may occur at a much later time. Recovery may occur by dispersion, with perhaps a few points of gangrene in the skin; or there may be extensive suppuration and breaking down of tissue, and still recovery may take place. Fistulous openings may continue for a long period, and even the subjacent bone be affected. In some cases, there may be a recession of the tumor, and death quickly ensue; more often, however, the fatal ending is due to an exhaustive suppuration; or a large vessel may be opened by erosion, and the patient then quickly bleeds to death. The pressure on the vessels and nerves of the neck may contribute to a fatal issue.

The necropsy shows that the adjacent muscles are decomposed, while the glands show but slight changes; the parotid has been found but slightly affected, though it is in the midst of disorganized structure.

This affection occurs oftener in the young than in the aged. Death occurred in one-half of those attacked.

Metzler observed a similar affection of the subcutaneous cellular tissue in other parts of the body.

The treatment used in the disease in the commencement comprised emetics, mild laxatives, diaphoretics, blistering the affected surface, and discutient ointments. In some cases the affected part was vesicated, the epiderm thus detached, and, as dressing, lint was applied, saturated with the following solution:—

℞. Hydrarg. Chloridi. Corrosivi..... ℈j
Aquæ.. ....℥i
Misce.

Apply this until an incrustation is formed, and then use moist dressing over the surface. Should pus form in spite of this treatment, open with the bistoury.

The writer in his comment on this form of cervical abscess, thinks its causation may be found in the embolic processes which sometimes attend or follow typhus or typhoid fever of adynamic form; and of which a usual site is the parotid gland. The obstructed vessels retard the current of blood, or wholly suspend its movement; and thence the tissues, not being nourished, the conditions for developing phlegmon or, its kinsman, gangrene are present. The writer has seen a few cases which fell within this group, and, as a rule, they ended fatally.

CHAPTER XXVII.

TUMORS OF THE NECK.

THE cervical region, especially the anterior portion, is richly fertile in neoplastic growths, which, here as elsewhere, naturally separate themselves into two classes: the benign and the malignant.

The benign class may be divided, as König has done, into those of liquid content, viz., cysts, and those of solid or semi-solid content.

Cystic tumors of the neck are thus classified by König, to whom the writer is indebted for much of the material which follows: (1) Those containing air. (2) Those of serous content. (3) Those containing blood. (4) Echinococcus cyst. (5) Those cysts that have arisen from the softening or liquefaction of solid growths

Cysts containing air are directly connected with the air-passages, as the larynx or trachea; and they arise from a protrusion of a portion of the wall of one of these passages. One of the most common is that which arises from a hernia-like protrusion of the thyro-hyoidean membrane, due to dilatation of the ventricle of Morgagni, which is contained in the larynx. Cysts thus arising have been seen here, of the dimensions of a small walnut.

An air-cyst may arise from the trachea; and this tracheocele has been seen in front, at the side, or on the posterior wall of the trachea. This cyst may be congenital, and be due to imperfect closure of the branchial cleft; or it may arise from violent expiratory effort, as severe coughing, or vomiting.

Such air-cyst has a mucous wall similar to that of the trachea; and besides air, mucous material is also contained in the cyst. It is dilated and contracted alternately in expiration and inspiration. Respiration is rarely much affected; yet the voice may be weakened by such cyst.

Something analogous to this is the pneumocele, which has been observed in the subclavian fossa, above the clavicle, and which is due to the apex of the lung protruding hernia-like.

The tracheocele and pneumocele demand no treatment; and a knowledge of them is chiefly of diagnostic value: viz., such air tumor should not be mistaken for an abscess, liquid cyst, or other tumor. Only in the case of the tracheocele causing much trouble should an attempt be made to extirpate it; yet this necessity will seldom occur; the rule being in such cases to limit treatment to simple compression, should the cyst disturb by its volume.

Cysts of liquid content are sometimes found in the median line of the neck near the upper border of the thyroid cartilage and hyoid bone. Near the notch or incisura in the upper edge of the thyroid cartilage, is often found a bursal space; and this is not near the skin, as anatomists have stated, but it is subfascia, and close to the cartilage. Near this space, which may be named the præ-thyroid bursa, there is found, sometimes, a bursal space just below the hyoid bone in the median line of the neck, which may be named the thyro-hyoid bursa; and a third bursa occasionally exists near the upper border of the hyoid bone close to the insertion of the genio-hyoid and the genio-hyo-glossi muscles.

The blind cul-de-sac, known as the foramen cæcum, at the base of the tongue, and a small gland which lies on or near the middle of the hyoid bone, and likewise abnormally located portions of the thyroid gland, may give rise to cystic development.

The bursal spaces mentioned are normally so small that they are unknown to the possessor; yet from any cause that can excite inflammation, they may become cystic tumors of greater or less dimensions; and then they contain a viscid fluid; and should they be highly inflamed, pus may form in them.

A cyst arising from the præ-thyroid bursa presents itself as a round tumor located on and above the Pomum Adami. Inasmuch as it is often small and painless, if it be of small size, it may escape observation; but when it attains a large volume it protrudes externally, and likewise internally, beneath the tongue. In deglutition it follows the movements of the larynx.

A cyst from enlargement of the thyro-hyoid bursa or of the supra-hyoid bursa, is of frequent occurrence; and its nature would be indicated by the attachment of the cyst to the hyoid bone.

These cysts, when they grow upwards and encroach on the sublingual space, simulate ranula; and such cyst is not inaptly named a pseudo-ranula. In the chapters devoted to ranula, this matter has been treated of.

Bochdalek and Zuckerkandl have observed cases of cyst derived from occlusion and subsequent dilatation of the foramen cæcum. And Zuckerkandl has seen cysts which were derived from a degeneration of the small gland which lies near the body of the hyoid bone.

An accurate diagnosis of these bursal cysts based upon structural origin is difficult, sometimes impossible; and this is due to the structural ground of origin being so limited; and also to the fact that the bursæ whence they arise are very close together; such diagnosis, however, is of no practical advantage to the patient.

From irregularities in development of the visceral arches and closure of the intermediate clefts cysts arise; and these, in situation, may be on the side of the neck or near the median line; those on the sides arise from the ill-closure of the horizontal clefts between the arches, while those in the median line arise from defective closure of the anterior ends of the arches. The cysts comprised in this group may contain dermoid, atheromatous or liquid content.

Dermoid cysts of large volume have been observed here; the content of such may be epithelial detritus, sebaceous matter and hair. Or, not infrequently, it is a pure atheromatous tumor of sebaceous content unmixed with other material.

The cyst of liquid content may originate from irregular closure of the clefts between the arches; and the usual sites of such cyst correspond to that of the second and third branchial clefts. And the content may be clear, serum-like; or it may be viscid and gelatinous in character.

Both the cysts of atheromatous and serous content are remarkable for the firmness and density of their containing sacs; and this sac is closely adherent to parts around; the latter characteristic is one which the surgeon who has removed them has well learned.

An anomalous miniature thyroid gland may degenerate and assume a character similar to some of the cystic forms that have just been mentioned. Likewise, the lymphatic gland may undergo changes in which it assumes a cyst-like form.

The cysts which have been considered, whether of dermoid, atheromatous, or liquid content, may be present at birth; or they may develop after birth. They can remain stationary for a long time; and then they may, from some cause, often unknown, be awakened to fresh development. They are commonly located in

some part of the space between the larynx and the parotidean space, frequently near the angle of the jaw. Yet in a few cases the growth was located on the lowermost part of the neck. Exceptionally, such cyst has been found located within a lipomatous tumor of the neck.

These cysts may run a long course without giving inconvenience, sometimes even not attracting the attention of the possessor; again they may attain such dimensions, that through compression on muscles, nerves or vessels they cause trouble. The cyst may open externally; and, very exceptionally, it has ruptured into the pharynx, as was seen by Savory.

When it opens externally a fistulous orifice may remain indefinitely long; and inflammatory action, alternately appearing and disappearing, may seriously interfere with the health and comfort of the patient. And when such perforation is threatened, it is better to resort to some plan of treatment which will avert the consequences of a rupture of the cyst.

Treatment.—As curative methods of these cysts are excision, injection, and subcutaneous rupture; the latter two are only suited to cases of liquid content, as, for example, the bursal.

In extirpation the containing wall must be wholly removed; a fragment left behind will insure a recurrence of the cyst; a fact which the writer has verified by observation; and he regrets to add, also, in practice. The close adherence of the cyst's walls to parts contiguous renders dissection tedious; and the field of work is obscured by the bleeding which results from opening small vessels which enter the wall of the sac. The liquid species may be treated with injection of tincture of iodine.

Lymph-Angioma.—A recent chapter has been added to the surgery of the neck, detailing a cystic tumor which has its origin in the lymph vessels of the neck. Koster and Wegner have discovered the lymphatic origin of these growths. Both the lymphatic vessels and the lymphatic glands are concerned in the origin of this tumor, which is correctly named by Wegner, a lymph-angioma. It is chiefly found in the newborn child, yet it has developed in adults; and it may occur elsewhere than in the neck.

At birth the lymphatic cyst may be well developed; or it may be in the first period of development. In the fœtus, miscarried at an early age, such tumor and other deformity have been seen.

Such growth is a congeries of smaller cysts; and in volume these may vary from the size of a pea to that of an apple. The

growth may be on the back of the neck, and divided there into two parts by the ligamentum nuchæ. The containing wall may be thin or thick; and sometimes thin plates of bone or cartilage are found in it. From the main wall polypoid processes sometimes project into the cystic cavity. The content varies; it may be a translucent serum, or it may be discolored with pigment; and in some cases it is gelatinous in character.

This cystic tumor is usually multiple, and then contains a number of hollow spaces, in chain form, necklace-like; or as an irregular conglomerate, it may lie in the spaces of the cervical connective tissue, in which normally lie the lymph vessels. And following the loose connective tissue spaces of the neck, the growth develops laterally, as well as inwards; the muscles and vessels are severally forced asunder; and sometimes the cyst is closely attached to the veins. It grows in the direction of the least resistance; and may ascend on the face, and penetrate the floor of the mouth; and below, it may penetrate the thoracic cavity.

Though this cystic growth attains great dimensions, it rarely injures the muscles on which it encroaches; though from such pressure the salivary glands may be caused to atrophy.

In some cases, this cystic growth remains subcutaneous in site, and then uplifting the skin, the surface of the latter is rendered nodulated, or uneven. But if the growth commences deep in the structures of the neck, it may remain invisible for a long period, especially if the panniculus adiposus be thick. The overlying skin commonly remains unaffected in its texture, and often it remains freely movable over the subjacent tumor.

The functional disturbance which can arise from the lymph-angioma depends on its site; if it lie superficial, although of broad extent, it causes but little trouble; but if it lie deeper, it may impede the return of venous blood from the head, and disturb breathing and deglutition; such functional disturbance is exceptional; and commonly, the infantile subject shows no symptom except slow emaciation. And then, if the lymph-angioma lies deep, the diagnosis of the causal agency of such emaciation is not easy to determine; but in cases in which the growth is present as a nodulated development on the neck, then the cause of failing nutrition is evident. It might be mistaken for a lipomatous growth; yet a puncture with the hypodermic needle would banish doubt, since the cyst would yield its characteristic content.

The prognosis of this lymphoid cyst is not auspicious; a few

cases through spontaneous rupture of the tumor have recovered; a few have yielded to surgical treatment; but the greater number of infants so affected have perished through gradual atrophy.

As treatment, extirpation, free incisions and injection have been resorted to; extirpation is difficult to do, and attended with risk of life, owing to the irregular tumor penetrating deeply into the structures of the neck; so that such operation has often been suspended before completion. Multiple incision has been found to be a safer plan; such incision causes inflammatory, and perhaps suppurative action, tending to obliteration of the lymphoid cystic spaces. Cases have been treated by injecting into the affected parts some corrosive fluid, as a solution of chloride of zinc or the tincture of iodine; this work must be done carefully, else swelling may be provoked which will cause suffocation. The introduction of a seton through the affected structure is recommended by Smith, who has cured cases in this way; others, however, strongly condemn it.

Amidst these conflicting opinions of the surgical authorities, the practitioner, who may have a case to treat, is left in wavering uncertainty whether he shall commit his patient to the resources of nature, which here are equivocal, or adopt one of the means mentioned, of which the event is equally equivocal; and were the writer to adopt the latter course, he would inject, drop by drop, a five per cent solution of chloride of zinc.

The cystic lymph-angioma, as stated, has rarely been seen except in the infant; a few cases, however, have been seen in the adult, and were situated near the sterno-cleido-mastoid muscle, either above or below. In some of the cases, the tumor was easily extirpated.

Angioma.—Every grade of angioma, from the superficial blood-mark and capillary telangiectasis to the massive cavernous tumor, has been observed on the neck. Of such growths, the cavernous tumor of venous structure is not unfrequent; and this tumor is often distinguished by its tendency to spread over a large part of the surface of the neck; and though its favorite site is the supra-clavicular fossa, yet it may extend beyond the limits of the neck, and then appear upon the thorax below; or the growth may appear above on the cheek, or within the mouth.

The venous angioma may be congenital; or it may appear later in life; and it may remain of an unchanging volume; or it may lessen in form; or from some cause, patent or latent, it may be excited in increase of growth. Through compression, the vol-

ume may usually be reduced; yet, if the angioma have but slight communication with contiguous vessels, then pressure scarcely changes its form. The angiomatous tumors when near the surface are easily recognized; but when situated deep, they have resemblances to the deep-seated lymphangioma or lipoma; in such cases, doubt can be exchanged for certainty by the use of the hypodermic needle, through which the content, if liquid, can be obtained. The lipoma, through its attachment to the skin, if displaced, carries the skin with it, and maps the latter off into rounded elevations and intervening depressions.

Treatment.—As treatment, numerous plans have been advised; those meriting mention are the following: (1) Excision and immediate or subsequent closure of the breach by one of the plastic procedures; (2) transfixion of the structure with heated pins; (3) inclusion of the transfixed structure by elastic or inelastic ligature; (4) cauterization thermally, or potentially.

In case the angioma occupy a limited space, the speediest and most satisfactory means of liberation from the growth is to excise it at once. To do this, surround the growth by a circumscribing cut, which shall lie in the normal tissue, directly contiguous to the growth; thence pass inwards between the affected and unaffected structures; and should a vessel be opened, close this by torsion or ligature; by the former, if possible. And then proceed to closure of the breach by juxtaposition through lateral sliding of the dermal margins; and, if possible, this must be done, so that the line of closure will be vertical and not transverse; for thus placed, the movements of the neck will but slightly disturb the wound. In case direct apposition cannot be thus affected, a pedunculated replacement-flap can be uplifted from the lateral integument, where the skin is least tense, and can best be spared. If the bridge can not then be dermally bridged over, it can be accomplished epidermally, by means of Thiersch's method of closure by cuticular grafts, in which elongated strips of epiderm are removed with a razor from some part of the body (by preference from the thigh), and are transplanted on the raw wound.

Another method is transfixion with pins, which may be thrust in after being heated; or the heat may be applied to the pin after its introduction by a plan that has already been described in the section devoted to angioma seated on the head. After such heated pins are in place, they may be constricted by elastic cord, by which the included structure will be strangulated. The cure obtained in this way is objectionable, since it consists in the exchange of the angioma for an unsightly scar.

The treatment by actual cauterization may be done by applying heat to the surface of the angioma; but this superficial application of heat is unsatisfactory, since in order to thus consummate the work, the cauterization must often be repeated. But should the potential cautery be preferred, then one of the following escharotics may be used: chloride of zinc mingled with an equal part of wheaten flour; potassa fusa mixed with a similar amount of calcined magnesia; Emplastrum Picis Burgundicæ, on each square inch of which there has been sprinkled one grain of Antimonii et Potassæ Tartras; or Pulvis Ipecacuanhæ commingled with an equal quantity of vaseline may be applied on the surface of the angioma. By means of the first two agents, the surface to which they are applied is quickly deprived of its vitality and becomes gangrenous; but by the compounds of Ipecacuanha and Antimony, the work of destruction is done through severe pustulation. The action of the fused potash penetrates deeply; while the pustulating compounds act more superficially; and all are subject to the inevitable fault, that they leave a most conspicuous cicatrix.

Blood-cyst.—Michaux and others have observed cysts on the neck, of which the content is blood, and the origin of which is explicable in one of the following ways: the cyst may arise from some congenital defect of a blood-vessel; or it may originate in an angioma seated in the wall of a vein, and which, finally, by pressure, establishes a communication with the vein; and also, a varicose dilatation may form in a vein, near its entrance into a larger vein; and such dilated space may be so walled off as to resemble a cyst. And in whatever way the cyst may form, as a rule it is compressible and reducible through its blood being forced into an adjacent vessel; still there are exceptions to this, as in some instances observed, the volume was not lessened by compression.

It is probable that the blood-cyst may, sometimes, arise from a cyst of serous, lymphoid or other fluid content, through attenuation of the walls and the consequent rupture of a neighboring blood-vessel, and the replacement of the previous content of the cyst by blood.

The blood-cyst, whether appearing congenitally or subsequent to birth, may remain of limited proportions; or it may grow until it reaches great dimensions, and covers a large space, which may encroach on the thorax below, or on the head above. The skin is usually not implicated in the growth. Such tumor may

cause no inconvenience, yet when voluminous and near some vessel, it has caused much trouble by pressure.

The modes of treatment employed have been total excision, the injection of some coagulating agent, or coagulation induced by the introduction of a heated needle into the cyst. Total excision is the best method, provided the anatomical conditions are such as will permit of the entire removal of the cyst. A less radical method, if the tumor has no vascular connection or outlet, is to attempt coagulation by injecting into the cyst tincture of iodine, tincture of nut-galls, or a solution of a salt of iron. Should the cyst have a connection with a vessel, then this method of coagulation is hazardous, as the clotted blood might enter the circulation, and become the agent of embolic occlusion; in such cases the choice would lie between non-interference, or a perilous extirpation.

Cyst-like collections of blood may arise from external violence, through which a vein or artery is ruptured subcutaneously; and afterwards, the channel of communication becomes closed. Such cyst, when small, disappears through absorption; but if larger, the content may be aspirated, and the cystoid space closed by compression.

Cystic tumor of parasitic origin has appeared on the neck, the causal agent being echinococcus; and the site of the growth was the sides of the neck, and never directly in front, or behind. This lateral location points to the probable fact that the causal agents have reached the region through the large vessels on the neck, and then entering the smaller vessels have thence penetrated into the tissues, in which they further developed.

The echinococcus cyst has been known to attain great dimensions on the neck, and to cause serious trouble through pressure on the vessels and nerves; in the case reported by Dixon, the tumor so pressed on the subclavian artery where it crossed the first rib, that the circulation in the vessel was arrested; and as result of this, the pulse disappeared at the wrist. And in another patient the growth developed upwards, and encroached on the pharynx.

The content may be transparent, yet it may be mingled with pus. A characteristic of the tumor is that it may suddenly grow rapidly, and then cease for a period, and, afterwards, start into activity again. Usual qualities of the tumor are the absence of albumen in the fluid, the presence of benzoic acid, and of fragments and hooklets of the parasite; these hooklets, discoverable by the microscope, definitely decide the nature of the tumor.

This tumor is commonly painless, and if it remains small, it may be borne without inconvenience; yet when voluminous, there is danger that it may press on a vessel, and opening its wall, serious bleeding can thus occur. Boegonhold reported a case of fatal hæmorrhage thus arising.

Treatment.—The usual treatment is excision and enucleation of the cyst; or, what is safer, the cyst may be opened by an incision, and then the sack, separating itself from the neighboring structures by suppuration, may be more safely removed than if directly dissected out with the knife; in the latter way there is more peril of opening a vessel.

Solid Growths of the Neck.—The lymphatic glands are the frequent site of neoplastic development; and these may be benign or malignant in nature.

Simple hypertrophy of the cervical glands, which may be named benign lymphoma, is a phenomenon familiar to both physician and surgeon; let there be a lesion of the derm, mucous membrane or intervening structures of the neck, which is attended by suppuration for a few days, and there will occur a swelling in one, or several of the lymphatic glands, which are near the site of lesion. If such gland could be microscopically examined, the enlargement would be found to be due to a multiplication of the glandular elements. The tumor is painless, and even in the observing adult, it may long remain unknown unless it be accidentally discovered by the subject of it, or by his physician.

Such hyperplased glands which have arisen from simple purulent irritation, may remain of constant volume for a number of days, or even weeks; and then they usually vanish without suppuration. Should the causal agency be of tubercular nature, or should the local lesion be associated with a tubercular diathesis, then the prospect of an early disappearance is less promising; for in such cases, suppuration and perforation of the skin, are the usual events.

The sovereign remedy for the hypertrophied glands of the neck is iodine given internally, and applied externally. As external application, iodized collodion, previously referred to in this work, is one of the best remedies; the collodion compresses, while the iodine exercises its dispersive action. And should this method fail, a resort may be had to enucleation, described hereafter.

As a means of reducing the glands, especially when the enlargement is due to tubercular disease, the writer advises the injection into the tumor of the following mixture:—

℞. Iodoform..... .. ..ʒi
Ol. Olivæ.
Aether. Sulph.... .. ..aa ʒvij
Misce.

Of this inject a few drops every third day. It may be added that Garré of Tübingen has lately reported the cure of a large number of cases of goitre by this interstitial use of iodoform.

Sarcoma of the Cervical Glands.—The sarcoma may appear in an isolated lymphatic gland; or the disease may appear simultaneously in several glands.

When an isolated gland is the seat of sarcoma the first symptom is enlargement; and, if examined, the characteristic round cell of different dimensions will be found; also the fusiform cell may be seen, which has arisen from a transformation of the round cell. The normal glandular elements may be entirely replaced by these round or elongated cells. The enlarging gland crowds on the overlying skin, and perforating it, an ulcerating, self-producing, and self-destroying neoplasm forces itself into view. The self-asserting growth takes possession of the contiguous space around and underneath; and, in doing so, it erodes and penetrates vessels and muscles: thus bleeding on a small or large scale can arise. Also, from lesion of the vessels, a door is opened for the admission of sarcomatous elements: thence the reappearance of the disease in parts near by or remote; yet more commonly at some distance from the site of origin. As a rule, the immediately adjacent glands are overleaped in this metastatic development. Sites of distant reappearance are the lungs, liver, spleen and other remote parts. The disease commonly ends life, according to Winiwarter, within eighteen months. Sometimes, however, the disease runs a prolonged course of some years.

Instead of confinement to one point in its origin, this glandular sarcoma may appear simultaneously in a number of the cervical glands: a form that may be named multiple sarcomatous adenoma. And this may run a rapid or a slow course; and it tends to metastatic diffusion similar to the form just described. The writer has seen several examples of this form, in which, during a few months, the glands of one side of the neck became, almost simultaneously, the site of sarcomatous disease. In one case an attempt at extirpation served no better purpose than to give the disease general diffusion.

Sarcoma of adenoid origin, in which sarcomatous and cystic structure were commingled, has been seen by the writer; in such a case shown in the adjacent sketch the tumor was borne by the man until it had reached a volume equal to his head. After the removal of this tumor, it was found, on section, to consist of adeno-sarcomatous tissue, in which were spaces filled with serum-like fluid. It seemed to have originated from glands in the parotidean sulcus, behind the ramus of the lower jaw, and in its development it had distended and greatly displaced the derm of the cheek and neck; and in the subdermal tissue were numerous veins of dimensions greater than the normal external jugular vein.

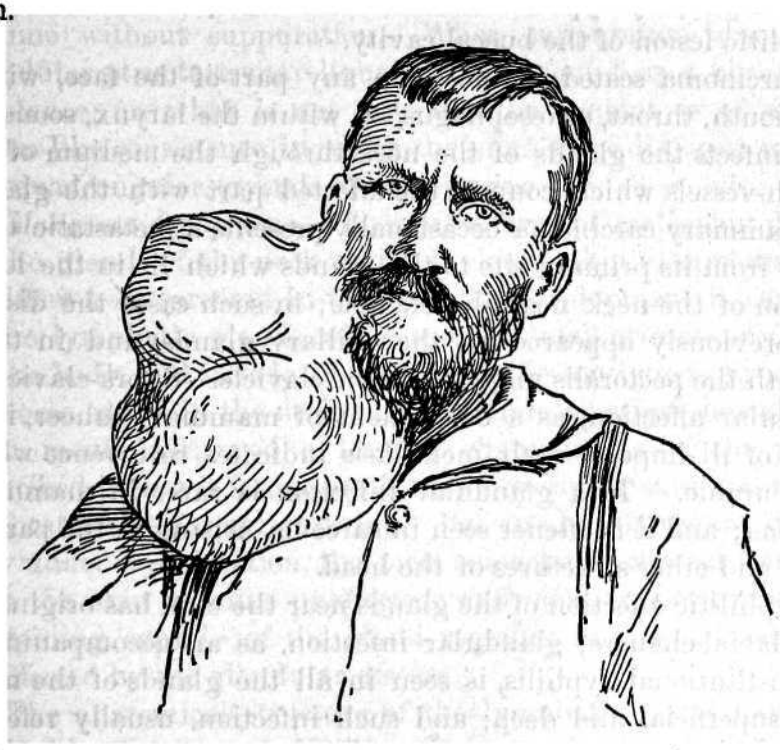

FIGURE 94. Exhibiting a sarcomatous tumor successfully removed by the writer.

As ætiological factor, König refers to slight traumatism near by or remote as causal agency.

The treatment of these cases will be given at the close of this chapter.

Malignant glandular disease, similar to the forms mentioned, has been described under the head of carcinoma by some writers. Yet these are pathological types which decline to be stereotyped; for elements which forsake the physiological domain often indulge in ruleless liberty and lawless riot, and in their altered

form they embarrass the diagnostician. In the microscopic examination of many specimens of malignant growths, the writer has occasionally found resemblances so close to both sarcoma and carcinoma that the tumor would not have been inaptly named sarcoma-carcinoma. Such a name would screen surgeon, writer and microscopist from mistaking the one form for the other, and would properly designate those tumors which the writer has occasionally seen, in which the cell-forms of both sarcoma and carcinoma coëxist.

The glands of the neck are often the site of secondary enlargement, as the metastatic concomitant of carcinoma, sarcoma or of a primary syphilitic chancre in the lips, or a secondary syphilitic lesion of the buccal cavity.

Carcinoma seated in the scalp, any part of the face, within the mouth, throat, or œsophagus, or within the larynx, sooner or later infects the glands of the neck through the medium of the lymph-vessels which connect the affected part with the glands.

Mammary carcinoma occasionally presents a metastatic transition from its primary site to the glands which lie in the lower portion of the neck near the clavicle; in such cases the disease has previously appeared in the axillary glands, and in those beneath the pectoralis major, near the clavicle. Supra-clavicular glandular affection, as a consequent of mammary cancer, is an omen of ill import; such metastasis indicates recurrence which is incurable. This glandular infection is rarer in mammary sarcoma; and it is oftener seen in sarcoma arising in the parotid gland and other structures of the head.

Syphilitic affection of the glands near the chin has originated from labial chancre; glandular infection, as an accompaniment of constitutional syphilis, is seen in all the glands of the neck, both superficial and deep; and such infection, usually referred to vaguely as a manifestation of secondary syphilis, is probably referable to some local secondary lesion; namely, an ulcer or breach of surface on the tongue, floor of the mouth, palatal structure, tonsil or pharynx. A breach of surface in any of the parts named seems to be inoculable by the salivary or mucous secretions of the patient; and thus through the lymph-channels the glands of the neck may be tertiarly affected.

The syphilitic glands may attach themselves to the skin, and from non-treatment or improper management, the glands may suppurate, and finally perforate the skin. If permitted to run its own course such a gland disintegrates from the center towards

the circumference; and as it does so the broken-down elements are eliminated through a fistulous opening; and the derm around the opening becomes of a purplish color, which continues long after the gland has disappeared through suppurative or absorptive action.

Scrofula or tuberculosis often appears secondarily, and sometimes, primarily in the cervical glands. Frequently but one or two glands are, at first, the seat of enlargement; thence the affection extends to adjacent glands; and it may, finally, appear as a nodulated chain of enlarged glands from the chin to the sternum. The tendency is to suppuration, though under appropriate treatment, the glands may be restored to their normal volume without suppuration. When suppuration ensues the glandular structure may liquefy, and be found as a cheese-like substance; or, what is not unusual, the content is of a thin, cream-like consistence, in which the microscope discovers numerous quadrangular crystals of cholesterine.

Malignant Lymphoma.—There is a form of malignant disease of the glands of the neck which is closely akin to sarcoma; but it differs from sarcoma in this, that its development is confined to the lymphatic glands, while sarcoma may arise in any tissue of the body, and invade in its growth the contiguous structures. Sarcoma seated in the neck, and of glandular origin, has already been mentioned; and a leading characteristic of the tumor described is that it fastens itself to the overlying skin and finally perforates the dermal covering. But in the malignant disease now under consideration, the most remarkable clinical feature is that the skin remains unaffected; and, also, in most cases, the containing capsule of the gland remains, in a great measure, unaffected by the glandular disease.

The anatomical structure of the lymphatic gland has been studied by Teichmann, Kölliker, Robin and others; and in the main, these structural elements may be grouped as follows: the gland is contained in a fibrous capsule consisting of connective tissue; and from the inner face of this proceed trabeculated partitions, dividing the gland into alveolar spaces. The gland when enlarged is often easily separated from this wall: and, when in the work of enucleation, the gland is adherent to a vessel, or dangerously near it, then the operator may work safely by merely incising one side of this envelope, when he is able to enucleate the proper glandular structure. As said, within this capsule, and subdivided by trabecular septa, is contained the glandular

substance: a tissue abounding in nuclei and cells resembling lymph-corpuscles; these elements are more numerous near the outer part of the gland; while towards the central portion of the gland one finds a mesh of blood-vessels and lymph-vessels.

In the malignant lymphoma, named also lympho-sarcoma, there is also a great increase of the proper glandular elements; but the containing capsule is usually but slightly thickened, and is easily separable from the glandular tissue. An exception to this was observed by Verneuil, who saw a case in which the enlargement consisted wholly in a great thickening of the capsule; so much so, that he named the growth capsular lymphoma. In this patient there were a number of such enlarged glands in the neck, separated by slight intervals.

The malignant lymphoma is usually soft in structure; occasionally, examples have been seen in which it was hard. In fact, in the history of the malignant lymphoma, though there be a want of unanimity on some points, yet most writers agree that the disease commences as a soft form, and thence changes to a hard one.

In malignant lymphoma, the disease appears unsuspected, and, for a time, unseen; when discovered it consists of an enlargement of one or more of the cervical glands; and these enlarged glands finally appear in segregated groups on one side of the neck; yet exceptionally the disease attacks the glands on both sides of the neck. These masses are commonly three in number. In the soft variety the enlarged glands are exceedingly movable. If such a growth be removed and examined, it will present, on section, a grayish yellow, non-vascular structure; and though less soft, it resembles the substance of the brain of an infant; with the microscope, one discovers that the tissue consists of elements analogous to those of the normal gland; yet the cells are increased both in number and in volume. The structure is homogeneous from periphery to centre.

In case the glands become indurated, they often excite some inflammatory action contiguous to them, so that they are less movable than in the soft form.

In both the soft and hard species, according to Winiwarter, the new growth is from the preëxisting cellular elements of the gland; and the new structure is, at first, soft, and afterwards hardens through conversion into indurated or fibrous tissue.

If the disease is behind the angle of the lower jaw, the tonsil becomes involved. Instead of the affection remaining unilateral,

it, exceptionally, appears on both sides of the neck; and in each case the subjacent glands which lie in the axilla, in the mediastinal space, and those about the tracheal bifurcation, finally, become infected. The mesenteric glands are next implicated, and become so enlarged that they can easily be felt through the anterior abdominal wall, in the hypogastric and iliac regions. During the time that the disease is confined to the cervical glands, the patient, who is in childhood or mature youth, is in general good health; but when the disease penetrates the chest, there often arises a teasing cough, due, probably, to pressure on the sensory nerves of the lungs. A tenacious material is expectorated; and there is some elevation of temperature. As the disease proceeds, localized infiltration takes place in the lungs, spleen and liver; and such infiltrate is texturally similar to that of the affected glands. The general nutrition is impaired; the patient becomes pale and listless; his tissues become soft, flabby and anasarcous; and there is often an ascitic accumulation. The chyle-channels being obstructed, the nutritive materials are directed from their destination, and, as in enteric fever, they excite a diarrhœa. The ill nourished heart fails in its propulsive power; and life commonly ends within two years, if the disease has not been arrested by treatment.

After this enumeration and description of the glandular affections that appear on the neck, before entering on the treatment, something should be remarked in regard to their diagnosis, and the signs by which one class can be distinguished from another.

The true nature, in case of simple hyperplastic enlargement arising from some traumatic, eczematous or other lesion of the adjacent surface, is revealed by a discovery of such lesion. In the tubercular or syphilitic subject, the appearance of glandular enlargement is due to the existing dyscrasy, which, if not at once apparent, is discoverable in the history of the patient. If the case be one of sarcoma or carcinoma, it will be characterized by growth without suspension of development, or limitation of volume; and with a tendency to invade and penetrate neighboring structures; and finally, to perforate the skin and to present a mass of growing and disintegrating tissue. Metastasis may occur in parts remote, as well as in structures near by. Before the disease has reached these widespread dimensions, its malignant nature ceases to be a matter of question. But as an early determination of the disease is important for operative purposes, hence, as aid, a particle of the growth may be extracted

with a small harpoon, or special acupuncture needle, and its nature determined by the microscope. The prominent and distinguishing features of the malignant lymphoma have been detailed, and offer a well-defined diagnostic picture of the disease; to rehearse the principal of these, the following may be mentioned: the infantile, youthful or vigorous subject, the softness and great mobility of the glandular tumor, and the aggregation of these into definite groups on the neck, are facts sanctioning the diagnosis of malignant lymphoma.

The diagnostician is sometimes held in doubtful embarrassment by the apprehension that the case may be one of aneurismal tumor; for example, any glandular tumor which is so contiguous to an artery as to receive the pulsatile movement of the vessel may closely resemble an aneurism. Distinguishing aids in such a case are the following: if the aneurism be grasped gently between the fingers, it will swell during arterial diastole, and, by pressure, its volume is reducible; such pressure, however, should be done cautiously, lest the fibrinous clots be loosened within the tumor. If the pulsatile tumor be non-aneurismal, it is not expansible nor compressible, and frequently it can be so moved or displaced from its site on the vessel that the pulsatile movement cannot be perceived in it. Should the evidence still be equivocal, there is a ready escape from the difficulties in the use of the hypodermic syringe; for, as soon as this enters an aneurismal tumor, a fine stream of red blood will escape; but if it enter a solid or semi-solid tumor, nothing will be seen, unless it be a drop or two of serous or sanguinolent fluid.

Treatment of the Cervical Glandular Tumors.—The treatment may be divided into two methods: the non-operative and the operative or surgical; and not unfrequently the two methods are resorted to in the same case; medical means having been tried and failed, the aid of the scalpel is invoked.

Certain classes of these tumors are amenable to and sometimes are curable by endermic or interstitial treatment; viz., the syphilitic glandular enlargements and the malignant lymphoma.

The syphilitic glands, whether due to contiguous chancrous inoculation, or to constitutional syphilis, are often reducible by the internal use of iodine and mercury, and the local use of the tincture or ointment of iodine. An external application which acts well is the mixture of the compound tincture of iodine and tincture of galls before referred to; this should be well painted

on the swollen glands once daily. Or, instead of this mixture, the compound of iodized collodion may be applied. Thus by treatment, general and local, syphilitic glandular enlargements may be reduced, and deforming scars thus avoided.

Local treatment often fails to accomplish the reduction of scrofulous glands, and some operative method is usually resorted to for relief in such cases.

Cervical glandular enlargement, due to some simple lesion of surface near by, is removed by the topical use of iodine, and of the iodized preparations, iodized collodion is the best; and this should not be so strong as to blister the surface. Such weakened mixture is the following:—

℞. Collodii.... .....ʒij
Iodinii puri. ....gr. xvi
Kalii Iodidi. .... .gr. xij
Misce.

Apply with a camel-hair brush once daily over the swollen glands. By such an application compression and absorptive disintegration are obtained, and diminution of volume secured; to effect this it is often necessary to continue the application for some weeks. And even should suppuration occur, the tincture of iodine may be used along with a cataplasm. In fact, by the union of these seemingly antagonistic means the writer has seen absorption accelerated, and, if suppuration was not arrested, still it was lessened.

The glandular disease of the neck in which internal medication has won its chief laurels is malignant lymphoma. It has been discovered by Billroth, with the active coöperation of Winiwarter, Czerny, Israel and Tholen, that this disease can be arrested and sometimes cured by the internal use of arsenic. Long ago arsenic was given internally and applied outwardly in the cure of malignant disease; and this fact led to recent experimentation, which verified the belief previously existing.

To remain on the hither side of the line of danger in the use of arsenic, in the essays with it, the patient was ordered at first a small dose, and then to gradually increase the dose; and along with it some gave a preparation of iron or some bitter tincture. Fowler's solution was the form in which the arsenic was administered. The dose must be graduated to the age of the subject. If a child, commence with one drop of the solution three times a day, to which a half-teaspoonful of the wine of

iron, or of the infusion or tincture of gentian or Peruvian bark, may be added; and, if the patient be anæmic, the wine of iron is the preferable adjunct. If the patient be an adult, then the incipient dose should be five drops. These doses in the child or adult should be continued for three days, and then increased one drop; and every third day the dose should be increased thus, until the medicine causes some constitutional disturbance; and this, in the child, will probably arise when the dose reaches ten or fifteen drops, and in the adult twenty to thirty drops. The irritant action on the constitution, as described by Tholen, was as follows: in one patient the toxic effects of the arsenic were manifested in an impairment of sight and hearing. In another case the lymphomatous growths receded very rapidly, and, as this occurred, there supervened a hæmophilic or general hæmorrhagic condition, with sudden enlargement of the spleen: and these conditions rendered the suspension of the remedy necessary. In most cases the growths were rapidly reduced in volume, and such reduction was attended by some pain in the shrinking structures. Children were less affected by the arsenic than adults; in the latter, the prolonged use of the arsenic gave rise to sleeplessness or disturbed sleep, trembling and unsteadiness of the muscles; the patient was unfitted for mental and physical exertion; and finally, from general weakness, loss of appetite and energy, the patient sank into melancholy. The use of the arsenic sometimes is limited to accessions of remittent fever of a mild form; this fever appears on the fourth or fifth day of the administration of the remedy.

Besides the internal administration, the remedy was used by Winiwarter interstitially with the hypodermic syringe. To do this, let the needle be carefully cleansed on its surface; for if used moistened with the solution it is apt to cause suppuration. The needle should be inserted deeply into the gland, and a drop of the fluid there deposited, and this may be repeated three times daily. Should signs of suppuration appear, the evolution of the pus should be favored by the use of warm poultices.

The remedy should be discontinued when its atrophic action has been obtained, or temporarily suspended, should the toxic action of arsenic appear.

Though the arsenical treatment may cause almost a total recession of the glandular enlargements, yet unfortunately this reduction is usually not permanent; as a rule, after some months or a year or two, the disease occurs, and it becomes

necessary to repeat the treatment. Though a complete cure is exceptional, and despite the fact that the remedy causes local pain, and a depressing cachexy, yet the respite which has been obtained in this grave disease must give arsenic a distinguished place among the therapeutic acquisitions of modern medicine.

Verneuil has announced some essays with favorable result in the use of phosphorus against malignant lymphoma; he gave of a solution in oil from one to three milligrammes of phosphorus daily.

The observation was recorded by Winiwarter that malignant lymphoma may recede under the action of erysipelas which has invaded the affected parts; and an attack of articular rheumatism has had a similar effect. And carcinoma has vanished in the same way. Bérard mentions a malignant tumor in the neck which quickly disappeared under an attack of erysipelas, yet it soon afterwards reappeared. And Reclus has observed a patient in whom a malignant lymphoma quickly receded under an attack of erysipelas on the arm; yet the permanency of the cure remained undetermined, since the patient died from the erysipelas. The facts here cited are suggestive of the probable efficacy of the injection of the dilute culture of erysipelas in the treatment of malignant lymphoma.

Mention should be made of other means of treatment of the cervical lymphoma, whether benign or malignant; and among these electrolysis deserves prominent notice. The electrical treatment has been tried and commended by Schuster, Adams, Duchenne and others. Duchenne found it to act the best in cases in which the glandular enlargements are small, movable and superficial. Demarquay is an ardent champion of this treatment; he claims that failure to thus cure is rare. As a rule the enlargement simply vanished; but in a few cases suppuration was excited.

For a time the galvanic or constant current only was used, later Meyer advised the employment of the interrupted current. Generally the electricity was transmitted from the surface of the skin; a few applied the current directly through needles which penetrated the tumor. Meyer, who used the interrupted current, reports some remarkable results by the employment of a very strong current; by this means he claims to have sensibly reduced the tumor within a minute or two. The reports are sufficiently favorable of the action of electrolysis in the reduction of adenoid growths to justify its trial in such disease.

Trial has been made of massage, or rhythmical compression, in the treatment of these affections; or in place of interrupted compression, continued pressure has been employed. Larrey and Recamier have recommended this plan. Kneading may be done with the hand; but if continued pressure is employed, this may be done by means of compressed or ordinary sponge. which is retained in place by a bandage, adhesive strips or some clasping and fixing instrument, of which one branch rests on, and presses the sponge or lint against the enlargement. Such pressure must be watched, lest it be carried to the extent of causing sloughing of the integument. Massage was used by Baudens as a means to loosen the tumor, and thus facilitate the operator in his work of removing it.

Malgaigne, Velpeau and others have practiced subcutaneous laceration or discision of the gland by means of a fine needle, which, being inserted in it, was twirled about so as to divide the glandular structure in different directions. Suppuration was sometimes induced in this way.

Cauterization, thermal and potential, has been advised in the treatment of glandular enlargements. Verneuil advocates thermal cauterization, done either on the surface or by ignipuncture, in which heated points are thrust into the enlarged gland. Potential cauterization has been practiced by Maisonneuve, who applied the escharotic peripherally or centrally. For central cauterization he made a mixture of chloride of zinc and flour, which, being cut into arrow-shaped bodies, were thrust through incisions in the skin into the gland. By this plan sections of the glands were destroyed; and also atrophic contraction was induced in the portion which remained. A serious objection obtains against the treatment by cauterization, in the fact that it is painful and entails deforming scars of the surface.

The use of one of the several methods which have been described will, sometimes, cure the benign glandular tumor; and may be tried in patients whose lack of courage forbids the use of the knife, or in whom the cure by non-operative measures is desirable; but in a large number of cases, viz., in most malignant growths, and in a number of the benign class, the aphorism of Sanctorius is the proper rule for guidance; strumous or glandular tumors will never be cured unless they be extirpated.

Writers under the exclusive inspiration of patriotic nationality have claimed for their countrymen the honor of originating the method of excision in the treatment of the cervical glandu-

lar tumor. Thus Gillette claims this palm for Petit, Chopart, Desault, Dupuytren and Bégin; especially for the latter two. The impartial writer, however, will find that besides the Gallic, Anglican and American surgery has claims which would command recognition in such an international court of adjudication.

The surgeon who approaches the cervical field should be warned that his presence there will only be justified by the possession of certain natural gifts: coldness, intrepidity, skill, self-possession. Such being the requisites, they are acquisitions possible to those who, Mezentius-like, will hold close communion with the cadaver: one who has sacrificed uncounted and innumerable hours in the dissecting room, will fearlessly penetrate and separate the anatomical structures of the neck, even though they be pathologically entangled and confused.

The surgical strategist, when he proposes to invade any region, should first mentally recount the anatomical elements which exist there; and those structures, which are vitally important and will be imperiled, should be noted in memory by ever visible warning marks; thus proceeding, with a moderate share of manual skill, the surgeon makes his way safely among the apprehended impediments of any region, and is normally able to add another unit to the statistician's column of "Successes."

In this mental survey of the topography of the neck, the operator will remember that the external jugular veins lie near the skin, and may be shunned by cuts in the long axis of the neck; but transverse incisions will endanger the veins: a danger, however, which can be obviated by double ligation and intermediate section of the vein. Superficial nerves, viz., the branches of the superficial cervical plexus which rest on or near the upper portion of the sterno-cleido-mastoid muscle, can generally be shunned; the auricularis magnus nerve should not be injured; for this lesion disturbs the patient through the anæsthesia, which is caused in the integument of the pinna. The spinal accessory pierces or passes behind the upper third of the sterno-cleido-mastoid muscle, and its section will leave the trapezius muscle, which it supplies, functionless.

The sterno-cleido-mastoid muscle has frequently been divided without much detriment to the subject; and even a large part of the muscle has been sacrificed by the writer, in the extirpation of malignant growths, without ill consequence. The division of the omo-hyoid muscle has also given no inconvenience.

As the knife penetrates deeper, and passes from the median

line laterally, the following structures will be met: the laryngo-tracheal tube and thyroid body; the superior and inferior laryngeal nerves; the latter lying in the grove between the trachea and the œsophagus; the carotid artery, the pneumogastric nerve and the internal jugular vein; and behind this vasculo-nervous group lie the sympathetic nerve and its three ganglia, which have connection with the heart. On the side of the larynx and hyoid bone, besides the external carotid and its branches lie numerous veins of large calibre; also the hypoglossal nerve. In the lower part of the side of the neck lie the confluent roots of the brachial plexus; and on the anterior face of the scalenus anticus muscle lies the phrenic nerve, which enters the chest between the subclavian artery and vein. The subclavian artery, arch-like, appears on the lower part of the side of the neck. This subclavian arch in different subjects has a varying height above the clavicle; a variation that has, sometimes, led astray the searching scalpel.

The deep portion of the cervical region is separated from the thoracic cavity by a thin pleural septum; a partition which must not be forgotten in the hazardous excavations sometimes made here to enucleate glandular neoplasm. Such a perforation announces itself by a whispering or hissing sound of air rushing to fill the vacuum arising in the inspiratory act. The breach, if accidentally made, may be occluded by lateral displacement of some contiguous tissue.

Though the structures enumerated are so important, yet their loss can be tolerated provided the destruction be limited to one side. Duplication of structure, here as elsewhere, becomes an ally in the continuance of life. Vessels have been closed by ligation, both arteries and veins, and even sections of them excised in the removal of malignant growths, and yet no serious trouble followed. The pneumogastric and the phrenic nerves have been destroyed on one side, and life still continued; nevertheless, though patients have tolerated such mutilation of nerves, yet it should be avoided: for it is safe to conclude that if death follow the destruction of the vagus and phrenic on both sides, their unilateral destruction cannot be an unimportant assault on the organism.

The vessels must be sedulously cared for; and the veins demand a greater share of this care; since a large one being opened, not only may death occur from the escape of blood, but also from the aspiration of air into the vessel. This latter danger was long ago observed, and many explanations of the fact have been offered. The first impression was that the air contained some

toxic principle; this has been abandoned, and replaced by the theory that the air admitted into the right heart expands there, so that ventricular closure is prevented; others, however, claim that the air mingles and forms with the blood a gaseous emulsion, which entering the lungs interrupts the current of blood, and fatal asphyxia thence results. And like the fish which drowns itself when trying to escape from the angler's hook, so the victim of aspirated air dies from too much air in his lungs.

It should be stated that Pirogoff asserts that the danger of death from air entering a vein is much exaggerated; in fact, in experiments on animals, he states that a large amount of air can be tolerated if it be admitted slowly. Few share Pirogoff's opinion that air in the veins is not dangerous; authority is united in teaching that it should be shunned as an element of extreme peril. In vivisective experimentations E. S. Cooper, of San Francisco, was accustomed to show his students the fatal action of air thrown into the vessels; and as means of relief, he withdrew with the same instrument the air which he had introduced, when the dog, which the experiment seemed to have killed, quickly rallied, and was none the worse for the surgical lesson which he had taught.

As preparation for an operation on the neck, the patient's chest should be somewhat uplifted, so that the head will be slightly retroflexed; and the surface which is to be operated on, should be well illuminated, and not darkened by shadow of surgeon or his assistants.

As instruments required in the operation are the following: a scalpel, blunt retractors, scissors, clasp-forceps in number proportioned to the extent of the operation, blunt dissector, thread, needles, drainage tube, sponge, antiseptic solution and aseptic lint or gauze for dressing.

The primary incision, as a rule, should be longitudinal in direction; in some cases, the cut may be made transversely or obliquely. When practicable, such cut should be made in the line of the normal depression of the skin: for example, along the anterior margin of the sterno-cleido-mastoid muscle; the scarring is thus somewhat masked. The initial incision is best made as an uninterrupted cut, which is carried from above downwards, and should pass over the summit of the tumor. It should be long enough to permit of complete exposure of the growth; and will be best made when the derm is divided by one stroke; for such a wound permits of perfect marginal coaptation and reunion,

and leaves a vanishing scar. One incision often suffices; but if the tumor be a large one, two parallel cuts some distance asunder will facilitate the extirpation; for through the two incisions which include the growth, the dissection can penetrate alongside of, and beneath it; and through one lateral cut, the fingers can enter, uplift and thrust the tumor out through the other incision. Also, the dissection can be pursued on one side and then on the other, with such alternate displacement as will bring the subjacent structures to view. In case the glandular growth lies beneath the sterno-cleido-mastoid, the incisions should run along the borders of the muscle; and then through one incision the introduced fingers can force the tumor upwards and outwards through the other cut; thus, without injury to the muscle, growths beneath it can be removed. By the aid of such parallel incisions, an intact dermal bridge will remain, which will span the breach which is made, and promote the healing of the latter better than would integument which had been sutured.

Incisions of flap-form are sometimes made; an objection to this form is that the multiple incisions composing it do not admit of such accurate coaptation as do single or parallel lines. Also, the angles, when included in sutures, may become gangrenous and prolong the time of healing.

The removal of enlarged scrofulous glands is frequently demanded: for such removal intrusted to nature is unendingly tedious. Such diseased glands lie chiefly near the vessels; and if they become inflamed, they contract adhesions with the vessels, which render their extirpation difficult and perilous, from the risk of opening the vessel. The incision should reach to the capsule of the gland; and this being opened, the gland can be enucleated with a curette, a blunt dissector or the finger; and, though there be adhesion to a vessel, the gland can be loosened and lifted out without disturbing the adherent capsule. This capsule being left becomes a bulwark against bleeding. This enucleation always proves a longer task than was at first calculated; the removal of one only opens to view another gland; the searching index ever finds new work for the scalpel, or safer curette; and finally, when the terminal link of the glandular chain has been reached, there remains a deep chasm in the neck, in the bottom of which lie the carotid artery and internal jugular vein, bared as if for an anatomical demonstration. In this glandular excision it is rarely necessary to ligate vessels; veins are oftener wounded than arteries; and when these are of some

calibre, they should be doubly tied and intermediately divided. The internal jugular vein is more endangered than the carotid artery, since during the struggles, and expiratory efforts of the patient, the vein becomes turgidly swollen with blood; and in this state, a frightful flood of blood will follow its rupture. Such a wound of the vein was treated by Wattmann by lifting up the wall of the vein around the breach, and tying this: a procedure known as parietal ligation. From the possibility of this procedure leading to the formation of a clot in the vessel, it has had but few advocates. Veins which are entirely divided, sometimes retract so as to temporarily cease to bleed; and afterwards, when the patient makes an expiratory effort, the bleeding may begin again; and in such case, it is often difficult to find and seize the vein in its retreat: hence to avoid such difficulty, the operator should tie before cutting the vein; or what answers as well, seize the vein, before cutting it, with forceps, and then apply torsion to both ends.

Should a large vein be opened into which air might be aspirated, the surgeon should instantly close the breach with his finger; and then, while compression is being made on the vein on the cardiac side, the vessel may be sought for and ligated. A precautionary measure, which the writer has resorted to, is to have an assistant maintain constant pressure, after the vessels are reached, on the lower part of the neck above the clavicle; such pressure will prevent the admission of air into an opened vein.

In the treatment of the malignant lymphoma, as before stated, internal medication is chiefly to be depended on; yet from the writer's experience, he is convinced that the scalpel may be a valuable ally of the arsenic which is given internally. After the enlarged glands were removed in a typical case of malignant lymphoma, the internal medication was continued for some time: some five years afterwards, when the girl was reaching puberty, the disease reappeared on the neck, and was treated similarly without subsequent return of the affection. The operation in such a case is a simple one, since the glands are usually movable, and, as soon as the containing capsule is open, the gland can be isolated from the latter and removed with the loss of but few drops of blood.

The removal of the sarcomatous or carcinomatous glandular tumor is often one of the most difficult pieces of surgical work; especially if the tumor has already attained large dimensions.

During the early period of its growth, the sarcomatous glandular tumor is movable, and, at that time, its extirpation is not difficult. The work can be done in the manner described for removal of the benign glandular growth. If, however, such tumor has been neglected until it has formed adhesions with the adjacent muscles and vessels, and become immovably fixed to the deep structures of the neck, then the removal becomes a laborious task, in which the blood-vessels must be severely guarded, while dissection, proceeding stroke by stroke, accomplishes the work of removal; and this, to be a benefit to the patient, must be complete; for incomplete excision not only weakens the patient, but opens the way for a speedy return of the disease. The subject of malignant disease can ill lose blood; all loss of this must be watchfully avoided. To do this, initial steps should be taken to seek the artery on the cardiac side, and the vein on the distal side, of the tumor; and if one or both be inextricably adherent to the growth, then ligation should be done; and this accomplished, the operator proceeds *cito, tuto et jucunde* with his work in almost bloodless tissue.

If the dimensions of such a growth be such that it reaches below into the thoracic cavity, or above, it has involved the structures which emerge from the foramen lacerum, or it penetrates the carotid canal of the cranium, then the operation should not be done, since it can have no other effect than the immediate destruction of, or the abridgment of, life. Such unfortunates should be told that they have a kindlier friend in the poppy than in the scalpel; the acquisition of the opium habit will serve as a distraction during the brief remainder of their existence; and instead of shortening, it will probably lengthen life.

The wound should always be so situated that the excreta effused into it will have free escape, both in the sitting and the recumbent posture. In some cases the wound may be entirely closed, and the way or ways for drainage then are made through the sound contiguous derm. If the mouth of the wound be on

In the nucha or posterior structures of the neck neoplastic developments occur, which are of non-glandular origin, and benign in nature; such tumors are the lipoma, fibroma, and the osteoma.

The lipoma is of the most frequent occurrence, and commonly occupies the median part of the nucha. The normal capsular wall of the lipomatous tumor, so well defined elsewhere, is commonly not distinctly formed on the nucha; sometimes it does not exist, and then the tumor is fused indefinably with the neighboring structures. This ill-bounded lipomatous development commonly abounds in fibrous tissue, so that texturally it is denser, harder, firmer, and less movable than the normal lipoma; and the fibrous adhesion of such growth to the adjacent and subjacent structures embarrasses the surgeon in the work of extirpation.

These adipose neoplasms may be sessile; or, in development, they may project from the surface and, through their massive form and weight, acquire a pedunculated form. Such a pedunculated tumor, shown in figure 95, was operated on by Little-

Figure 95. In which is exhibited an enormous pedunculated adipose tumor arising from the posterior face of the neck. (From Dictionaire Encyclopédique des Sciences Médicales.)

wood; though arising from the upper part of the nucha, it was pendent, and rested like a sack of wallet-shape on the upper part of the back. It weighed when removed nearly eight pounds. In surgical literature a number of such cases have been recorded, and, as a rule, such voluminous growths have had deep connection with the structures of the neck; and where the growth has had lateral location the connections with the

vessels have been such as to render the removal a critical task. Exceptionally, the tumor has been found to have only superficial connection with the subcutaneous tissue.

The fibrous tissue may so far predominate in the formation of the tumor that the neoplasm is properly named a fibroma; the leading characteristic of such a tumor is its extreme hardness; in other respects it closely resembles the lipoma, and, as already remarked, the fibrous and fatty elements may so equally concur in the structure of the neoplasm that a proper title for it is fibro-lipoma.

These growths cause no pain, and become only sources of inconvenience when their volume interferes with the dress of the patient's neck; or, from dragging or encroaching upon the lateral structures of the neck, they interfere with the freedom of the circulation. And when the tumor attains large dimensions it may interfere with the recumbent posture of the subject.

An osteoma may arise in the nucha, and has, as starting point, the spinous or transverse process of a cervical vertebra. Such growth seldom reaches a size which is either a marked deformity or a source of trouble to the patient; should it do so, it may be removed by means of scalpel, chisel and mallet; or when the growth has been freed from the soft parts, if it be pedunculated, it may be excised by means of a resection-saw or chain-saw.

The extirpation of the lipoma or fibro-lipoma, when situated elsewhere on the body, is the simplest of surgical operations, but when seated on the back of the neck, the task becomes much more difficult. In the first place, some effort is required to place the patient so that the growth is accessible to the knife. The patient must lie nearly prone, with the breast somewhat elevated, and the head inclined forwards, positions difficult to maintain in the anæsthetized subject. The patient lying in position, a vertical incision is to be made, and the growth dissected from the structures in which it lies imbedded. For this dissection a scalpel with thick, strong blade and large handle is needed. In the deeper part of this dissection blood-vessels will be met, which should be ligated, for, if not tied, they will continue to bleed, since they lie in tendino-muscular structures, which interfere with their normal contraction. A case remains vivid in the writer's memory in which a neglect to secure all the vessels at the time of the operation was followed by hæmorrhage and a tedious healing of the wound. After careful ligation of the

vessels, the wound should be closed by strong sutures passed deeply by means of a long curved needle; such sutures approximating the sides of the wound will favor healing.

Carbuncle, Anthrax.—The carbuncle, of which the Greek synonym is anthrax, occurs in several regions of the body, yet the tissues on the posterior face of the neck and the upper part of the back are specially liable to this affection. It is a localized inflammation of the dermal and subdermal connective tissue, probably beginning in the walls of the sudoriparous and sebaceous glands. It resembles the malignant pustule, and the furuncle; it is less severe than the former, and more so than the latter, so that a carbuncle is not inaptly named an assemblage of furuncles or boils.

The usual site of the carbuncle is on the upper part of the neck, where the nucha merges into the hairy scalp; it commences as a hard, painful, isolated swelling, in which the affected part is uplifted above the surrounding skin, and presents one or several vesicles; these vesicles, at first filled with a gelatinous fluid, soon become filled with pus. If the cuticle be removed, these pustules will be found to penetrate inwards, so that the surface has a cribriform appearance. These sieve-like openings are the seat of a necrosing process, which penetrates inwards as well as laterally, so that there is finally death of a considerable extent of surface. The part which thus dies is only slowly detached, and, in the dying mass, small islets of living structure may escape the gangrenous destruction which is occurring around them. The slough is, at first, blue or dark, and afterwards assumes an ashy gray color. It has not much odor. The gangrenous process extends sometimes more rapidly and widely under the skin than on the surface.

The disease was well described by Celsus as follows: "Of the diseases which deeply affect the body none is worse than the carbuncle, of which the marks are the following: redness of surface, on which a few pustules project, and these, for the most part, are black, yet they may be sub-livid or pale. These pustules within are black and contain sanies. The body is dry and harsher than usual. There is a crust on and around it, and this is begirt with inflammation. The skin of the part cannot be uplifted, but seems to be attached to the subjacent parts. Sometimes there is shivering, or fever, or these may both be present. This disease seems to creep, as if with latent roots, in the subjacent parts, extending sometimes more rapidly, sometimes more

slowly. And while thus spreading, the surface above is at first palish, then it becomes livid and small pustules appear." This Celsian picture of the disease is as correct as any which modern surgery has sketched.

John Hunter says carbuncle begins almost like a pimple, and goes deeper and deeper, spreading with a broad base under the skin. It produces a suppuration, but not an abscess, somewhat similar to erysipelas. The matter lies in cells, where it is formed, almost like water in anasarca. A diffused ulceration on the inside for the exit of matter takes place, making a number of openings in the skin.

Ludlow, who published on this subject in 1855, found that carbuncle may appear at any time in life; it is seen in early youth as well as in old age, and occurs oftener in men than in women. It may appear without a warning signal, or it may be preceded by insomnia, headache, vertigo, fatigue, loss of appetite, constipation and a profuse discharge of the urates in the urine. A low form of fever usually accompanies carbuncle. It varies in size from an inch to ten inches in diameter. In case of recovery, the average duration is seven weeks.

Prichard, in an essay on carbuncles read before the British Medical Association in 1865, stated that the disease was annually increasing in England; for example, in 1842 there died in all England but forty-two persons; in 1846, seventy-seven died; and, yearly the numbers of deaths increased until, in 1855, there were reported two hundred and fifty-five deaths. The disease was nearly three times oftener among men than women. A few cases occurred among children, but none among nursing infants. The most usual sites of the disease were the neck, back, buttocks, and the extensor surface of the limbs. Where the central sloughing is slow in formation, the disease spreads rapidly around the affected part, and this has been referred to the density of the skin, which prevents the exit of the ichor and causes its diffusion underneath. Death, Prichard finds, can occur from exhaustion caused by pyæmia, also from tetanus, and thirdly from the disease extending into and affecting some adjacent cavity; thus the disease may penetrate into the pleural cavity, also into the peritoneal cavity, and, occasionally, into the intra-cranial serous cavity.

Laycock found that the disease was not specific and could not be communicated by inoculation.

James, an English writer, in 1866, wrote on carbuncle. He

thinks that there are two kinds of inflammation, one tending to localized isolation, and the other to indefinite diffusion. The carbuncle tends to circumscription, and appears especially in very vascular parts: for example, on the neck and in the perineum about the urethra. Its ending is a circumscribed circle of dead tissue around the central point of origin. Bérard found that in one-third of the cases of carbuncle, erysipelas arose, but modern antisepsis has removed this from the list of events.

Carbuncle occasionally appears in the glycosuric or diabetic subject, and in such cases the disease is of a severe form; the carbuncle is then large, and combined with the existing constitutional malady, it usually destroys the patient's life.

Copland says "that anthrax rarely occurs excepting in habits of body evincing more or less of cachexy with sanguineous plethora and disorder of the digestive functions. For some days before its eruption the patient complains of anorexia and increased disorder of these functions, and of lassitude, chills, or shiverings. With the development of the tumor, the febrile commotion increases, and presents the usual concomitants of inflammatory fever. If sphacelation takes place, or if the ulceration is protracted, the attendant fever assumes gradually an adynamic character; and in delicate, old, or very cachectic persons, it is nervous or adynamic from the commencement."

Richet, in 1868, finds that carbuncle may appear in different grades of severity; and he warns against treating all cases alike, since different cases demand different management.

Croly thinks carbuncle is a diphtheritic product, against which he advises the local use of carbolic acid.

Diagnosis.—The carbuncle is much larger than the boil; if a number of boils were to arise simultaneously contiguous to each other, the condition would not be distinguishable from a carbuncle; but boils appear as individuals separated by some space from each other; and the boils are of different ages, and, when coëxisting, are at different stages of development; hence these conditions make a clear distinction between the boil and the carbuncle.

The carbuncle has often been confounded with the malignant pustule the latter is a more severe and a more dangerous affection Malignant pustule owes its origin to inoculation with the virus known as cattle-poison. Such inoculation may be direct from contact with the diseased animal; or it may be carried from the carcass by a fly, which, by its bite, infects the human sub-

ject. Such inoculation speedily produces death of the infected part. Its sites are the hands and exposed surface of the face. The infected part presents the condition of moist gangrene, and spreads without limit; and if the disease is not arrested, the patient dies within a few days. These features clearly distinguish the malignant pustule from the carbuncle.

Prognosis.—Carbuncle is not a dangerous affection when it occurs in the strong and otherwise healthy subject; but in the subject whose muscular, digestive and assimilative functions are enfeebled, and whose fund of vital resources has been curtailed by spirituous or other exhausting excess, and also in the diabetic subject, carbuncle sometimes ends fatally; and in all cases in which the disease embraces a large amount of structure, though the patient may escape, yet he approaches perilously near to death.

When carbuncle ends fatally, it is often through the disease reaching some visceral cavity; for example, the encephalic, the pleural or the peritoneal.

Treatment.—If the disease be seen in the beginning, its progress may sometimes be checked, and the disease arrested by the hypodermic use of carbolic acid. For this purpose liquefied carbolic acid is to be used; and to do this, charge a Pravaz syringe with a few drops of the acid, and insert the hollow needle at some four or five points in the carbuncular structure, and inject a drop at each point. The pustulated surface may also be cauterized with the carbolic acid. Instead of this agent the compound tincture of iodine may be used hypodermically. In this way the author has seen the development of the carbuncle arrested, and the patient given speedy relief.

Other local remedies used as abortive means have had earnest advocates; of these the following deserve mention: Theilmann treated three hundred and forty-three cases of carbuncle, of which all except five recovered; his treatment was simply local applications, and consisted of the following compound: turpentine and spirit of camphor, of each one ounce, the yolk of an egg, and a pint of the decoction of chamomile; and in some cases he gave acids and camphor internally. Rigby used the tincture of iodine externally; Cook used belladonna locally; an opium plaster was used by Gutzeit, the extract of opium by Shillitoe, and the acid nitrate of mercury by Startin.

Early in this century, Dr. Physic of Philadelphia treated the carbuncle by blistering; and in 1876 the same was recommended

by J. Guérin. Guérin asserted that by this treatment, a hard, tense and painful tumor was changed into a painless and benign one. The blister should have an opening through the centre; and on the blistered surface a cataplasm should be applied. Guérin thinks the vesication extracts the virus from the carbuncle.

The greater number of surgeons have advocated some more energetic treatment than the means above enumerated; such treatment may be classified under the heads of cauterization, incision, open or subcutaneous, and excision.

Celsus, in the following words, advised the actual cautery: Nothing is better than to immediately burn it: nor is this severe, since the flesh having already died does not feel. And the burning is only to end when the sense of pain is felt in the parts acted on. The force of the attack should be proportioned to the magnitude of the disease.

In 1821 Physic published the beneficial results which he had derived from the escharotic action of caustic potash; he applied this as soon as vesicles appeared on the skin, and so destroyed the latter that there was a free opening for the escape of the acrid matters. In all cases he found that the pain of the carbuncle ceased as soon as the action of the potash had terminated. In 1863 Prichard recommended the use of caustic potash; he used the solid stick, and thrust this deeply into the carbuncle. To abate the pain from the caustic he placed on the part a mixture of salt and ice. On the remaining diseased surface Prichard painted the following mixture:—

℞. Collodii. .. ..℥i
Iodi.
Potasii. Iodidi. .. ..aa ℈j
Misce.

On the cauterized surface Prichard applied resin ointment; he wholly discarded poultices in the treatment of the carbuncle.

The writer has derived benefit from the escharotic action of sulphate of zinc applied in crystals to the interior of the carbunculous structure, after the latter has been freely incised; thus, sections of the affected structure can be made to rapidly slough off, and detach themselves from the sound tissues.

The Celsian plan of attack with the actual cautery has been employed in a few cases by the writer. For this purpose use the incising point of the thermal cautery, and burn deep furrows

into the diseased part. Over the carbuncle thus furrowed, place a poultice which may consist of boiled chamomile flowers, or boiled starch, or boiled carrots. Under this treatment the detachment of the gangrenous tissues will be accelerated.

Compression was advised by O'Ferral and Colles: this was done by means of an adhesive plaster which contained opium. Others have used lead plaster and collodion.

Trèlat advises prolonged baths and dressing with wadding.

The plan of treatment which is most in favor, is that of incision; and yet like all surgical procedures this one has had its opponents.

One of the earliest advocates of treating the carbuncle by incision was the English surgeon Wiseman of the time of Charles the Second, who wrote: "I advise scarifying or cutting deep into it (the carbuncle) to give a breathing to the humor." And he awakens our incredulity when he says: "I never saw a true carbuncle suppurate." Free incisions were practiced by Cooper, Abernethy and most of the English surgeons. The French give to Dupuytren the credit of popularizing this method of treatment.

The method of incision has been practiced in several ways. The most conservative plan was that of Guérin and Gosselin, who did the work subcutaneously. They introduced a narrow bladed knife through the skin, and then twirling the instrument about, they divided the structures circularly around; and thus a large wound is shunned through which pyæmic infection can occur. Hueter advocates the method by subcutaneous incision.

In a discussion of this subject in 1881, Le Fort, Sée, Marjolin, Le Dentu, Boinet and other French surgeons recommended the treatment by incisions; yet some would limit the work to subcutaneous division. Verneuil and Tillaux are more conservative, and the former thinks that in eighty per cent of the cases the patient may be cured without incision. Després advocates the expectant method; yet his report of fifty-seven cases which he thus managed, and of which six died, does not encourage the adoption of his mode of treating the disease.

Ludlow strongly praises the treatment by free incisions; and this should be done early in the disease, since it will lessen the pain, and diminish the development of the carbuncle.

Colles advises to make a number of incisions deep enough to divide the superficial fascia; for he contends that this tissue causes strangulation and death of the structures which are con-

fined beneath it. Velpeau makes multiple incisions, from twelve to fourteen in number, in case the carbuncle be of large dimensions. The method commonly in practice is to make a crucial cut, which will traverse the carbuncle from border to border, and penetrate quite through the affected structure. In such work the scalpel will creak or cry as if it were dividing leather.

The effect of such free incision is free, but not excessive bleeding, and a draining or "breathing out," as Wiseman calls it, of some of the morbid elements of the affected parts. For a few moments the pain caused by incising is great; yet it brings quick cessation of the pain which previously existed. A free outlet is thus made for the disintegrating and gangrenous carbuncular structure.

After incising the carbuncle, the breaking down of the diseased tissue should be favored by an anodyne poultice; for this purpose a mixture of moist hops and poppy leaves may be applied. As soon as shreds loosen, they should be detached with forceps and scissors; thus dead material may be gotten rid of at once, which otherwise would encumber the wound for several days. Besides the cataplasm, the wound should occasionally be cleansed with some disinfectant lotion; for this purpose, dilute chlorinated water, or a weak solution of permanganate of potash may be used for cleansing the wound; and the same may be added to the cataplasm.

The eminent English surgeon, Paget, besides his opposition to the free incision of the carbuncle, does not favor the practice in use of giving the carbuncular patient spirituous drinks and generous diet. The experience of the writer does not accord with this course; the patient fed to repletion and allowed wine or other spirits, will do better than one confined to an abstemious regimen. As internal medication, the adult may be given three times daily, a teaspoonful of the compound tincture of gentian, or cinchona; and if to each dose there be added a teaspoonful of pulverized ice and a half tablespoonful of cognac, the mixture will awaken the desire for other food.

Should the pain continue after the carbuncle has been freely incised, then an opiate should be given: viz., a fourth of a grain of morphia every five or six hours; and the efficiency of this will be augmented, if to each dose there be added a grain of camphor and three grains of quinine.

The ragged breach in the nucha will be slow in healing; and there will remain a large uneven scar, to mark the site of the carbuncle.

There remain to be mentioned certain modifications of the method of treatment by incision. In 1866, Foucher advised to lay open the carbuncle, and then apply over the cut surface a large suction cup; thus Foucher sought to extract the affected fluids of the diseased structures.

In 1865, Broca announced to the Society of Surgery, that, struck with the gravity of carbuncle, he had conceived the notion of treating it as a malignant growth; he had not, however, carried out his idea, since it is difficult to foresee the extent to which the carbuncle may develop. Blackley, an Irish surgeon, pursued this plan in one case; after freely opening the affected structure with the knife, he then proceeded to excise the carbunculous structure with scissors; this done he replaced the flaps and compressed them with adhesive strips, and obtained a speedy cure. The author has put this plan into partial practice, in this way, that after making the cruciform incision, he excised the diseased structure from beneath the four angular sections, leaving the skin as a covering. Some benefit resulted from the excision, since the sloughing process was lessened, and there remained less diseased structure for detachment.

In conclusion of this chapter upon carbuncle, the writer would advise the following treatment of the disease: if seen in the commencement, endeavor to arrest by the interstitial injection of carbolic acid; if seen somewhat later, incise crucially, and use an anodyne cataplasm; and if seen still later, when the tumefied structure is perforated with gangrenous sinuses, then incise crucially or stellately, and excise the diseased structure which is accessible, and dress with an opiated ointment, or cataplasm.

Malignant Pustule.—There is an affection so closely cognate to carbuncle that a consideration of it here is deemed proper; this is malignant pustule.

This affection commences as a red point, which is but little elevated above the surface, and is the site of itching and prickling. Such initial red points appear in numbers; the part swells; the cuticle is uplifted like a slight blister; and the underlying rete mucosum and corium are of a dark red or purplish color. The dermal tissue has suddenly become the site of moist gangrene; and the sensation there is rather that of tightness and tension than of severe pain. The general circulation is much disturbed; the pulse is small and often irregular; nausea, vomiting, delirium and great physical depression are present. When located on vascular and distensible parts, there is great swelling. The affec-

tion has no tendency to self-limitation, but rather to indefinite diffusion. If near the brain the latter becomes congested.

The disease is caused by a special contagious virus, which is developed in cattle, sheep, and rabbits; the human subject contracts the disease from such affected animal. From their occupation, the butcher, skinner, tanner and scavenger are the most usual subjects of malignant pustule. The disease occurs oftenest in wet weather.

Pasteur and others have studied the causal virus and found that it is very tenacious of existence and power of infecting: qualities which are not lost by long burial of the dead animal. And the virulent intensity is so concentrated that it remains, though the virus be greatly diluted in water.

The disease is reported to have arisen in man without actual contact with an affected animal. This may be doubted and has arisen from the lack of accuracy which too often obtains among patients in regard to their ailments. For the subject of grave disease in his state of physical pain and alarm must necessarily furnish a history alloyed with many errors: errors too great to be sifted out by the attendant who is not a severely critical analyst.

The use of the flesh of animals thus affected may cause serious illness; this probably depends on whether the meat has been imperfectly or thoroughly cooked.

Bourgeois, who saw many cases of this disease in France, says that he never saw any delirium attend it; and this is in accord with the writer's experience.

The affection is preëminently a dangerous one, tending to death unless it be vigorously treated at the onset. This depends on the fact, that the part which is the site of the gangrenous process is in immediate and uninterrupted connection with the adjacent living parts: no wall of coagulated proteinaceous material is formed as a barrier between the dead and the living tissues; the infecting content of the former enters and does its fatal work in the latter. And thus the diseased area continually widening, the ichoræmic process is rapidly augmented.

In surgical literature the malignant pustule has been confounded with the carbuncle; and as the two radically differ in nature and treatment, it is necessary to clearly indicate their diagnostic differences. Carbuncle is more of a local trouble, and, commencing on the outside, it penetrates inwards; malignant pustule is more rapid and thorough in its destructive work, completely killing at once, the structures which it attacks.

Carbuncle has, as its more special sites of development, the neck, back, and buttocks; but malignant pustule appears almost exclusively on the uncovered parts of the body; and its action is limited to the skin, while carbuncle attacks chiefly the subcutaneous cellular tissue. In carbuncle, the affected part is hard, red and circumscribed; malignant pustule, however, though hard, is pale and not well defined, and vesicles appear on it. Carbuncle is painful, but malignant pustule occasions a sensation of biting, burning and tension.

According to Ancelon, malignant pustule begins as a phlyctæna-clad surface, and it penetrates rapidly inwards; from the affected focus reddish streaks radiate into the surrounding skin; and as the disease advances peripherally, the central part dying becomes cold and insensible. A shooting, burning pain is felt in the sinuous border.

Pathological Changes Present after Death.—The slough or gangrenous structure of the surface primarily attacked is seldom more than a line in thickness, and is brown, livid or black in color; and the blood-cells contained in it appear under the microscope, disintegrated, and the blood contains microphytes which will presently be considered.

The blood-vessels are filled with a black and liquid blood. It has been noted that the left side of the heart contains but a small quantity of blood; and this is uncoagulated. The blood putrefies with the greatest rapidity, and is found to contain but little fibrin. The serous cavities, as the pericardial and pleural, contain a blood-stained serum.

Davaine and Raimbert have made a microscopic study of the fluids of animals and men who have died of malignant pustule, and they have found bacterial corpuscles; these have been the subject of much experimental research on the part of Davaine. These microphytes are discovered in the serous fluid which intervenes between the masses of aggregated blood-cells; and in their form they are elongated, rod-shaped, smooth, of equal size from one end to the other; and are found floating, or at rest. Though generally elongated and straight, yet sometimes they are curved, or bent at an acute angle. The blood which contained these bacterial microphytes had lost its power of coagulating and the microscopic forms which existed in it were not destroyed by water or alkaline fluids.

Treatment.—Treatment to be effective should be commenced early and pursued with prompt diligence. That the disease is

curable has been verified several times in the writer's experience.

If seen early, the vesicles must be opened, and their content removed. The subjacent gangrenous surface should be incised crucially and the four flaps should be dissected from the unaffected underlying structure, and excised; thus one radically disposes of the sloughing structure which is teeming with the elements of the disease. The dissecting knife should confine itself to the line which separates the dead from the living tissue; thus done, no bleeding occurs. After this excision of the gangrenous structure, the actual cautery is to be applied to the denuded, as well as to the contiguous affected structure; the line of cauterization must pass somewhat beyond the vesicular and indurated structure. The pointed cautery should be made to penetrate quite through the diseased tissue.

The potential must reënforce the actual cautery; and for this purpose, numerous agents are at our service; those which have best repute are the chloride of zinc, the chloride of antimony and caustic potash. The chloride or butter of antimony is preferred by Enaux, Chaussier, Bidault and others. To use this, let portions of lint saturated with the agent be placed at different points of the affected surface, and covered with dry lint, and the whole fixed in place by adhesive plaster. Caustic potash is a very effective escharotic; this may be rendered less severe by mixing it with an equal amount of calcined magnesia or powdered Sanguinaria. The severe action of the potash requires that some precautions be used to prevent it reaching and attacking the adjacent sound parts; for this purpose, let these parts be covered with adhesive plaster. The writer has often applied the caustic potash in pencil-form as an escharotic, in cases other than the one here treated of. For this purpose, the fused material fixed in a holder can be applied, and the tissues destroyed to the extent one wishes. The escharotic action can be arrested by pouring water or olive oil over the cauterized structure. The action is speedy and attended by little pain.

In 1864, a charlatan in France had wonderful success in treating the disease; and his secret, published at his death, consisted in the application of pure corrosive sublimate to the diseased surface. This salt was applied to all of the surface which was the site of vesicles; the affected structure was thus wholly destroyed, and detached itself. On the part thus cauterized, an ointment compounded of styrax was applied.

The author has treated several cases of malignant pustule

which had been contracted from dead cattle: the disease was commonly on the hands; yet in one case it was on the face; and the manner of treatment which was pursued, and proved almost uniformly successful, was as follows: by ecraseur or scraping with some blunt instrument, the vesicular surface is to be removed; and then, if the subjacent derm has not become gangrenous, apply to it the following solution of bromine:—

℞. Bromi.. .. ..ʒss
Aquae.... ..... .℥xij
Glycerini..... ... .℥iv
Misce.

Let the diseased surface be well covered with this, and then let a piece of lint be saturated with the same and placed on the affected site. As the odor of bromine is disagreeable, and may have a pernicious effect on the patient, the dressing should be included in a piece of oiled silk. If the disease be on the hand, as is commonly the case, the limb should be flexed and carried in a sling. The dressing should be removed daily.

Should the erasure of the vesicular surface not be followed by the exuding of normal red blood from the denuded corium, this indicates that the derm is passing into gangrene; and in such condition the scraping must be continued, and carried deeper into the true skin; and if it is found that this is wholly gangrenous, then the dead skin should be excised, the subjacent tissues thermally cauterized, and over this cauterized surface the dressing of bromine should be applied. By this treatment, without any internal medication, the writer has successfully treated several cases in which the disease was on the hands. One patient, in whom the disease was on the side of the face and scalp, did not recover; it should be mentioned that the disease was far advanced when first seen, and death occurred on the fourth day. In this treatment, if the patient be addicted to alcoholic drinks, these should be continued.

CHAPTER XXVIII.

WOUNDS OF THE NECK.

WOUNDS of the neck have been classified most diversely. Not content with the old division of incised, lacerated and contused, penetrating and gunshot wounds, some have proposed the classification of penetrating and non-penetrating; others according to gravity have named them fatal and not fatal. Others have adopted a regional nomenclature in which one finds the groups supra-hyoidean, sub-hyoidean, thyroidean, etc., according to the site of injury. A practical division is into superficial and deep wounds, which may be further defined by mention of the structures involved.

The wound may result from accident, from violence inflicted by a criminal hand, or surgery itself may be responsible for it; thus in tracheotomy, œsophagotomy, tenotomy, and particularly in the removal of growths from the neck, wounds of greater or less severity are made by the surgeon.

Dupuytren has observed that the dress of the neck often protects the part from injury; and hence in winter, when the neck is thickly dressed, wounds are rarer than in summer when the neck is more exposed.

The superficial wounds may be longitudinal, transverse or oblique in direction; and when transverse the gaping is the greatest. If only the derm is involved, such wound is of little importance; but if one or more of the superficial jugular veins be divided, then there may be dangerous bleeding; in one reported case a quart of blood was lost, with the result of destroying the patient's life. Besides hæmorrhage, aspiration of air into these veins has occurred with the perils arising from this accident.

Besides the gaping of these wounds alluded to, there may be in-rolling of the borders; and this, which is due to the action of the platysma myoides, occurs more at the upper part of the front of the neck than at the inferior portion. And to correct both

these conditions, the suture, twisted or knotted, has been used by some surgeons; yet Dieffenbach and many modern surgeons, having found that suppuration occurred under such closed wounds, have discarded the suture, and attempted union by adhesive plaster; in fact, fearing such suppuration, they have left the wound somewhat open. The writer, however, advises closure by catgut or metallic suture after the wound and adjacent surface have been rendered aseptic. And such stitch should be so inserted as to retain the unrolled edges aptly united; and to accomplish this the margins should be everted during the passage of the needle. The surface should be painted with the compound tincture of benzoin, covered with isinglass plaster, and the whole covered with cotton wadding. The wound should be inspected daily, and, if no irritation appears in it, the metallic sutures may remain in site for four or five days; but if there be indications of suppurative action, then each alternate suture should be removed, and a dressing applied consisting of lint wet with a twenty-five per cent solution of alcohol. In case the suture consist of catgut, this will vanish through absorption; and as such absorption may occur before firm closure of the wound, the writer gives preference to fine wire as material for suture.

Deep or penetrating wounds may implicate the nucha, side or front of the neck.

The deeply penetrating wound of the nucha is most frequently caused by the sword, sabre, knife or gunshot missile. The records of military surgery contain numerous cases of deep incised wounds on the back of the neck; often frightful wounds in which the subject was half decapitated. If the lesion does not implicate the spinal column it is not necessarily fatal. Such wound has been in flap form, and the flap, as in the case of Larrey, being pendulous downwards. Such wound should be closed by metallic suture, and the patient remain absolutely at rest in the lying posture. In Larrey's case, though the patient recovered, he remained without generative power.

The penetrating blade may enter the spinal canal and injure the cord. The new-born infant has had its existence criminally ended by a needle which has been thrust between the atlas and the occiput, or between the atlas and axis into the spinal cord. A bullet or other missile would be equally sure to terminate life.

Deep wounds on the side and front face of the neck rarely fail to imperil some structure of vital importance; and should

the common carotid artery or the internal jugular be divided, the work of death is so speedy that the surgeon's services are dispensed with. Nélaton has said that it takes a man four minutes to bleed to death from the severed carotid, and but two minutes for the surgeon to tie the vessel; if he were on the ground and prepared, the writer will add. The writer recalls the case of a man in the New York Emigrant Hospital, who bled to death in much less than four minutes after cutting his throat; a surgeon, who was at the side of the suicide within a minute, found him dying.

In the study of these wounds it is most convenient to start from the posterior part and proceed towards the median line.

Wounds in the outer or lateral part of this region may implicate superiorly the upper part of the sterno-cleido-mastoid muscle, some branch of the superficial cervical plexus, and the external jugular vein; lower down, in addition to these structures, the formative trunks of the axillary plexus, and the subclavian artery and vein, and the phrenic nerve may be wounded. The treatment of such deep wound should be the reunion of the severed muscle when the ends are much separated; and an opened vessel should be ligated; and such ligation becomes most efficient when the vessel is tied on each side of the wound, and then severed between.

Above the hyoid bone lies a space bounded superiorly by the inferior maxilla, which is rarely the site of wounds, nevertheless a penetrating instrument entering here may wound veins of some magnitude: also the facial and lingual artery: likewise the submaxillary gland, the duct of Wharton, and the hypoglossal nerve. As treatment, wounded vessels should be tied, and if the wound opening the duct of Wharton remains as a salivary fistula, the most rational management is to remove the source of supply, viz., to extirpate the submaxillary gland. This is readily done by a cut two inches long parallel with the margin of the maxilla and midway between this margin and the hyoid bone. Through this cut the gland is reached, and the facial artery, which is imbedded in or on the gland, is to be ligated doubly and divided intermediately; then the gland is readily enucleated from its niche; and when this is done it will be found suspended to the gustatory nerve above, and to its excretory outlet in front; these being sundered, the work of extirpation is done. This extirpation of the submaxillary gland has been practiced by the writer eight times in the removal of epithelioma of the tongue

or from the floor of the mouth; and it was so easily done, and the wound healed so quickly, that though the procedure may appear somewhat radical, yet he advises it as the proper treatment of an unclosing fistula in the duct of Wharton. It is probable that if the hypoglossal or gustatory nerve were severed, continuity might be restored by a suture of the two ends of the nerve.

The suicidal knife sometimes enters this region, and may accomplish its fatal purpose; yet, as a rule, such wound fails of its intent. The treatment of this wound will be considered hereafter.

Within the triangular space having its base at the hyoid bone, and bounded laterally by the sterno-cleido-mastoid muscles, lie the laryngo-tracheal canal, the œsophagus, and the large cervical vessels and respiratory nerves. A wound of any of these, if it does not destroy, will at least imperil life.

The median air-canal is often opened; of thirty-one wounds of the neck seen by Dieffenbach, of which fifteen ended fatally, two implicated this channel. Horteloup has collected one hundred cases of such wound.

The suicide and homicide have furnished many examples of this lesion, in which the wounds passed from without inwards; and, reversely, violent expiratory effort has wounded the trachea from within outwards, leading to emphysematous diffusion of air into the tissues of the neck. Wounds penetrating the air-canal may be caused by an infinite variety of instruments; in fact, they can arise from any sharp-pointed instrument or object, from a needle to the wooden staff of a rocket; an example of the latter was seen by the author.

Of wounds which implicate the tracheo-laryngeal canal, the figures of Durham and Horteloup show that the upper portion is less often wounded than the lower part; the former found that of one hundred and fifty-eight cases fifty-six, or about one-third, were situated above the thyroid cartilage; and these figures do not differ much from those of Horteloup.

The direction of the wound is usually oblique or transverse, yet such wounds in longitudinal direction have often arisen from the surgeon's knife. The wound may be a single one or it may be multiple; the maniacal inspiration of the suicide has furnished frightful examples of the multiple form; his instrument, frequently dull or unsuited to such work, seeks, often in vain, to penetrate the larynx, which offers a protective barrier to vessels

which lie at its sides. And this security is increased by the ossific change which, in the old subject, occurs in the larynx and trachea. In his maddened fury to effect his destruction, the desperate subject has been known to wound his thyroid cartilage at several points, and sometimes he has detached a large part of the larynx. Of the ferocity with which, sometimes, such self-inflicted wounds are made is the case narrated by Jameson: a woman who had cut her throat and was unable to speak, drew from her pocket the cricoid, the arytenoid cartilages, a portion of the thyroid cartilage, and a tracheal ring, which she had cut out. This woman lived thirty-four hours, and had she been found dead, her death would certainly have been attributed to violence perpetrated by an assassin's hand.

That such violence can be inflicted by the subject himself seems incredible, and it could not be done were it not that in his frenzy he becomes insensible to pain. This fact the writer has verified by statements of those who have attempted self-destruction: in one case a woman had thrust a knife, handle and all, into her chest, and yet she had no recollection of any pain from the act. And this statement has been corroborated by others who failed in their suicidal attempts.

The wound implicating the laryngo-tracheal canal, owing to the complexity of structure, presents a variety of conditions, and these, according to their time of appearance, may be immediate, recent or late.

As immediate results which may arise are emphysema, bleeding, which may cause syncope and asphyxia, and gaping of the divided tissues; and, as respiratory trouble, there may be suffocation, and disturbance of or loss of voice. As subsequent morbid development there may be swelling and œdema of the mucous membrane, suppuration, and inflammation of the air-canal, and this may reach into the lungs. As phenomena which can arise still later, are narrowing of the canal, disturbance of phonation, cicatricial retraction, and consequent displacement of parts; and in case of non-closure a fistulous orifice may remain.

In case the wound is a large free opening of the air-channel, the air is inspired and expired through the wound; but if the wound consist of a narrow fistulous canal, then the patient will breathe in the air through the mouth or nose, but will expire it partly through the narrow wound; and as the exit through the latter is not free, the escaping air may enter the subcutaneous tissue and produce a puffy swelling around the wound; and this

intravasation of air sometimes occurs on an enormous scale. In a case seen by Paré the emphysematous diffusion extended from the neck to the body, the entire surface of which became swollen. The air, instead of entering the subcutaneous tissues, has penetrated underneath the mucous membrane and lessened the calibre of the canal, and, if this should encroach on the glottis, the patient may be asphyxiated. In the operation of tracheotomy subcutaneous emphysema has been seen; such accident is referable to inexpertness in doing the work.

If vessels are opened near the tracheal or laryngeal wound, the escaping blood may be aspirated into the air-passages and cause asphyxia; such unfortunate accident, as the writer's experience can authenticate, has brought to a sudden halt the work of the tracheotomy, for the clotted blood lodged in the bronchial branches can obstruct aeration as effectually as can the croupal pseudoplasm fixed in the trachea or larynx above. And such blood may arise not only from lesion of vessels outside of the canal, but a wound of the congested mucous membrane, according to Gueterbock, has yielded blood which asphyxiated a feeble subject.

In the improper closure of a wound which has opened the larynx or trachea, by which gaping vessels were concealed, blood has laterally entered the air-tube, and entering the lungs, it has maintained, for a time, a harassing cough; and this in its turn favored the bleeding.

If the amount of blood lost be considerable, it may induce syncope, and this syncopal state has lasted so long in some cases as to simulate the moribund condition. Horteloup records cases in which this condition lasted eight or ten hours.

The gaping of the wound may be great; for example, if it lie transversely, the divided muscles retract greatly, but if the wound pass irregularly from its outer to its inner ending, then it spontaneously closes, valve-like, especially in the inspiratory act. A transverse wound in the thyrohyoidean space, or the cricothyroidean membrane, may leave a widely gaping breach in the air-tube. If it is yet lower, the trachea may be wholly divided, and a considerable interval be left between the ends. Through such widely gaping wound the patient breathes, and, in coughing, mucus and pulmonary excreta are expelled through it.

The wound opening into the air-tube, if below the glottis, influences the voice; if it be large, complete aphonia results; but if the wound be small, the voice may be changed in tone and

strength. The large gaping wound which annuls phonation is taken advantage of by the vivisectionist to enforce the silence of his victim.

Injuries of the larynx, if severe, as a rule, annul or destroy the voice; yet there are reports of cases in which the voice still remained, although the larynx had been opened near the vocal cords. In such cases, which are at variance with the accepted facts of physiology, perhaps, the superior thyro-arytenoid ligaments vicariously represent the normal chords.

In these laryngo-tracheal wounds, if the inferior laryngeal nerves be intact, then a closure of the wound will enable the patient to speak aloud. And in legal medicine this fact has been utilized; the wound has been temporarily closed to permit the subject to speak the name of him who has wounded him: and with the object of restoring phonation, Paré was accustomed to close such wounds.

Wounds of the air-passage can, soon after their receipt, awaken an inflammation and œdema of the mucous membrane, which, besides obstructing the respiration, may cause extensive suppuration, from which the pus, entering the air-channel, may descend into the lungs and cause a low form of pneumonia. In addition to the pneumonic trouble, the pus may descend on the outside of the trachea and enter the thorax; such gravitating material may, fortunately, be arrested by the sternum and clavicle; in fact, from the writer's observation, the anterior and lateral spaces are so well closed by their attachment to the sternum and clavicle, that pus descending will rarely pass beyond these barriers; however, downward escape of pus, along the nerves forming the axillary plexus, into the axilla has occasionally been observed. But pus, which enters the air-tube, or œdema developing there, may descend and awaken disease in the lungs; thus fatal pneumonic disease has not unfrequently arisen. And to avert such ill action, an external exit should be prepared for all pus, or pus-like excreta; and the position of the patient should be such that gravitation will become an ally, and not an opponent of the surgeon, which it often does become, through his inattention to a familiar physical law.

Besides the primary and early secondary results of wounds of the larynx and trachea, there is a third class, which may be denominated, from their time of appearance, remotely secondary events: such are cicatricial contractions, displacement of parts, and fistulous openings: also vocal and respiratory disturbances

thence arise. Cicatricial shrinking of the structures which have been wounded may, according to site, lessen the laryngeal or tracheal canal. Thus the air-tube may be so narrowed, that it barely permits the passage of air sufficient for respiration; and in such cases, the breathing is labored, and for its accomplishment some voluntary effort is necessary. Such patients are trammeled in their movements, since they can only indulge in active exercise at the cost of labored respiration, or even of painful dyspnœa.

The condition of the healed parts may be such that in expiration the tube is nearly of normal calibre, yet during inspiration the covering of the opening is drawn inwards, and so narrows the passage that breathing is hampered. And when the respiration is excited from any cause, this indrawing of the cicatrized breach is so great as to painfully impede the breathing. Again, there may be a valve-like formation which develops within the air-canal, in the healing of a wound, and which, in the inspiratory or the expiratory movement, is uplifted, and partly occludes the canal. Both of these cases, in which the passage is alternately narrowed and then reopened, have been observed as the result of tracheotomy performed by the writer; such occlusive result, fortunately, rarely follows this operation; yet in a series of fifty tracheotomies done by the writer, it occurred twice, and remained as a troublesome result of the operation.

Such tracheo-laryngeal wound may not close, but leave a fistulous orifice; and this fistula, according to its position and size, will influence the voice. If the opening be underneath the vocal chords and be large, the voice will be obliterated, or reduced in tone and force; but if the opening be above the glottis, then the voice may also be weakened, and whatever may be the site of the opening, the voice will be altered in its character; and its tone may be piping, sibilant, harsh and unnatural. If the wound be laryngeal and near the glottis, in healing, whether the wound remains open or closes, the vocal chords may be forced into various mal-positions; and the cicatricial contraction in such wound may render the chords convergent or divergent, thus causing the glottis to be abnormally narrow or unusually wide; and, again, the triangular form of the opening may be converted into a rounded or other irregular outline. And such variety of outline must furnish equal diversity of phonation.

Alteration, or a loss of voice, can arise from lesion of the inferior laryngeal nerve; and if this lesion be only unilateral, the voice will be nearly altered to a falsetto tone; this the writer

has observed in two cases of unilateral recurrent lesion. In one case, the vagus, in the removal of a growth on the neck, was severed above the origin of the inferior laryngeal nerve, and the voice was reduced to a creaking falsetto; and, in a second case, the nerve was injured but not destroyed on one side, in the removal of a goitrous tumor; in this case a falsetto phonation resulted, which continued for a number of months; yet finally, the voice was restored to normal character.

In these injuries of the laryngeal vocal apparatus, writers have reported cases in which the patient could not pronounce correctly certain letters; it is probable that such irregularity was dependent on some defect of the organs of articulation, rather than of the larynx or trachea.

Remote trouble from wounds involving the air-passages may arise from adhesions, which interfere with the ascent and descent of these parts in deglutition; also, such cicatricial adherence may interfere with motions which normally occur in the use of the voice.

In case an opening remains in the air-passage in the male who has an abundant hirsute investment of the parts, the hair may grow inwards from the inverted derm, and obstruct the canal. Thus in a case seen by the writer, in which there remained an opening into the larynx, the hair penetrated the air-passage, and almost suffocated the patient. This occurred at sea, the man being a sailor, and but for his presence of mind in tearing open the wound when he was nearly suffocated, he would have died. At a later time when a similar accident seemed impending, the patient consulted the writer, who performed an operation on him for the permanent closure of the wound.

Along with the lesion of the larynx or trachea, the œsophagus may also be wounded. In the suicidal attempt to cut the throat, if the wound be high on the neck, it may penetrate the pharynx; also, in the wound which is lower, in which the trachea is wounded, occasionally the adjacent œsophagus shares in the injury. At whatever point the œsophagus be wounded, it would be indicated by the escape of mucus from the wound. Also, should the patient swallow a fluid, especially a colored one, as milk, this would escape from the wound, and be evidence that the gullet had been opened. Again, the œsophagus alone may be wounded; and this lesion may be from the inside, or from the outside. On the inside, wounds can arise from some sharp object which has been swallowed; it may be surgical, as in internal

œsophagotomy. And wounds from the outside may be from external œsophagotomy, or from some accidental cause. Such wounds, when longitudinal, gap less than when they lie transversely: and the former are more readily healed.

The simultaneous opening of the œsophagus along with the air-passage is more frequent than an isolated wound of the former. And the wound, according to Horteloup, is usually of large dimensions. Such large wound has, as symptoms, the constant escape of mucus, the exit of food which is swallowed, and retraction of the lips of the wound; and even when the section of the tube is incomplete, the lower end is retracted.

Small penetrating wounds are less dangerous; still, in the case observed by Craveilhier, in which the small blade of a knife pierced the œsophagus above the sternum, the patient died.

The œsophagus, though so narrow in calibre, may be wounded by the gunshot missile; and such wounds often leave a fistulous opening; or, should they close, the canal remains in a narrowed condition.

Besides the alimentary and air-passages which are contained in the inner cervical triangle, there are situated there the great vessels, which being wounded, the patient's life is at once lost or greatly imperiled. The simultaneous severing of the primitive carotids, done with suicidal purpose, quickly destroyed life in a case before mentioned, which occurred within the author's observation.

As vessels which may be opened here, are the carotid artery, internal jugular vein, the thyroid and vertebral arteries, and their attendant veins. The innominate artery rising abnormally high, as it does sometimes, would be endangered by a wound in the lower part of the right side of the neck. A penetrating wound may implicate a single one of the cervical vessels; and the diagnostic determination of the one injured is often a difficult problem to solve. For example, when the vertebral is wounded, the surgeon is puzzled to decide whether the resulting hæmorrhage may be from the middle or inferior thyroid, carotid or vertebral artery: especially, where the wound which reached the vessel was a narrow one, and traversed the overlying structures, obliquely.

Besides the danger of bleeding from a wound of the carotid artery or internal jugular vein, the patient's life is sometimes imperiled by the means which are employed to arrest the bleeding. The ligation of the carotid artery has interfered with the

nutrition of the brain, and, as result, the patient has remained crippled in motor power, sensation and intellect. As exceptional accident, the ligation of a wounded internal jugular vein has led to a thrombus which reached into the venous sinuses of the lesion, and caused irreparable mischief there. The aspiration of air into such venous wound has already been considered.

In forensic medical inquiry the question may arise, whether the wound on the neck was self-inflicted or was the work of an assassin's hand. In 1868 Achille Juhel announced the following as the result of his study of this matter: the assassin's cut proceeds from the patient's right toward the left side; the cut passes from below upwards, and from before, backwards. The wound is deepest in front where the knife first entered. The suicide's cut lies nearly horizontal, and is more on the left side, running towards the right. The assassin, as a rule, severs more muscles and vessels than does the suicide.

The prognostic augury of wounds of the neck is often a sinister one. The opinion of Dieffenbach, and which other surgical writers generally accept, is formulated as follows: Simple wounds of the neck which are limited to the cutaneous structures rarely heal by first intention. And when the wound is deep, even though it does not enter the air-passages, it may cause death by suppuration within the cellular tissue, and by deep burrowing of pus. The dangers here referred to are less since the advent of the antiseptic treatment of wounds.

Treatment.—The treatment will vary according as the wound is superficial or deep, and, when deep, according to the parts which are injured.

The superficial wound, if its edges are smooth, should be closed by suture; but if the margins are lacerated or irregular, they should be trimmed, and then united by proper sutures. Such closed wound may be dressed with the compound tincture of benzoin, and covered with isinglass plaster. In this way, the writer has often obtained union by first intention; yet this fortunate termination is not always arrived at: the wounded parts may suppurate, and healing be prolonged. From the writer's experience, suppurative action is less frequent if such wound be dressed after sutural closure with lint retained moist with a dilute alcoholic solution. To promote healing, all movements, as flexion and extension of the neck, should be guarded against, as much as possible, by some contentive appliance.

If the wound be deep and situated in the anterior region of

the neck, and involves, as it often does, the vessels and the air-passage, then, as immediate consequences, are gaping of the wound, bleeding from the opened veins and arteries, possible aspiration of air into the veins, and impending asphyxia from the flowing or suction of blood into the air-passages. To forestall the fatal termination to which these accidents tend, prompt thought and speedy action are demanded: action free from error, since a mistake there made can only be corrected in the next opportunity.

If vessels are opened, the first thing to be done should be to compress the wound with one hand so as to check the bleeding; and then with the other hand make pressure on the cardiac side, so as to control the arterial bleeding; or this compression can be done by an assistant who may press with one hand on the central side, and with the other, on the peripheral side of the wound. Compression thus done, will control both arterial and venous bleeding, and will prevent aspiration of air; and the bleeding being thus, for the moment, controlled, the vessels must be sought for and caught with clasp forceps, and then, one by one, carefully tied. And if there be refluent blood from the untied end, this end must likewise be tied.

Should the thyroidean structure be wounded along with the air-passage and there is general bleeding, as from a wet sponge which is squeezed, then the peril of asphyxia deserves the first care; and the best means to avert this is to quickly turn the patient so that the blood will flow outwards rather than inwards; and as soon as possible, introduce a tracheal canula into the opening in the air-passage; such canula should be large enough to fully occupy the tracheal calibre. If the wound be of such character or shape that it is unsuited for the admission of the canula, then an opening may be made lower down. And thus provision being made for respiration, the surgeon can search for the open vessels and tie them; and in the case of parenchymatous hæmorrhage, in which the vessels are indistinguishable, then circumscriptive ligation in mass may be practiced.

In the event that the patient is asphyxiated or drowned from his own blood, then the practice has been resorted to of withdrawing this blood by suction: a plan akin to that of Hueter, by which he extracted bronchial excreta. This procedure of suction was also advised by Roux; but, though rational, it does not appear to have often been resorted to. Such aspiration, or, better named, expiration, may be done by means of a catheter

constructed of vulcanized rubber, to which the suction end of a rubber syringe is attached; or, instead of the syringe, a compressible elastic bag may be attached, and the blood or other material thus withdrawn.

A fragment of cartilage has been detached and inspired into the air-canal, and obstructed the breathing; such fragment might be extracted with a long pair of forceps. Or the fragment might be in the shape of a pedunculated valve; and this valve during inspiration, could be drawn inwards so as to obstruct breathing. In such a case, a canula should be introduced through the wound, or underneath it.

The deep gaping wound of the air-canal has been the matter of much contentious controversy among surgeons. Shall such wounds be left open, or closed by suture?

The older surgeons, chief among whom is Paré, completely closed such wounds by suture. He treated three cases of cut-throat by complete sutural closure, and of the number but one lived; and so little personal credit did the pious surgeon assume to himself, that concerning his work, he wrote the famous sentence which stands over the speaker's rostrum in the École de Médecine, in Paris, "*I treated him, but God cured him.*" The old Huguenot showed a degree of modest humility now seldom seen. The boastful manner in which the surgical feats of to-day are sometimes heralded to the world, is in ill accord with the self-abnegation of Ambroise Paré. In more recent times Sabatier and Dieffenbach have espoused the opposite plan of treatment, viz., of non-suture of such wounds, owing to the difficulty of getting immediate union. As reasons for the difficulty of obtaining union after such sutural closure, Dieffenbach offers the following: the wound is composed of tissues which are complex and differ in character; and there is unusual laxity of the cellular tissue; and, as a result of such conditions, it is difficult to obtain complete coaptation of the edges of the wound, which are often infolded: and also, difficult to immobilize the parts. Bertherand, who has studied these wounds, thinks the wound should be suturally united when the wounded surfaces are smooth and regular; and in such condition of surface, union will be gotten, provided the sutures are properly introduced. If the sutures are only superficially inserted in such a case, there may be failure of complete union. If the closure is merely superficial, the wound will reopen. To prevent this, the sutures should be introduced deeply; such suture, including the skin, muscles and fasciæ, so

immobilizes the parts that union is not interfered with. The one wounded face must be brought accurately against the opposite one, and the two then sutured together.

Such evenly wounded surfaces rarely occur; when seen, the treatment of Bertherand might be safely pursued; but in ordinary cases, in which the surfaces are ragged, lacerated, or in some way irregular, the author advises that the closure of the wound should be incomplete; the sutures should be introduced only at the ends of the gaping breach, while the middle, or immediate portion, should remain open. Thus an outlet will remain through which excreta and disintegrating tissue can escape externally; for should such a wound be wholly closed, after the skin unites, as it usually does, the pent-up excreta would pass into the air-canal, and descend to the lungs.

Gosselin, Nélaton and others, within recent times, have practiced the introduction of deep sutures, in which the breach in the cartilage of the trachea or larynx is closed by sutures; and this, from its site, might be named the cartilaginous suture. The outer part of the wound is permitted to remain unclosed, that is, the soft parts are left unsutured. And in case the wound be in the hyothyroidean membrane, or in the cricothyroidean membrane, deep closure may be done, in which the cartilage is pierced by the suture only on one side. In a case cited by Horteloup, the suture passed through the upper border of the thyroid cartilage and included, on the other side, the hyoid bone.

According to South, the plan to be pursued must conform to the freedom or difficulty of respiration which occurs when the wound is closed; for, sometimes, when the wound is closed, the patient finds it difficult to breathe; and, in such a case, the plan of non-closure must be pursued, which will permit a part of the inspired air to enter through the wound. But if the breathing is unimpeded when the union is complete, then South would totally close the wound.

Other surgeons, rejecting the suture entirely, have closed the wound by adhesive strips, which may be prepared from rubber adhesive plaster; or isinglass plaster may be used, which is made yet more adherent, and impermeable to water, by being covered with collodion. Though not adopting this plan, the writer thinks it might be made an adjuvant to the suture; namely, after the wound, in which the surfaces are uneven, has been partially sutured, the closure might be completed by means of the adhesive strips.

Whether closure or incomplete closure of the wound be done, an important aid in the treatment is to counteract, as far as practicable, the movements of the head and neck. A simple plan to do this is to fasten a cap on the head; and from this straps descend, which are to be fastened to the shoulders, and also to a circular band around the waist. The same may be done by strips of adhesive plaster, or by a gypsum bandage. The appliance of fixation by a gypsum bandage, though unsightly and heavy, is more trustworthy than the other plans mentioned. For this purpose, in a manner similar to that mentioned in the treatment of torticollis, let the head, except the face, be covered with a cap, and the shoulders and armpits be enveloped in cotton wadding; and about the parts thus protected, let the gypsum-covered bandage be carried and so placed as to leave an opening for dressing the wound; and as this is being done, the head must be so inclined that all tension should be removed from the wounded parts; and this position must be continued until the hardened plaster will maintain the uplifted head in permanent fixation.

As additional precaution to be observed, the movements of deglutition should be avoided as far as possible; and this may be done by passing aliment in fluid form, through an œsophageal tube; and should there be a large wound in the œsophagus, for some time the tube of alimentation may continue downwards through the wounded portion to the stomach. If this cannot be done through the mouth, the food may be carried through a tube which is introduced through the inferior meatus of the nose, pharynx and entire œsophagus. Permanent retention of the tube in place, rather than its occasional introduction, is advised; for, in the latter way, the healing wound may be disturbed, or reopened.

In the cicatrization of wounds which open into the air-canal and œsophagus, there is often a tendency to strictural contraction. Such narrowing may be counteracted by the occasional introduction of a sound into the air-passage, or the œsophagus. In the event of the wound having healed, and stenosis remains, the latter may be relieved by the plan of Dolbeau and others, in which a narrow-bladed knife is passed into the contracted canal, and an incision made by which dilatation can be done and maintained by means of sounds introduced daily, or once in two days. A recent authority of distinction in this work is Schrötter, who has invented a series of sounds by which narrowing in the

larynx can be overcome. As aid in this work, the mucous membrane of the parts may be rendered insensible by means of cocaine.

Instead of stenosis the wounded œsophagus may become the site of dilatation at or above the site of the lesion; a species of diverticulum is thus formed, which may be relieved by excision of a section of the pouch.

Emphysematous infiltration of air in the subcutaneous and cellular tissue seldom occurs to an extent that demands attention; should it do so, the treatment of Hennen may be pursued, viz., to make numerous punctures into the emphysematous structure, and then make compression so as to express the air through the openings.

In some wounds of the air-passage there may arise a harassing cough, caused by inflammatory action within the trachea or larynx. Formerly, to combat this inflammation, free bleeding was resorted to; this treatment has properly become nearly obsolete, and if practiced, it should only be done in the very plethoric subject. If there be such indication, the abstraction of blood might be done locally by leeches. The functional irritation can generally be alleviated by the administration of opium or hyoscyamus. Should the cough and spasmodic movement of the parts depend on the retention of muco-purulent matter, which, not having exit, causes these troubles, then relief could scarcely be expected from the means just mentioned, and the better course is to open the wound, so that these materials may have more direct escape. Later, when the excreta become less viscid and less in amount, the wound can be reclosed.

Secondary hæmorrhage, occurring early, or at a later period, has sometimes supervened, and given much trouble; indeed, death has thus occurred in cases which promised a recovery; and this has happened in cases which had been closed, as well as in those left open. To guard against this, diligent search for, and accurate ligation of, all vessels opened, should be done at the first dressing of the wound; for such work done after the parts have lost their natural features is one of the most difficult of surgical tasks: so difficult indeed, in some cases, that the surgeon has sought refuge in the dubious expedient of the tampon. Only in the case of parenchymatous bleeding, in which it is impossible to secure the vessels, should one resort to plugging the wound. The material for such tampon may be of lint or gauze moistened with alcohol, camphor, or other asepticizing agent. Sponge has

been used for the same purpose; and, as a mechanical hæmostatic, it is one of the best which can be selected.

In case there remains a fistula into the air-canal or œsophagus, after the healing of a wound which implicated these canals, closure of the same may be attempted by a plastic procedure, according to one of the following plans:—

1. If the fistula be small and deep, and the parts adjacent easily movable, then closure may be accomplished by carefully and thoroughly excising the wall of the fistula, and then closing by one or more deep metallic sutures, which should not be too tightly closed. If no suppuration occurs, the sutures should remain in site for a week, and, after their removal, the closure should be maintained by adhesive plaster.

2. If the fistula be deep or shallow and the inner portion be surrounded by immovable cartilage, then the tissues which inclose the cartilage must be opened and dissected from the cartilage, and then closure be made with metallic sutures. Upon the external dressing, some pressure should be made so as to force the occluding soft parts into the opening, and thus complete closure is insured.

3. Should closure not be feasible by one of the plans mentioned, then, after trimming the walls of the fistulous opening, a pedunculated flap may be uplifted from the side where it can be best spared, and twisted and carried into the opening, and retained there by sutures.

4. Balassa advised, as a plan of closure, to form a flap, which, when put in position, will leave the epidermal surface turned inwards. An objection to this plan is that the flap would contain hair-bulbs, whence hair developing, would be seriously out of place, and certainly disturb respiration.

In the fistula of small calibre, such as is usually met with as the result of wounds opening the larynx or trachea, closure is commonly practicable by the first method; but should there be some loss of cartilaginous structure resulting in a larger opening of the air-canal, then it would be necessary to employ the third method; and then, if the breach were a large one, some bronchoplastic, or rather chondroplastic, procedure would be required; for if merely a bridge of soft parts were stretched across the breach, then such movable operculum would sink during inspiration and interfere with breathing. To obviate this, the expedient might be resorted to of shifting a small section of the cartilaginous wall so as to support and give fixity to the replacing

bridge. Such sustaining arch might be devised by shifting a part or whole of a tracheal ring.

Roux, to close such fistulæ, dissects off the lining membrane and thrusts this inwards; then he closes the outer opening with deep sutures. He next forms a canal near by, of which the inner end lies in the inner part of the fistula; thus proceeding, the outer part of the old fistula is closed, after which the new one will close spontaneously.

Wounds of the air-passages in which there is no breach of the derm will now be considered; this list contains fracture of the hyoid bone and of the thyroid and cricoid cartilages, and, finally, hanging.

Fracture of the Hyoid Bone.—The os hyoides may be broken by external violence acting directly; it may also occur from muscular action.

The fracture is usually limited to one or more of the cornua. As exceptions to this are the gunshot wounds, from which the bone may be broken in any part of its body or processes.

South states that he had only observed this fracture in persons who had been executed by hanging. Casper, whose official duty it was to examine the dead bodies of those who had died by hanging (of suicidal subjects as well as of those who had been executed), says that in no case did he find the hyoid bone broken. And Mackmurdo, who was surgeon to the famous Newgate prison in London, in which occurred numerous executions, found the hyoid bone broken in but one case.

In the hanging of Wirz, executed in 1868, for his inhuman treatment of Union prisoners, the executioner, in his work, outdid that done at Newgate, viz., the bone was broken at six points: whether by accident or otherwise is best known to the hangman. A strong hand grasping the upper part of the neck in front can fracture the hyoid bone, and this may be verified by experimentations on the cadaver. It has been seen by Murchison, Dieffenbach, and others, as the result of criminal attempt at strangling. Harley and Wood saw the bone broken from falls, in which the point of impact of violence was on the bone. And, as a rare occurrence, the bone has been broken from muscular action, in which, the subject falling backwards, there occurred such violent contractions of the muscles of hyoidean attachment as to break the bone.

This fracture is followed by interference with the several movements or actions in which the bone is directly or indirectly

concerned: thus there is trouble in speaking, swallowing, and other movements of the tongue. There is swelling, which may reach into the larynx and cause labored breathing. If the fragments are in contact, pressure over them elicits crepitation; and usually there is deviation from the normal form of the bone; and, if the violence has been great, a fragment may be driven through the pharyngeal mucous membrane, and bleeding result. In one case reported a fragment was driven between the epiglottis and the glottis, and caused death.

Treatment.—Recovery with perfect restoration to form is scarcely to be hoped for, since some of the indispensable functions of the pharynx will necessitate occasional movements which will disturb the coaptated fragments.

Nevertheless, restitution to normal form must be attempted by external and internal manipulation. Should the broken ends tend to jut outwards, correction may be made by a small compress held in place by adhesive strips; and should the ends fall inwards, as suggestion for trial, this compression may be made near the end of the great cornu. Should the displaced ends defy simpler means of rectification, then tracheotomy being premised, the throat may be plugged with lint, and pressure on the outside be maintained by compresses fixed by adhesive plaster; and, meantime, liquid food may be given through an œsophageal tube, which has been introduced through the inferior nasal meatus. Most cases, however, may be treated in a very simple way, viz., to restore the broken parts to normal site, nourish with liquid food, which may be swallowed or conducted through a tube, with injunction to maintain the parts at rest as nearly as possible.

Fracture of the Larynx.—The larynx, from its more exposed position, is oftener fractured than the hyoid bone, and the causal agency may be any kind of outward violence acting on the part, viz., hanging, great compression, a blow, and falling against a hard object. Casper never saw the larynx broken by hanging; still cases thus arising have been reported. Morgagni, an accurate observer, saw such fracture from hanging. To decide this matter, experimentally, Haumeder suspended, as in the act of hanging, twenty-six cadavers, with the following result: the hyoid bone was broken in twelve cases. The cornua of the thyroid cartilage were fractured in but six cases; and in one single case, in which the cord was placed beneath the thyroid cartilage, the cricoid cartilage was broken.

Cavasse has likewise done some experimental work in this field; he found that from a blow on the front of the larynx there can be produced a median fracture or a lateral one; and he considers a fracture in the median line more apt to unite than one at the side. The cricoid cartilage was only fractured at the side. The cricothyroidean membrane was often torn, but that of the interior of the larynx was found intact. In a case in which the cadaver was hanged by a rope, the larynx was fractured; in another it was uninjured. In violently grasping the throat, the larynx could be broken, provided the pressure was at the upper part. Maclean and others have observed laryngeal fracture which had arisen from falls against some hard object, as the edge of a box or a table. In twenty-nine cases collected by Hunt, he found that the fracture occurred at an age prior to ossification of the cartilage.

The most usual fracture of the larynx is that in which the superior cornua of the thyroid cartilage are broken; and this arises as follows: in pressure, such as is caused by hanging, the cartilage is forced backwards, the wings are separated by the vertebral column, and the upper horns, being forced against the column, are broken. And at the same time, the thyrohyoidean membrane being stretched, may tear off one or both horns of the os hyoides.

Symptoms.—Cavasse observed the following: trouble in breathing, aphonia, cyanosis, swelling, and ecchymosis of blood in some cases. There is expectoration of blood-stained, foamy mucus.

Palpation of the laryngeal region detects crepitus or undue mobility of the parts composing the larynx. Swallowing is impossible or attended with great trouble. The carotids beat violently, and the face is turgid, or perhaps pale from compression of the carotids.

Laryngeal fracture is exceedingly dangerous. Hunt found that death occurred in seventeen patients in a series of twenty-nine who had fractured larynx; and the cases invariably died in whom the mucous membrane had been wounded and tracheotomy was not performed. Death is not unfrequent from partial or complete closure of the laryngeal canal; in some recorded cases death immediately followed the fracture.

Treatment.—In laryngeal fracture to guard against asphyxia from sudden occlusion of the air-canal, tracheotomy should be performed at once, and a canula worn until the broken parts have reunited. If the ala be broken, and it be impossible to

otherwise maintain the parts at rest, then a resort may be had to metallic ligature, fine silver wire being used for the purpose. As a rule, it is enough to bring the parts into proper site, and enjoin the maintenance of rest. Meantime the calibre of the laryngeal canal should be maintained patent by means of the occasional introduction of a sound, which may be passed through the mouth from above; or the sound can enter the tracheal opening if the latter has been made for tracheotomy; thus doing, fragments which have been displaced inwards can be forced outwards, and satisfactory calibre preserved.

Strangulation, Hanging.—The neck is the site of parts of which the functional activity is essential to life, viz., vessels through which blood passes to, and returns from, the head; the air-canal through which air reaches to and returns from the lungs; and nerves which are concerned in respiration. The accessibility and exposed situation of these structures render the neck the chosen point towards which the hand of Penal Justice, as well as that of the assassin and the suicide, are directed in their work of abruptly ending life. The means used to accomplish this fatal purpose are, in the main, strangulation and hanging. Though the greater portion of this subject falls for consideration to the medical jurist, yet it claims the attention of the surgeon sufficiently often to be entitled to a chapter in a work upon surgery.

Laugier, who finds a marked difference between violence done by strangulation and by hanging, defines strangulation to be "an act of violence consisting in constriction exercised directly on the front, or on the entire circumference of the neck; and which has the effect of so compressing the vessels and the air-canal as to cause death through the sudden suppression of the encephalic circulation and the respiration." The violence may be done with the hands, or by means of a cord; that done with the hands is wholly homicidal; that with a cord may be homicidal or suicidal; and in each case, the work may be complete or incomplete; if done with the hand, one or both hands may be used; or if a cord be used, this may vary in size, and be applied in different ways.

The amount of violence necessary to cause death through strangulation done by the hands, will vary with the subject. Thus a small force will suffice in the aged subject, in the one weakened by disease, and in the infant. Likewise, if the neck be small or emaciated, so that the hands can grasp it in its entirety, death can be caused by a much smaller degree of force than when

the subject is strong, or has a well-developed neck. The compression may be done with both hands, when the neck rests behind against some hard object; and the pressure may be backwards and laterally: or it may be directly backwards. Again, it may be made with one hand in front, and while the other supports the nucha. Or, instead of backward compression, the force may be directed upwards, so that the tongue being forced against the posterior wall of the pharynx, death results from occlusion of the larynx, and may be caused thus by a small amount of force.

Manual compression acts mainly on the larynx; the carotid arteries, which share in the violence done by the rope, often escape manual violence. Yet a singular exception to this was observed by Laennec, in which the larynx escaped and the carotids only were compressed.

In all cases in which the violence is fatal, the result is accomplished speedily in subjects unable to resist; death is less rapid in persons who are able to resist.

If the violence be done by a partially or wholly encircling agent, this may be a large or small cord, a handkerchief, or a portion of clothing, or a sheet. Ingenuity stimulated by the fury of purpose which animates either the assailant or the suicide, has evinced marvelous invention.

Faure and Hoffman have experimented in this field; and they found that the fatal phenomena, whether the strangulation be done suddenly or slowly, consist first in the induction of unconsciousness, which deprives the victim of the power of resistance; and secondly, in the occlusion, partial or complete, of the air-passage, which completes the destruction of life. In regard to death caused by strangulation with a cord, it must be stated that opinion varies as to whether death results more from obstruction of the vessels, or of the air-passage; each opinion has as active partisans in its behalf, as has the subject of death from chloroform, whether the fatal work be mainly due to action on the heart, or on the lungs. In whatever way death by strangulation arises, local traces of violence can be found on the neck, and symptomatic phenomena remain on other parts of the body, the leading ones of which are the following.

The face of the strangled subject is usually found swollen and purplish in hue; and the tinting is irregular, or mottled, or marbled in disposition. Yet in case of death having been rapid, the face may be pale or colorless. The eyes are commonly open, prominent and congested, and the pupils dilated. The tongue,

swollen and black, may be found between the teeth, or lying behind them. A fluid containing blood and foamy in character escapes from the mouth; and blood has also been seen escaping from the ears. According to Tardieu, conditions found most frequent are multiple ecchymoses found beneath the ocular and palpebral conjunctiva; likewise in the skin of the face and neck. Contusions or marks of great violence from the efforts of the assailant may be found on other parts of the body. Special marks of violent force are found on the neck and throat, which, in form and location, furnish evidence of an assailant's hand. Prints of finger nails will be found; and such being usually made with the right hand, they are chiefly on the left side of the subject's neck.

If the strangulation has been done with a rope or cord, there will remain some compression of the latter in the cervical integument; certain professionals in the hideous work of strangling have so perfected their art, in the use of a broad band, that scarcely any outward mark remains to indicate the violent work which has been done. In the use of the ordinary rope, a mark corresponding to its breadth or narrowness is left on the surface. Such mark made by the strangler's cord usually passes horizontally over the larynx, or the trachea; but the hangman's cord is placed obliquely, and is usually situated above the larynx, and between it and the hyoid bone. The hangman's cord leaves a deeper impression than does that of the strangler; for in the former case, the weight of the body and the usually longer continuance of the violence both tend to deepen the furrows on the victim's neck. The depression of the hangman's rope diminishes from before backwards; that of the strangler diminishes from behind forwards.

The subcutaneous structures may be the site of much more violence than is indicated by lesions visible on the surface; the former may be severely bruised or torn, while the skin is but slightly injured. Ecchymosed blood may be discovered in the intermuscular spaces, as low down as the sternum. The hyoid bone, larynx and trachea have been the site of fracture from manual strangulation: no infrequent occurrence, according to Henocque. Within the air-passage there is found ecchymosis in the mucous membrane; and according to Tardieu, an invariable accompaniment of such strangulation is a sanguinolent mucus studded with minute bubbles, lining the larger air-passages.

The lungs present variable appearances; they may be nearly

normal; or congestion may be found; and most frequently, superficial air-vesicles are ruptured, and some emphysematous extravasation is present; and from this condition a crackling sound is caused when pressure is made on the part.

In the encephalon, marks of congestion are present, or slight apoplectiform rupture is found.

In brief, the changes which are found in the body after death from strangulation are such as should arise from a sudden obstruction of circulation of blood in the cervical vessels, and an arrest of the passage of air through the laryngo-tracheal canal.

In case the victim has survived the force of the assailant, traces of the violence done will remain on the body of the subject. And as there has been a prolonged struggle, in which the victim successfully resisted the attack, he will have marks of the same on other parts of the body, besides the usual red points, or abrasions, about the neck. In one case, the ears of the woman who survived, had been torn nearly from the head. It has also been remarked that such survivors often present more extensive ecchymoses on the neck than do those who have succumbed to the assault: for in the former, the blood has had time to suffuse itself within, or underneath the skin. As functional symptoms there are present the following: bloody foam is escaping from the mouth and nose; the voice is altered, broken and sometimes extinguished, and deglutition is interfered with: and these conditions may continue for a few weeks. And from the contusion of the cervical structures, suppuration may arise.

Again, the assault may only be of momentary duration, and cause syncope, in which the subject becomes quite unconscious for a short time; or the unconsciousness may continue longer, and be accompanied by convulsive movement of the muscles.

Strangulation, ordinarily the result of a criminal attack, may arise from causes purely accidental; and in the latter case, the position and surroundings of the dead body, would aid in the determination of the mode of death. If the work be that of a criminal, the number, arrangement and deviation of the lesional marks on the neck, indicate the relative position of the assailed and assailant. If a right hand has done the violence, there will be found the imprint of four fingers on the left side of the neck, and that of the thumb on the right side; or the reverse, if the assailant be left-handed.

Strangulation may be counterfeited: for example, it may be

done on one already dead. Yet the conditions found would differ from those of genuine strangulation in this, that in the former, the spots of ecchymosis are slight or wanting; or in the event that the work of fraud has been done so soon after death that ecchymosis may result, yet there will arise no swelling of the face, nor cyanosis of the skin: for these only arise from violence done during life. And in such post-mortem strangulation, a necropsy will find none of the appearances which have been mentioned as present in cases in which the strangulation was the fatal agency.

In some cases, strangulation has been done by some one upon himself for the object of visiting the penalty on some one else, on whom would rest the suspicion of having done the act; and such work is so cunningly planned, that the expert has difficulty in disentangling the plot; and especially if the planner has transcended his purpose, in actually killing himself. The impostor in such case, less wise than the expert who afterwards investigates his work, often leaves out a link in the chain of evidence which he forges against the would-be assailant. A case akin to this, was that of the colored student at the military school of the United States a few years ago. He was found tied with his ears cut off; and whether this mutilation was self-inflicted, or was done by his persecutors as he claimed, was a problem which remained unsolved by the commission of inquisition; his friends believed that he was the victim of a brutal outrage; his enemies declared him an impostor, and that his deception was justly paid for by the forfeiture of his ears.

Hanging.—Hanging is defined by Laugier to be an act in which a rope-like cord, which is attached to a fixed point, is passed around the neck, when the body being abandoned to its own weight, traction is caused, which destroys life, through either the arrest of the circulation in the head, or by the closure of the air-passages; or death may arise from both these agencies. Hanging differs from strangulation only in the direction or manner in which the violence acts; the weight of the body becomes the agency of death. This act is oftenest that of the suicide; of seventy-nine thousand five hundred fifty-seven deaths self-caused collected by Brouardel, nearly one-half were caused by hanging or strangulation; and nearly thirty thousand of this number were men.

The subjective phenomena of hanging have been learned from the experience of those in whom the fatal purpose failed of

completion; and who recovering were able to narrate their sensations. And Fleischmann, a zealous student of the subject, studied his own sensations after suspension for a brief time; and the following has been reported by Laugier concerning this matter: The instant the body is suspended and abandoned to its own weight, the face reddens and the head is hot, and there is a general sensation of heat through the entire body; there is a hissing and buzzing in the ears, sometimes amounting to loud noises, like some loud music; the legs feel exceedingly heavy; finally, all sensation vanishes. In some cases, the first phenomenon is total syncope, in which consciousness is lost at once. The popular idea propagated by a few writers, that in the first moments of suspension the subject experiences voluptuous sensations, is incorrect; the seminal escape sometimes seen, occurs when the patient is in an unconscious condition.

The loss of consciousness which takes place in the first period of hanging is soon succeeded by a convulsive stage, in which the muscles of the face and eyes are distorted, and the limbs are spasmodically moved. The suspended one striking his feet against the floor or wall has apprised those near by of his suicidal act.

Hoffmann and Amussat have studied the effect on the cervical vessels of hanging; and they have found that the internal and middle tunics of the carotids are often lacerated. They have likewise discovered that when the loop of the cord is placed near the chin, the effect is to arrest the flow of the blood through the carotid arteries, even when the body is but imperfectly suspended. Hoffmann states that when the rope is above the larynx, that is between the larynx and hyoid bone (its usual site in hanging), the larynx is not closed by compression on it, but through the root of the tongue being forced against the posterior wall of the pharynx so as to close the passage. This he found in section of frozen cadavers. Brouardel in experimenting in this field, finds that suspension can be done in such a manner that blood may continue to flow through one carotid while the other is closed.

Hoffmann has also directed attention to the effect of the compression of the rope on the nerves of respiration which lie in the neck; he probably overestimates this action: since the pressure on the vessels and air-passages is sufficient to destroy life independently of any action on the adjacent nerves.

In case of fracture of one or more of the upper cervical verte-

bræ, there may be injury done to the medulla oblongata, which will, at once, destroy life; such cases are rare, yet when they happen, death occurs independently of any obstruction of the air-canal or blood-vessels.

Sudden death has also been seen as the result of syncope from the instant induction of cerebral anæmia through closure of the vessels; the face of the cadaver in such cases presents a waxen discoloration. On the contrary, if the cord is so placed as to close one carotid and permit the passage of some blood through the other artery, and at the same time, the jugular veins do not allow the return of the blood, then death will occur slowly, through congestive apoplexy; in such subjects, the face will be cyanosed or purple. Such cases are those in which resuscitation is possible; while in those in whom death is instantaneous, according to Brouardel, life cannot be recalled. Notwithstanding this eminent authority, an attempt should be made to resuscitate in all cases; for failure cannot make the unfortunate subject's condition any worse.

In a small number of cases observed, the violence done has not destroyed life at once; the patient found suspended was discovered before life was extinct, and an attempt to resuscitate has been partly successful; yet after some hours, or even days, death sometimes ensued. In one such subject who lived twenty-four hours, the body never became warm. The necropsy revealed no other lesion than an intense encephalic congestion. And in another case the attempt at suicide was not immediately successful. The skin of the face was red and swollen; respiration and circulation were restored. Later, there appeared hemiplegia, also muscular contracture; and finally, the patient returned to consciousness and was able to speak rationally; on the sixth day he died, with symptoms of pronounced meningo-encephalitis.

From those who have recovered after temporary hanging some knowledge has been derived; the sensations remembered were those which have been mentioned above; and in one who recovered, the subsequent symptoms were loss of memory, voice nearly extinguished, incontinence of urine and paralysis of the rectum, sharp pains and convulsive movements of the limbs; likewise, cough and bronchial catarrh with dyspnœa. In another case there remained pains in the head, giddiness and trouble of swallowing.

The patient in one case was rescued after being suspended seven minutes. Taylor thinks recall to life is possible after

hanging five minutes. It is clear that the time is subject to variation, dependent on the manner in which the rope has been adjusted about the neck, and also, whether there has been a fall along with the suspension. A fall of the body through a few feet after the cord has been fixed around the neck, becomes the more important factor in the fatal work. This has been verified in the work of judicial hanging: the long space through which the body has dropped has frequently caused the cord to make a deep cut in the structures included; and in one case known to the writer, the work was so effectually done that the head was severed from the body in the fall.

General facts of cardinal importance, to which reference has been made, are that if the suspension has been brief, and the death immediate, the face is pale and of natural appearance, the eyes half closed and the lips are discolored without swelling; but where the dying has been slow, then the face will be found cyanosed and swollen.

Death has often occurred when the body had not been totally suspended; life has been extinguished where the body was partly supported by the feet; also in cases of half reclination, either in the supine or prone position.

Epicharis, one of the conspirators against Nero, after being terribly tortured to extort her secret, destroyed what life remained in her by sitting in a chair and passing her head through a loop of her girdle, and attaching the latter to the top of her chair. "Thus dying, she put to shame many men who hastened to betray their fellow accomplices." (Tacitus.)

The impression made by the suspending cord has been carefully studied; and this may be slight; it may also be absent, or it may be distinctly formed; and in certain circumstances the cord may cut or tear the structures of the neck.

The impression has been so slight that it was not discoverable; thus a broad or elastic band may leave no trace of its action; yet usually, there may be detected some red discoloration of the derm; however, the interposition of a dense beard, or a thick cravat, or a layer of clothing, may render the impression of the cord invisible. These cases are unusual, and the rule is, that the rope or suspending agent leaves a clearly discernible furrow on the neck, of which the site, direction, form and depth have been carefully studied.

In most cases this cord-mark passes transversely over the front of the neck, between the larynx and the chin. In a col-

lection of one hundred fifty-six recorded cases, the furrow was found in one hundred twenty-seven cases above the larynx, and oftenest between the larynx and the hyoid bone; in twenty-six cases the mark was on the larynx, and in six, it was below the larynx. And the furrow was always lower down when the subject was in oblique suspension.

The furrow commencing at the hyoid region ascends upwards and backwards behind the mastoid processes to some point on the nucha, where the ends of the cord meet in the closing knot; and if the knot is near the median line, behind, then the figure of the imprint will be that of an ellipse, which opens somewhat above and behind. The figure will be less regular, if the knot is at the side of the nucha. And if the knot be near the ear, then the action of the cord will be oblique and irregular, and the compression may thus occlude one carotid, and permit the passage of some blood through the other vessel.

The form, breadth and depth of the furrow depend on the form of the cord. A cord passed twice around the neck may produce a double impression; and these may be adjacent, or have an irregular interval between them; or if a hard broad band, as one of leather, be used, then its two edges may leave impressions, which are parallel.

The breadth of the furrow is generally less than that of the constricting cord; and the depth is directly proportional to the thinness of the cord and the time that the suspension is continued. The greater the development of the fatty couch is, the deeper will be the furrow produced by the cord. If the cord have knots or other irregularities, these will be represented in the furrow.

As to the color of the imprint caused by the constricting agent, this depends on its depth, and whether the bottom of the sulcus is soft, or dry and parchment-like. If there be no depression, the skin may remain of natural tint. But when there is left a decided furrow which is soft, this will be of a pale white color: in fact, whiter than the parts adjacent. Instead of a white hue this may be a dirty blue, due to a thinning of the skin, which permits the color of the subjacent muscles to be perceptible, or the attenuated and condensed skin may assume a bluish tint.

The skin lining the furrow may be dry and parchment-like, and then the color may be an orange-yellow, or a reddish-brown. Again the dried compressed skin may have a shining or pearly hue. The borders of the furrow are slightly elevated, and of a violet hue, dependent on a superficial congestion of the derm.

If the air be very moist, this desiccation does not take place; and for its full appearance, the furrow must be exposed some time to the dry atmosphere.

To obtain the discolored parchment-like furrow, the following preliminary conditions are needed: suspension with a cord that will produce a depression; the cord must maintain pressure enough to force the blood from the walls of the furrow; and after the removal of the cord, the part must be exposed some time to a dry air.

Hoffmann has examined a great number of bodies of young and vigorous men who had died by hanging, and in no one did he find penile erection. In case, however, the body had remained hanging for a considerable time after death, then there was found genital turgescence, which he referred to hypostatic congestion. Tardieu is not so positive on this point; he admits the possibility of genital erection, as a reflex act awakened by the violence done to the upper part of the spinal cord. And admitting the possibility of such reflex action, which, as stated, has been denied by most observers, there are two species of genital turgescence which may follow hanging, the one which is found immediately after death: and that which occurs later, and is purely a physical condition, the result of the position of the body; and in case the former occurred, the latter might follow it some time afterwards, provided the body remained in suspension.

Luxation or fracture of the upper cervical vertebræ was not seen by Casper, Tardieu and Hoffmann in cases of suicidal hanging; it was only seen in the neck of the hanged criminal; and occurred oftener in former times than at present, when the work is done with more complaisance to the victim.

Besides the violence done by the suspension, the body of the subject may present other marks of violence; thus there may be found contusions of surface, costal fracture and other lesions which arose during the struggle in which the victim was overpowered. And marks of wounds received some days prior to the hanging may exist. Such injury will have characteristics which will indicate its age.

The body being found hanging, it is often a question of importance in forensic medicine to determine how long the body had been suspended; and this question is still more important to those on whom devolve the task of resuscitation. If the body be yet warm, and the suspension has been incomplete, or there has been no fall, then an attempt is to be made to recall the victim,

provided he be not in the list of those whose life has been forfeited through crime; the death of the latter being decreed by the law, he is denied the privilege which the merciful hand of medicine extends to him who is the victim of suicidal or homicidal violence. A consideration of the means of restoration herewith follows.

Artificial Respiration.—The principal means of resuscitation of the subject which has been the victim of strangulation or suspension, is that of artificial respiration. And this is also resorted to in those who are seemingly dead from immersion in water or semi-liquid materials; or whose air-passages have been occluded by earth, sand or other means; or where breathing has been nearly or quite arrested by a narcotic or anæsthetic agent, or an asphyxiating gas; in all such cases, it is possible to relight or reanimate the expiring spark of life by resorting to artificial respiration: by which is meant the alternate introduction of air into, and its expulsion from, the lungs.

Resuscitation of the subject who is apparently dead from any of these causes may be attempted by several methods. If life be really extinct, it will be indicated by certain signs, among which may be enumerated rigor mortis and loss of the contractile power of the pupil. If the cornea of the dead subject be pressed on, the pupil will be displaced, and its circular form converted into an irregular one, which remains. And finally, if signs of decomposition are present, these denote that the undertaker's duties rather than those of the resuscitator, are demanded: for then, in the words of the great Dramatist, medicine "knows not where is that Promethean heat that can this light relume."

As resuscitating methods, the following may be named: (1) insufflation, or blowing the air into the lungs; (2) aspiration, in which the thoracic cavity is enlarged by some procedure so that the air spontaneously enters the air-passages, and then by reversing the procedure, the air is expelled; (3) intermittent pressure on the cardiac region; (4) rhythmical extraction and retraction of the tongue; (5) electrical excitation of the respiratory nerves.

Insufflation.—Of all the means employed to restore the inanimate to life, insufflation is probably the oldest. Traces of this method are manifest in the Biblical account of Elisha recalling to life the widow's son. Insufflation may be done orally, in which air is blown from mouth to mouth, the nostrils, meantime, being occluded; or it may be done with a tube which is passed through the mouth into the larynx, or into the mouth simply, or into one

nostril, the remainder of the nose and mouth being closed. An instrument which may be carried into the larynx is a common male catheter, either of silver, or of gutta percha. This is a good means of reviving the still-born infant, which the author, on several occasions, has employed successfully. A gutta percha catheter of smallest calibre should be used. To do this work properly, some preliminary practice must be had on the cadaver; the index must be trained to find the opening into the glottis, which is distinguished by its hard, cartilaginous borders. The end of the left index being fixed in this opening, the catheter can be carried along the palmar side of the bent finger, and readily introduced into the air-passage. It should be carried into the upper part of the trachea, and then external compression being made so as to close the trachea around it, the air, with moderate force, is to be blown into the lungs. If this work be properly executed, the chest will dilate as in normal inspiration, and when this has reached average expansion, the walls must be compressed to expel the air; thus inspiration and expiration are represented, and should be repeated twenty times in the minute. The rigidity of the walls of the trachea and larynx of the adult, as well as the longer distance which must be traversed to reach the part, and also the contracture of the muscles which close the lower jaw, render the introduction and use of such a tube difficult in the adult or aged subject. And, as an easier way of doing the work, Marchand advises to pass a tube into one nostril, and then closing the other and the mouth, the air can be blown into the nostril and can thus be made to descend to the lungs. As a tube which is usually at hand, and can easily be used, is the common pipe-stem. Marchand commends this means of insufflation above all others; and he pronounces it superior to all other methods of artificial respiration. The air from an elastic balloon can be utilized; or the operator can force the air from his own chest into that of the patient; and if the operator takes pains to forcibly expire and then deeply inspire, the air used will be sufficiently free from carbonic acid.

Objection to insufflation is that the air may pass through the œsophagus to the stomach, and filling this, the movement of the diaphragm is interfered with. This is true, especially if the air be blown from mouth into mouth; the writer has seen the stomach of a new-born child greatly distended in this way. Another objection is that air thus violently forced into the lungs may rupture the pulmonary tissue: and that, after resuscitation in this

way, there may remain an emphysematous condition of the lungs. Observation and experimentation on this subject are discordant. Thus, Dumeril and Magendie, appointed a commission to report on this method, say that they have seen fatal laceration of the lungs in animals thus operated on; and they have seen similar lesions in cadavers subjected to such insufflation. They admit, however, that insufflation in the apparently dead subject, and in the living robust one, is a different procedure: the former passively admits the air, while the latter, if an animal, vehemently resists it. And the commission also found that lesion of pulmonary tissue was only seen in cases in which the air had been forced in continuously, and with violence. Depaul, who examined this question, found that the fears of injuring the lungs are baseless, provided any prudence be used in the work; and the experiments of Budin confirmed the statement of Depaul. His experiment consisted in attaching a large inflated bladder to the lungs of a cadaver; a board was placed on the bladder, and two persons sat on this, so as to force the air into the lungs; such violence repeated on several lungs, only caused a slight injury in one case. The practical conclusions deducible from these experiments and observations are, that insufflation practiced either by the mouth or an instrumental appliance, is safe when the work is done gently and with rhythmical interruptions. Instead of insufflation through the nostrils or mouth, the air may be blown through a canula or tube, which has been introduced directly into the trachea after the performance of tracheotomy. This plan has been advocated by Hueter: and as special advantage which he claims for it is, that by means of the tube, mucus and other obstructing materials can be withdrawn from the air-passage.

In a case in which the patient had apparently died from an anæsthetic, the writer rescued the man by quickly plunging a pocket scalpel into the trachea, and inserting a silver catheter, through which air was blown into the lungs. Breathing for nearly an hour was very slow: yet by persevering effort, the patient's life was saved.

Against insufflation Pacini urges that it is the reverse of the ordinary respiratory act, viz., in this artificial procedure the air being forced in increases the pressure in the lungs; while in natural breathing there is a diminution of pressure. In the former condition, the carbonic acid contained in the blood has no tendency to escape, and the pulmonary capillaries are in a

state of compression; the heart, also, is pressed on, and is interfered with, in its normal action. Though these objections are not groundless, yet Pacini gives them too much importance when he says that the method, instead of saving, destroys life. That life may be revived by insufflation is shown in the observation of Guérard, that of one hundred and eighty-five persons immersed in water who were restored to life, in fifty-four cases insufflation was the only means employed.

Aspiration.—By the method of aspiration the thorax is dilated; and this may be accomplished by several methods: among these may be mentioned the plan of removing the pressure from the outside of the chest, so that a species of vacuum is created in the thorax; or this may be done by pressure so as to lessen the thoracic space, which reëxpanding forms a partial vacuum; or by traction on the arms, so as to dilate the thoracic cavity.

The first method, by which there is formed a partial vacuum within the chest, has been accomplished by means of a somewhat complicated apparatus invented by Woillez, and named spirophore, a hybrid name, like too many others, compounded from the Latin and Greek. This consists of a metallic envelope of cylindrical form, into which the body is to be introduced, except the head, which is exposed. Around the neck there is placed some flexible material, which hermetically closes the metallic cylinder. To the lower part of the apparatus an air-extractor of bellows-form is attached. By the aid of the extractor, the air can be removed from the interspace between the body and the cylinder, so that the chest is caused to dilate, and air is thus drawn through the nostrils and mouth to the lungs. And by a reverse action of the extractor, the air can be expelled from the lungs. Thus, as seen, the two actions of inspiration and expiration are imitated: and, as Woillez found, two pints of air can be aspirated.

This method has its analogue in action in a corset-like appliance, which being provided with straps and buckles, and placed around the thorax, by alternately tightening and relaxing, the space within the chest is lessened or increased. This plan was examined by the Royal Humane Society of London, but its use as a means of resuscitation was not advised. In fact, any means which is similar to the methods mentioned, is open to the fatal objection that time is lost in its application: the minutes which must be consumed in applying the vacuum cylinder of Woillez, or the corset girdle of Leroy d'Étiolles, are those precious moments in which the resuscitator has the only opportunity of

rescuing the victim: before such mechanical device can be placed in proper position for use, the latent spark of life will be wholly extinguished.

A method, celebrated and commended by the Royal Humane Society, is that of Marshall Hall, in which the body is so placed

FIGURE 96. Showing Marshall Hall's method of artificial respiration for resuscitation. From Harley; Holmes' Surgery.

that by rolling movements the chest cavity is alternately lessened and enlarged; and this is done as follows: the subject being placed on a flat surface, is first turned so that the face is prone, and the chest rests on a cushion; and while in this posture, the mouth should be opened, tongue drawn forwards, and mucus and other material wiped from the buccal cavity: also, pressure

should be made on the back between the shoulder-blades. From the prone position, the body is turned to the side, which rests on a cushion, and while thus placed, some pressure should be made on the upper or exposed side, so as to lessen the thoracic space.

FIGURE 97. Showing Howard's method of artificial respiration. From Harley; Holmes' Surgery.

These dorsal and lateral positions should be assumed twenty times in a minute. Hall's method is shown in Figure 96.

In Howard's method, shown in Figure 97, in which the alternate work of lessening and enlarging the thoracic chamber is effected, the work is done as follows: the patient's clothing, or

something analogous, is shaped into a cushion, and placed beneath the stomach, while the subject is turned with face and chest downwards; in this position, the tongue being drawn forward, the buccal cavity is freed from all extraneous material; and in this posture liquid material lodged in the throat, or air-passages, will flow from the mouth. The body is next turned on the back, which rests on the cushion; the hands are uplifted, crossed and placed underneath the subject's head, and retained there by an aid, who also holds the protruded tongue. The surgeon kneeling by the patient, grasps and compresses the thorax on each side at its lower portion, and continues this for three seconds; then he suddenly relaxes his hold, when the air rushes into the expanding chest. Thus expiration and inspiration are represented. Howard names his plan the "direct method," and he claims for it advantages over all the others.

The next method to be considered is that of Silvester, exhibited in Figure 98, which is executed as follows: the patient is

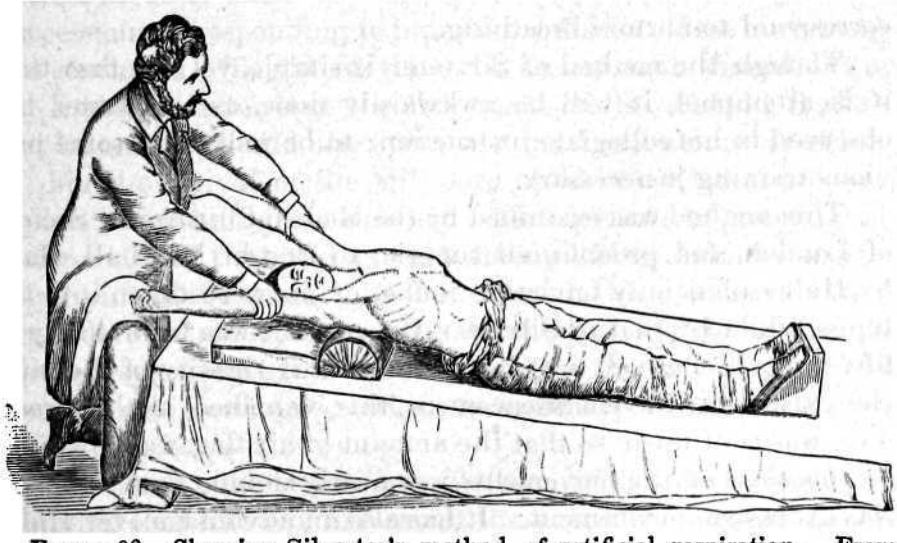

FIGURE 98. Showing Silvester's method of artificial respiration. From Harley; Holmes' Surgery.

placed on his back with a small supporting cushion under the chest. The mouth and nostrils must be freed from all extraneous matters. The tongue must be somewhat withdrawn, and held so as to retain the pharynx open. The surgeon now stands behind the head of the patient, and to do so, the latter should lie on a table, at the head of which the surgeon stands, while the one retracting the tongue occupies a lateral position towards the feet of the patient: if he stands near the chest, he will be in the

way of the operator. This the writer has learned from experience; and also, that instead of elevating the chest as Silvester does, it is better to lower the head, so that the blood will easily reach the brain. The operator now raises the extended arms above the head and makes some traction on them, during a period of two seconds; then the arms are lowered, and flexed at the elbows, which with the upper arms are to be forced against the sides of the thorax. The upward traction of the arms acts on the chest through the following muscles, which have costal attachment: the pectoralis major and minor muscles in front; the serratus magnus muscle at the side, and the latissimus dorsi muscle behind; the one which aids most efficiently is the serratus magnus, which extending from the posterior border of the scapula and being attached to eight ribs, is the medium through which much costal elevation can be effected. Since this muscle lies somewhat obliquely, to bring it into full action, the arms must be drawn upwards and somewhat backwards; and these movements should be repeated about fifteen times each minute, to correspond to normal breathing.

Though the method of Silvester is simple, yet the first time it is attempted, it will be awkwardly done, as the writer has observed in his collegiate instruction; to be well done, some previous training is necessary.

This method was examined by the Medico-Chirurgical Society of London, and pronounced superior to that of Marshall Hall; by Hall's plan only ten cubic inches of air were taken into the lungs, while by that of Silvester, the amount was from thirty to fifty cubic inches. It was also found that if rigidity of the muscles existed in the commencement, this vanished as the procedure was continued, so that the amount of air that was drawn in at the close of the movements was nearly double that which it was at the commencement. It has also an advantage over Hall's method in this, that both sides of the chest are acted on uniformly, while in the former, the action is, in a measure, limited to one side.

Pacini has introduced a method somewhat similar to the last described: the patient is stripped and placed on his back, and the buccal cavity being liberated of all materials, the operator seizes the shoulders above with the hands, so that the thumbs pass in front and the fingers behind, and he then lifts. In this work the outer ends of clavicles are elevated and thus the intra-thoracic space is augmented. Pacini was led to this procedure by observ-

ing that when the cadaver was thus carried in the dissecting room, air entered the lungs with an audible sound: and this escaped when the body was put on the table.

A plan similar to this has been proposed by Bain, who places the hand in the armpits and uplifts the shoulders; the difference between this plan and that of Pacini is that Bain fixes the hand in the axilla from behind, while Pacini fixes the hand in front.

The methods of traction described act through the medium of the arms; in 1878, a plan was proposed by Max Schüller, in which the traction is made at the lower part of the chest. To do this, let the patient be placed horizontally on his back, with a small pillow under the neck. The operator now stands or sits near the head of the patient, with his back turned towards the latter; and thus placed, he grasps the lower part of the thorax on each side, and, in so doing, he insinuates the hands under the false ribs. Thus holding on the lower costal arches, the operator pulls upwards and outwards, so as to expand the chest; then he compresses so as to force out the aspirated air: and in rhythmical succession, corresponding to natural respiration, these movements are continued. To aid in the work, an assistant should lift up the limbs, so as to relax the abdominal walls. Should the subject lie on the ground, the operator must kneel alongside of him.

For the revival of the still-born child Schultze has proposed a plan which he names *swinging*. This consists in grasping the lower limbs of the child and alternately lifting and lowering the lower part of the trunk. By the elevation, the abdominal viscera are made to move against the diaphragm, and to narrow the thoracic space from below; and when the trunk is lowered, this space is again enlarged, and so, in some degree, natural respiration is represented.

Schultze's method has recently been criticised, the opponents claiming that by such movement the abdominal organs may be injured. Thus Körber, of Dorpal, asserts that in the work the liver may be lacerated, vessels opened, and blood effused. He claims that though the child be born alive, yet it can die through such hæmorrhage. Such lesion appears in the form of hepatic hæmatomata, which may be inclosed by serous membrane; blood may actually be effused into the abdominal cavity. Schultze, on the contrary, replies that such rupture of the hepatic vessels is a phenomenon commonly present in the still-born child, and he supports the statement by reports of necropsies of still-born children which were made by Rokitansky, Förster, and Weber,

before the swinging method was practiced. The cause of such lesion is to be found in the conditions of the fœtal circulation in the asphyxiated child; its lung not being able to receive the blood, the latter accumulates through the medium of the umbilical vessels in the liver to such an amount that finally open rupture and a hæmatoma may arise. Thus Schultze, ingeniously and intelligently, vindicates his method. From the discussion of this plan by several writers the inference may be derived that such swinging is improper in cases in which the bones of the child have been fractured; also, if the infant be a very heavy one, the work should be done cautiously, since in such a child lesions can more readily be produced. And to practice this work properly the operator should previously make trial of the method on the infantile cadaver.

Schultze's method seems not to have been tried on the adult, and though theoretically it is inferior to some of the plans which have been described, yet it is evident that in the alternate elevation and descent of the lower part of the trunk, not only is the diaphragm subjected to rhythmical compression, but the blood is moved to and from the brain, conditions which favor the reanimation of the subject. But since the changes of dimension of the intra-thoracic space produced by such movements are slight, in order to accomplish much, the movements should be much more rapid than in normal breathing.

Recently König, of Göttingen, has announced a method of resuscitation by means of manual compression over the heart, and, while this compression is being done, an aid also compresses the chest. The pressure over the heart forces the blood towards the lungs; and such pressure should be made on the left costal cartilages, near the ensiform process of the sternum. König pressed from thirty to forty times per minute, but his assistant Maas proposes to do the work as often as one hundred and twenty times in a minute, and to press midway between the sternum and the site of the apex-beat.

In 1892, Kraske modified the plan of Silvester in this wise: that after five breaths, during full expiration he closes the mouth and nose of the subject, and then the arms are to be uplifted in the inspiratory movement. In this way the movement of the blood is promoted.

A very simple procedure has recently been recommended as a means of resuscitating the asphyxiated subject. This is to seize the tongue with a pair of forceps, and to draw it out of the

mouth and then return it. Let these movements be rapidly continued and they will have the effect to quickly awaken an inspiratory act, as the writer has verified on several occasions. This extraction and retraction of the tongue should be done simultaneously with Silvester's or Pacini's resuscitating protraction and retro-traction of the arms.

Electrical excitation of the respiratory nerves has been proposed as a means of resuscitation by Ziemssen, yet long before the publication of Ziemssen, electricity was used to arouse the apparently dead subject. As a way of applying it, one pole may be applied at the apex of the heart and the other on the back of the neck. The bold step has been taken of introducing a needle through the thoracic wall to the heart, or even into the cardiac wall, and then connecting this needle with an electrical battery. Though the patient might be revived by this method, it would be too perilous for employment, except in cases which were hopeless, for resuscitation with a cardiac wound, or coagulum within the heart, would offer an inauspicious prospect for the patient even though life were prolonged.

Ziemssen's procedure consists in applying an electrode over the phrenic nerve where it lies near the middle of the outer border of the sterno-cleido-mastoid muscle, and the other can be placed over the diaphragm or at the præcordia, and pressed well inwards. Thus doing, the diaphragm is made to contract and enlarge the thoracic space. The induced current is employed, and the current is to be broken at intervals similar to those in normal respiration. By this procedure the alternating contraction and relaxation of the diaphragm imitate that in the mechanism of normal breathing. Many years before the announcement of Ziemssen; the writer, in cases of interruption of breathing, as from an anæsthetic or from any other cause, employed electricity developed by a Faradic machine; and the nerves which were selected for excitation were the cardiac branches of the sympathetic in the neck and the pneumogastric and phrenic nerves. To stimulate the sympathetic, one electrode is to be pressed down on the structures which overlie the vasculo-nervous group near the cricoid cartilage; at this point the electric current will act on both the pneumogastric and the sympathetic nerves; and to complete the chain of connection, the remaining pole should be placed on the left side of the epigastrium, close to the heart, and contiguous to the diaphragm. The current should be interrupted once in three seconds, so as to imitate inspiratory and expiratory

action. The upper electrode may now and then be shifted to the site over the phrenic nerve. In thus proceeding one awakens a triple innervation, viz., on the sympathetic, pneumogastric and the phrenic, the effect of which will be stimulating action on the diaphragm the heart, and the lungs. In the latter, through the vagus, the desire of air (*besoin de respirer*) is awakened.

If this electrization be continued for a long period, the prolonged contraction of the subjacent cervical muscles will awaken an inflammation followed by suppuration. The writer has observed this in a patient who, from opiate narcotism, was saved from death by respiration maintained, by the electrical means described, for three hours. The violent irritation of the sterno-cleido-mastoid muscle during so long a period was followed by a large abscess in and around the muscle.

All methods having failed to recall the patient to life, the bold procedure proposed by Langenbeck might be essayed: which consists in making an incision through the lower thoracic wall on the left side and near to the ensiform cartilage. Through such an incision, which would pass to the heart through the skin, the attached margin of the diaphragm and the pericardium, Langenbeck suggests that the heart could be reached, grasped with the hand, and compressed so as to force the blood from the organ. Before this procedure be resorted to, some experimentation should be done on the cadaver to determine how much the general circulation could be influenced by compressing the heart. Though proposed by eminent authority, it is not probable that this procedure will be put into practice, unless in cases in which apparent death actually touches on real death.

Drowning.—Life is sometimes endangered or lost through partial or total immersion of the body in water; and in case of death, the fatal ending is familiarly known as drowning.

This subject has been studied and written on by both the pathologist and the humanitarian: the former seeking to determine how death thus arises, and the discoverable evidences pointing to such death; the work of the humanitarian has been chiefly directed to rescuing the partially drowned. Medical writers eminent in this field are Reaumur, Louis, Haller, Sprengel, Goodwin, Fothergill and Bert.

Any liquid or semi-liquid entering and closing the air-passages can destroy life through asphyxiation: the blood not being aerated in the lungs, life soon ceases. Water is usually the obstructing agent, yet, in a few instances, the subject has been fatally

immersed in wine. English history records the drowning of a prince in a butt of malmsey; and the writer knew a case of drowning in a vat of new-made wine.

Drowning may be from mere immersion or partial immersion of the head; yet ordinarily, the entire body is submerged. The act may be voluntary, accidental or homicidal.

In more than half of the deaths from drowning, Devergie claims that asphyxia and syncope are associated in the extinction of life; and that but one-fourth die from asphyxia alone, while about one-eighth die from syncope and cerebral congestion.

Falk, Hoffmann, Bert and others distinguish three stages in asphyxiation caused by immersion; and this division of the subject has been founded on experiments made on animals, and on the experiences of those who had been partially drowned.

1. The first sensation felt when the head is immersed is a feeling of occlusion of the ears and a rushing sound in them; an unpleasant fullness in the nostrils, especially in the upper part of them, and a sensation of tightness about the chest. The immersed animal, and also man, when unexpectedly immersed, inspires the water, and then with a strong expiratory effort, he expels the fluid, along with some of the reserved air of the lungs. Taylor says that when a person falls into the water, and retains his consciousness, he at once makes violent efforts to breathe; this applies to him who is suddenly surprised by immersion; he who knows how to swim will hold his breath until he is exhausted,or, becoming unconscious, he attempts to breathe.

2. In the second stage, according to Hoffmann, the submerged subject makes deep and short inspirations, followed by expirations, similar to what occurs in other forms of violent asphyxia And this stage ends in convulsive movements of the body. Bert and others state that the first surprise of immersion is followed by a calm in which the subject makes no effort; then the water which has entered the air-passages excites movements of coughing; but between the acts of coughing, the glottis is reflexly closed, so that nothing can enter it. Both the French and German observers state that the second stage ends in spasmodic movements and convulsions.

Taylor has well described the acts of the suddenly submerged subject, who in rising to the surface inspires air, but while he does so, since the mouth is on a level with the water, the latter is also drawn into the air-passages; and some is likewise swallowed: thus some of the aspirated water passes into the lungs, and some

into the stomach. The struggle for life continues for a longer or shorter period of time, according to the strength of the subject, yet ultimately he becomes exhausted, and speedily lapses into insensibility; then the body sinks so that the mouth and nose are quite underneath the water; the air can no longer enter the lungs, and a part of that which they contain, then escapes, and appears on the surface of the water, as bubbles; and then the subject becomes entirely unconscious.

3. In the third stage, during which the subject passes into a condition of unconsciousness, inspiratory acts are made at considerable intervals; the mouth is widely open, the pupils dilated and the muscles are convulsed clonically. At last, the sphincters relax, and there is absence of all voluntary or reflex movement and death finally occurs, though the heart continues to beat for some time.

The time requisite to drown man has been a matter of difference among writers; and those who have experimented on animals do not agree as to the time required to destroy life. Faure fixes the time for the animal, at one minute and a half in cold weather, and nearly twice that time in warm weather. The Medico-Chirurgical Society of London, pronounces these figures to be too small, and fixes the time required to drown, at from three minutes and a half to four and two-thirds minutes. Taylor thinks that submersion during one minute may so asphyxiate the subject that he makes no more efforts to escape from his impending fate; and as a rule, he thinks that a human being who has been submerged four or five minutes, cannot be resuscitated. Though the heart continues contracting for three or four minutes, this is no indication that the victim can be revived. In the annals of the Royal Humane Society, there are recorded but two cases in which life was restored after submersion lasting more than five minutes.

Death has sometimes arisen from mere syncope or fright arising from accidental or unexpected submersion: and such a subject makes no effort to rescue himself.

There are cases again, in which the body which has been rescued from water, and which presented all the signs of life, nevertheless died after some hours; two such cases are mentioned by Taylor.

In death from drowning, the body presents diverse conditions depending on the time which it has remained submerged.

The cadaveric rigidity may be of long or short duration; it

is believed to be brief in those who suddenly died from syncope, rather than from prolonged asphyxia.

In death from sinking in cold water, the skin is pale; but if the submersion has continued some hours, then the most dependent parts of the body are purplish or cyanosed, through hypostatic gravitation of the blood. And if submersion has lasted many hours, the temperature of the body will correspond with that of the containing medium. The action of the cold on the cutaneous muscles causes the irregularity of the dermal surface, familiarly known as goose-skin; and this is thought to be proof that the subject has been submerged while living, and not dead.

The attitude of the body will furnish evidence as to whether death was immediate from syncope, or after a struggle; in the former, the limbs denote repose; but when the subject endeavored voluntarily or involuntarily to save himself, the limbs are in constrained or unnatural positions; the hand has seized, and is clasping, some object, and the face is disfigured by distortion of the features, in which fright and pain are legible. A lad known to the writer, who was rescued when nearly drowned, was found by a diver at the bottom of a pond of water, clinging strongly to the root of a tree.

Additional signs of death by drowning are dilated pupils and foam in the mouth and nose; and if the body has remained immersed for a long period, the epiderm is softened through imbibition of water. But as such epidermal imbibition can occur in the living subject, its existence only denotes a prolonged immersion in water. Paré observed that the skin of the hands and feet is often excoriated, due to movements against a hard surface, during the last struggle.

In the cavity of the mouth there is found a quantity of foam white or pink in color; though this has nearly always been observed in the drowned man, it seems to be absent in the drowned animal, according to Montana and Bergeron.

A condition to which great importance is attached in the decision of the question of death by drowning, is the presence of a quantity of white or red foam in the larynx, trachea and bronchial tubes. This was seen in the drowned animal by Morgagni, Haller and other observers.

Orfila and Piorry have not found this foam in the air-passages of those who, having been wholly submerged, remained so until death; subsequent observers do not sustain Orfila in this statement; nearly all have found this foam present: even in those in

whom death was suddenly induced by syncope after submersion. Should this foam be absent, it could only be explicable by death having instantly arisen from syncope uncomplicated with asphyxia. When this mucus is present and tinted with blood, the death can be inferred as being preceded by a struggle of the victim.

The lungs of the drowned subject have been carefully observed; and the conditions found differ. In case the person has been submerged and died without rising to respire, the lungs are found in a normal state, and similar to those in whom the death has arisen from being buried under sand or earth. But if the victim has, in his struggles, risen and inspired air, then there is found a condition named by Brouardel and the old observers, aqueous emphysema. The pulmonary tissue has lost its normal elasticity, and when pressed on, it retains the imprint of the fingers. The density of the pulmonary tissue is considerably augmented. This augmentation has been pronounced to be three or four times that of the normal density; yet later estimates make this much less. The lungs fill the thoracic space completely.

If the death has been sudden and chiefly from syncope, the lungs will present no exterior spots indicative of congestion; but if life has ended through asphyxia, there will be found marked congestion; then the exterior surface will be reddish or violet, and not of uniform character. Spots denoting ecchymosis are visible, here and there.

The congested pulmonary tissue and the ecchymosed spots indicate a struggle for life on the part of the individual, and such local marks are greater, the longer such struggle has lasted. The lungs may present superficial emphysematous marks. If the pulmonic parenchyma be incised, there will escape a foamy liquid tinged with blood. Also, small clots of blood from ruptured capillaries, are sometimes revealed by incision.

The epithelial cells of the air-passages undergo alteration in the drowned subject, viz., they are found increased in size, and their protoplasmic content is abnormal. This change is referred to aqueous imbibition.

The blood of the recently drowned subject is characterized by unusual fluidity; but little or no coagulation is found; if this exists, it should be discovered in the cardiac cavities. This liquid blood has been studied, and it has been discovered that it contains a smaller number of red cells than normal blood. The

blood of animals drowned experimentally, and which have struggled in the water and inspired some air, is found to contain fewer cells; the number may be reduced one-fourth or one-third, in respect to the containing serum: that is, the serum being increased through the absorption of water, there is an apparent, not real, reduction of the red cells. Hence in the act of drowning, a state of hydræmia is induced, in subjects in whom much water penetrates the air-passages.

The general deduction from these facts is, that when the subject has been suddenly drowned, then clots may be found in the heart and vessels, and the red cells exist in normal proportion to the serum; but if the drowning has been prolonged, then there will exist hydræmia, in which the volume of blood is augmented one-fourth or third above normal quantity, and it will be liquid; and should there be an open wound, blood will continue to flow from this for some time; and in the blood of such subject, there will be a seeming diminution of red cells.

That water, which colors the air-passages, can be absorbed, has been experimentally demonstrated by injecting the fluid into the trachea. The quantity which can thus be absorbed is considerable; but as the animal resists the work and expels some which has been introduced, it is inferable that in slow drowning, a much larger quantity is absorbed, and that thus the hydræmia can be accounted for.

In the act of drowning, a quantity of water is swallowed; and to this Paul of Ægina attributed death from immersion. This was an error, and the amount swallowed was overestimated. In experimental drowning Brouardel and Vibert found that when the œsophagus of the animal was ligated, no water was found in the stomach; but in those animals in which the œsophagus was not tied, then water was found in the stomach, and the hydræmia of the blood was much greater in the latter than in those in which the œsophagus had previously been tied: hence the conclusion, that in drowning, the water enters the blood both from the lungs and the stomach; but the greater part enters through the lungs. The hydræmia will be greater in the case of slow than of sudden drowning. The amount of water found in the drowned subject's stomach has been variously given; in some cases seen by Taylor, none was found; and Hoffmann never saw a large quantity in the stomach. Bergeron and Montana state that they always found water in the stomach of the drowned: the normal amount being equal to a quart.

The question has arisen whether water may penetrate the stomach after death: a few admit the possibility of this; the most deny it.

The encephalic vessels have been found engorged in the drowned; this, however, is not always so; and when present, it is attributed by Taylor to congestion of the lungs.

In his final review of death by submersion, Laugier, to whom the writer is indebted for much that has here been presented, says that the individual may die in different ways: he may die suddenly from syncope and cerebral congestion; or in so brief a time, that there may be no struggle. And in such cases, the concussion from the fall, the coldness of the water, the startling fright, or drunkenness, may be, singly or combined, agencies of syncope, or cerebral congestion. Or death may result from asphyxia after a long struggle for life; and then the asphyxia is not due to swallowed water, as Paul of Ægina thought; nor the collection of blood in the right ventricle of the heart through pulmonary inaction, as Coleman and Sprengel believed; nor from apoplexy caused by respiratory obstruction, as taught by Littré and Boerhaave; nor from the occlusion of the glottis preventing the entrance of air, as Beau claims; nor from the vitiation of the blood due to lack of contact with pure air, as believed by Orfila; but death is caused by the penetration of water into the pulmonary passages. That life is thus destroyed in drowning has been demonstrated by careful and judicious experimentation by Paul Bert, Riedell, Bergeron, Montana, Brouardel and Vibert.

The suction of water into the air-passages which occurs in the first stage, when the subject is surprised by immersion under water, becomes much greater in the third stage when asphyxia has commenced; then, according as Bert has noticed, the water is drawn into the lungs by deep inspirations automatically produced: the mere continuance of the accustomed habit of breathing. And these movements are so strong that the water is drawn into the deepest portions of the lungs and there reaches the ultimate vesicles; then the unconscious patient, with the desire for air instinctively remaining, breathes the watery medium instead of air. And the water being abundantly introduced into the lungs, hydræmia is induced through its absorption; and thence is formed that foamy liquid which is discovered in all parts of the air-passages, and also, in the pharynx and buccal cavity. The aqueous transudation in the finer vessels produces changes in

the protoplasmic content of the epithelial investment of the finer tubes.

Death may come from immediate suffocation; or it may come after the subject has been rescued yet alive from the water, at a later period, varying from minutes to hours or days; and sometimes, death occurs because the nearly dead lungs cannot expel the admitted water; or the epithelial lining of the tubules and vesicles has been so changed, and is so degenerated through aqueous imbibition, that the oxidation and decarbonization of the blood are imperfectly accomplished. If enough water has not entered to produce these effects, then resuscitation is possible.

Many means have been resorted to to revive the partly drowned patient; and among these, that of removing the water which had been swallowed was one of the most popular: since from antiquity, the notion was current that the swallowed water was the prime cause of death. As a rude way of accomplishing this regurgitation, the patient was suspended by his feet. Intelligent medical men long ago decried this procedure; among whom may be mentioned Plater in the sixteenth century, who in a pithy comment on the plan, said that in suspension, more water flowed from the subject's clothing than from his mouth. And yet, to-day, among sailors, as soon as the submerged victim has been rescued from the water, the first cry is to "*roll him;*" and quickly "suiting the action to the word," the unfortunate one is rudely, and often violently, rolled to and fro, with the result that his body is more bruised than emptied of its water. Intelligent resuscitation has long since dropped from its methods vertical suspension and horizontal rolling.

Subsequently, the theory of Littré and Boerhaave, that death from drowning arises from cerebral apoplexy, led to withdrawal of blood by bleeding; and this was deemed to be most effective when the bleeding was done from the jugular vein.

Finally, when the cause of death had been solved by observation and experimentation, the methods of revival reduced themselves to two classes of management: one, in which general and local excitation of the body is resorted to; and the other method, in which are comprised the different means of artificial respiration.

Among the means of excitation, which fall under the first head, a popular one is the application of heat to the patient; this has been recommended by Tissot, Fothergill and others. Heat

may be applied in the form of warm water, warm sand, a warm plate from a stove, or any warm object which is accessible and applicable. Warm embrocations may be applied, consisting of flannels which have been dipped in hot water, and on which alcohol or turpentine has been sprinkled. Such excitant warmth may be applied to all parts of the body; it is best done, however, over the heart and lungs, since the chief aim is to awaken the functions of these organs. Friction with the palm of the hands may be done. Another excitant is electricity; also thermal cauterization of the limbs and præcordia. The tickling of the nostrils is an efficient means of awakening a reflex action, in which the diaphragm will be made to contract in acts of coughing and sneezing. Also titillating the pharynx awakens reflex actions of a respiratory character. And akin to this, as counseled by Heister and Desgranges, is the passage to the stomach of a tube or tampon, armed with a brush, with which friction can be made. Volatile stimulants may be introduced into the mouth and nostrils; and one usually at hand, is camphor spirit; and another yet more energetic is spirit of ammonia, of which the escaping fumes will excite the respiratory mucous membrane. The parenchymatous injection of alcohol may be done, and to hasten absorption, the penetrated structures should be well rubbed; thus the alcohol is made to enter the vessels, and its general action is hastened; and, at the same time, the friction diminishes the tendency to local irritation of the injected tissues. Strychnia may also be hypodermically used. These means are applicable in those cases in which apparent death has arisen from syncope, rather than from asphyxia; in all such the local excitants should be sedulously plied.

In case apparent death is from asphyxia, the jaws are sometimes found tightly clenched, and must be forcibly opened by means of some wedge-shaped object, or other divulsive instrument. And then through an aspirating tube which has been introduced into the throat, foamy material which has lodged there may be aspirated.

In addition to the use of the local and general excitant means which have been enumerated, there should be an immediate resort to artificial respiration; and of the methods before described, the author recommends that of Silvester as the most trustworthy; and this should diligently be proceeded with, while the local remedies are being used.

As a prelude to Silvester's method, which has already been

described, the subject's mouth and pharynx should be wiped out; and during the traction and retro-traction of the arms, the tongue should be drawn well forwards, and held in this position. And along with this work, rapid pressure, done intermittently, should be made on the left side of the thorax, near the ensiform cartilage.

The length of time necessary to destroy the human subject by submersion is probably about five minutes; yet numerous cases are on record, in which resuscitation occurred after a much longer period. For example: the Royal Humane Society of London mentions return to life after submersion for forty minutes. The memoirs of the Society of Amsterdam mention cases of rescue after the subject had been three-quarters of an hour under water. Franck has recorded a case which outstrips the record of his predecessors, viz., life was saved after three hours' immersion.

Though these statements of the historians of submersion are probably exaggerations, yet they justify the resuscitator in his efforts, and to err rather on the side of prolonged than of curtailed perseverance, in his humane work.

Foreign Bodies in the Air-passages.—Foreign bodies of the most diversified character have entered the air-passages, and finding temporary or prolonged lodgment there, have imperiled or destroyed the life of the subject. Such body, if of inorganic composition, may remain unchanged in its volume, being neither lessened nor augmented; but if it be of organized material, it may increase in size, or lessen through solution or disintegration; an example of the inorganic is a bead, a shot or coin, while of the organic class, fragments of food, the pea, bean, grain of corn, are familiar examples. Within the writer's observation, the bean and grain of corn have caused the greatest number of accidents of this kind.

Several writers have contributed to the literature of this subject; prominent among them have been Jobert de Lamballe, S. D. Gross and Chassaignac.

Jobert de Lamballe, writing in 1850, states that the foreign body usually enters the right bronchus. The weight of the body and the suction to which it is subjected carry it into the air-passages. The uplifting of the epiglottis is not necessary, since this valve never lies downwards and backwards, but its position is such as to form a kind of a guiding or conducting sulcus, along which passes any material which traverses the pharynx.

The entrance of the body is indicated by disturbed breathing, cough, constant or intermittent pain, and bronchial discharge, which is often tinged with blood. A peculiar rhoncus is heard, and the breathing is louder on the side which the body did not enter. A large body can cause immediate death through asphyxia, but a smaller body acts more slowly, namely: it causes suppuration, emphysema and progressive asphyxia. If the body exceeds four lines in diameter, it cannot be expelled by coughing; yet when less than four lines, there is a chance that the body may escape. Jobert advises the early performance of tracheotomy; and then, to facilitate the exit of the body, he tickles the mucous membrane of the trachea to provoke expulsive coughing; and when thus the body has escaped, close the wound with sutures which do not enter too deeply. In case the body is not at once dislodged, then the wound must be retained open.

In 1854, S. D. Gross wrote an elaborate monograph on foreign bodies in the air-passages; and the materials for this work were derived from personal observations and from published records, amounting to about 250 cases.

From an analytical study of these cases, he deduces the following facts: the body may remain in the larynx or descend into the bronchial division of the trachea; and then it usually lodges in the right bronchus. The form and weight of the body often determine the point of lodgment. A small, round and heavy body, as a bean, shot, or gravel, etc., descends more easily into the passages than a light, rough, or angular one. The body often changes position, passing from one bronchus to the other, or into the trachea or larynx.

As soon as a body has entered the air-passages there is an irresistible desire to cough, and a feeling of impending suffocation; the face is livid, and the patient may fall into a state of unconsciousness. After some time the violence of these symptoms subsides and remains so for some minutes. If the body has entered the larynx, the voice is altered, and there is commonly present a croup-like cough, and the resonance of air entering the lungs is diminished. In case the body is not fixed but is floating in the larynx, then the spasms of cough often recur, as if the body had only just entered. Such movement of the body can be felt by the patient, though it may be imperceptible to the examining physician. A large body has so completely filled a bronchus, that the corresponding lung collapsed. And in some cases, the site of the lodged body is indicated by a fixed local pain.

The body can destroy life at once, or at a later period; and the dangers of sudden death are greater when the body can move to and fro, and become engaged in the glottis. If it lodge in the lungs a fatal inflammation may arise from it. If the body be caught in one of the ventricles of the larynx, it causes less trouble than anywhere else; yet in some cases, though the body was lodged in the larynx, it caused a dangerous inflammation.

As treatment, Gross discards errhines, vomiting, inversion of the body, striking and shaking the thorax; but he depends wholly on tracheotomy, or laryngotomy; the latter is only to be done when the body is in the larynx. The opening should be one inch long in the child, and one inch and a quarter in the adult. And when the body is not found, or at once expelled through the opening, then invert the patient, shake and strike the chest; and these acts failing, then retain the gap open by means of retractors. And whether the body escapes early or later, close the wound as soon as the former has made its exit.

Kapesser of Giessen observed thirty-two cases in which bodies had entered the air-passages; tracheotomy was done in all, and in the greater number the patient was rescued at once; in three, the body was coughed up at a later period; and in one case, the patient was lost from bleeding during the operation. If the body is lodged in the upper portion of the windpipe, it causes less irritation there than if it be lower down, since, as Erichsen has observed, the mucous membrane is less irritable in the upper part of the trachea.

As a rule, the body lodges in the right bronchus; yet in one necropsy, Orth found it in the left bronchus.

In the case of the entrance of a foreign body into the windpipe, Chassaignac advises an immediate operation; and in the event of the body being felt, he cuts directly down on it; otherwise, Chassaignac performs the usual operation of tracheotomy.

The writer has had personal observation of five cases in which foreign bodies had entered the windpipe. The object in one case was a small cylindrical hollow metallic body, which was a line in diameter and three lines in length; the second was a grain of Indian corn; and in the other three the object was a bean.

In four of these cases, tracheotomy was done; in the one unoperated upon, the child died of pulmonary disease three weeks after the body was inhaled; on post-mortem examination, a grain of corn was found in the right bronchus. In the child which had mis-swallowed the metallic cylinder, tracheotomy was

done, and the object found in the upper part of the larynx. When the trachea was opened, a flexible catheter was passed into the wound, and the body pushed upwards into the pharynx, and caught there. In another child in which the object was a bean, the object was not discharged at once through the tracheal opening; but the wound being retained open, the body was expelled one week afterwards, and the child recovered. And in the remaining two, though tracheotomy was done, yet the body remained lodged in a bronchus, and the children died of pulmonary inflammation.

In those cases in which the body remained impacted deeply in a lung, there was only occasional coughing; the predominant symptom was accelerated breathing, with lessened respiratory murmur on one side, and increased or puerile breathing on the other side. And in the case in which a grain of corn was the obstructing agent, so long were the intervals between the paroxysms of coughing, that it seemed scarcely probable that they could arise from the presence of a foreign body. It would appear, then, that the longer the body remains in the bronchial tube, the less irritation does it cause: that is, the most marked and misleading condition in such cases is, that long lodgment of such body gives tolerance, and finally nullifies the reflex action of the local irritant.

CHAPTER XXIX.

ŒSOPHAGUS.

THE name œsophagus is derived from the Greek words *oisein*, to be about to carry or bring; and *phagein*, to eat. The word is used by Hippocrates and Aristotle to indicate the gullet; but later Greek writers employed the word *stomachos* as name for this part. Even Vesalius used the latter name. This confusion of terms may have arisen from the equivocal passage in Hippocrates' short chapters on the anatomy of the trunk; he says there that the œsophagus takes its beginning from the stomach, and ends in a hollow space; and the former, on account of being a great mouth (*stoma*) to this digesting cavity, is named *stomach*. In thus paraphrasing the Hippocratic text the latter has not been greatly elucidated by the license taken by the translator.

The œsophagus is a canal of variable calibre, which, according to Henle, begins at the lower border of the cricoid cartilage, or at the union of the sixth and seventh cervical vertebræ, and reaches thence downwards to the diaphragm, through which it passes to the stomach, into which it opens at a point corresponding to the body of the eleventh thoracic vertebra. Its beginning is somewhat indefinite; but it properly commences where the circular muscular fibres appear below the constrictor pharyngis inferior. While the pharynx has muscular attachment to the cranium, lower jaw and hyoid bone, the œsophagus has only very loose adherence to contiguous parts; the tube severed from the inferior border of the pharynx can easily be detached from the parts around.

The œsophagus, except when dilated by materials which have been swallowed, or those which regurgitate from the stomach, is closed, and is similar to a flat cylindrical cord, due to the contraction of the muscular walls; and the inner mucous wall is disposed in longitudinal folds, so that if a section of it be made it has a radiated appearance. The contracted œsophagus measures in diameter nearly a half inch.

Mouton has measured the calibre of the distended œsophagus, by filling it with gypsum, when he found the diameter to be, at the beginning, three-quarters of an inch; at the middle, an inch and a half; and at the lower end, nearly an inch. From its varying diameter, the œsophageal tube has been compared to the male urethra, which is narrower at its ends than at its middle.

If the distance be measured from the incisor teeth to the point where the œsophagus ends in the stomach, it is, on an average, seventeen inches long; and five-eighths of this pertains to the œsophagus; and the latter consists, according to situation, of a cervical, thoracic and abdominal portion. The upper portion of the œsophagus lies between the trachea and the spinal column; and at its entrance into the thorax, it deviates towards the left side; then it returns to its median situation again; and commonly, in consequence of the trachea deviating towards the right, when the œsophagus reaches the point where the trachea bifurcates, the former is situated behind the left bronchus. Lower down, the œsophagus lies behind the pericardium, and it is attached to the latter; and thence downwards it is pressed away from the spinal column by the aorta and the vena azygos, and when it reaches the lower edge of the left fourth costal cartilage, it lies nearly in front of the thoracic aorta. Its connection with parts around is through the medium of an extremely elastic tissue.

The wall of the undistended œsophagus is one line thick, and three-fourths of this is of muscular tissue: the inner lining being mucous membrane.

The muscular wall consists of longitudinal and circular fibres. The longitudinal fibres lie external, and arise above by three sections: two lateral and a median. The lateral portions start from the elastic structure in which the palato-pharyngeal muscles end; while the middle portion springs from the posterior part of the cricoid cartilage, through the medium of a three-sided elastic membrane. The circular muscular coat lies internal to the longitudinal fibres; and both the longitudinal and circular fibres pertain to the striated species, in the upper fourth or third of the canal; below that distance, the non-striped, or organic species of fibre, replaces the former; this change occurs where the cervical portion reaches and enters the thorax.

As before stated, the pharyngeal portion of the alimentary canal is formed and supported by muscles which have bony origin; somewhat analogous are the miniature muscles which connect the œsophagus to contiguous structures. Thus Hyrtl has

described the broncho-œsophageus and the pleuro-œsophageus muscles. Muscular slips have been described which connect the œsophagus with the pericardium and aorta. These muscles, which are of organic species, serve the purpose of maintaining the tube straight; and according to Henle, they screen adjacent vessels from compression. These muscles, also, are the means of attaching the œsophagus to the diaphragm.

The œsophagus receives its supply of blood from the inferior thyroid, œsophageal and phrenic arteries. The veins below empty into the portal system: and from this connection, these veins become swollen in cases of cirrhosis of the liver.

The innervation of the œsophagus is through the medium of the vagus; and this nerve has its nuclear origin in the medulla-oblongata. The branches of the vagus, which are chiefly concerned in this involuntary innervation, are the superior and inferior laryngeal nerves; other branches, when experimentally stimulated, have been found without action.

Some interesting vivisective work on the œsophagus has been done by Angelo Mosso, who found that an impression, made on the mucous membrane in the upper part of the œsophagus, traveled gradually downwards in a peristaltic manner; and what was most remarkable, this movement continued, even though the œsophageal tube were divided into two parts. The excitant irritation which awakened this movement lost its effect, if repeated too often.

Congenital Defects of the Œsophagus.—The œsophagus sometimes presents congenital defects which are explicable through an arrest of growth during the period of embryonic evolution.

In the development of the embryo, the alimentary canal consists of an anterior, middle and a terminal portion; and of these, the anterior becomes the pharynx and œsophagus; and cotemporaneously with this, the trachea and lungs are developed. At an early period, the tracheal and œsophageal structures form a common canal which opens into a hollow below, from which hollow the lungs are formed. As growth proceeds, a partition develops and separates the common tube into an anterior one, the treachea, and a posterior one, the œsophagus. But from some unknown cause, this differentiation of parts may take an abnormal course, and defects arise. Thus, instead of a continuous canal, the œsophagus may abruptly terminate in a blind sack; or the œsophagus may open into the trachea, or into a bronchus; or there may be a combination of defects, in which

there is abnormal ending, as well as interruption and closure of the canal. And finally, the œsophagus may be reduced to a cord-like structure, throughout a part or the entirety of its length.

Examples illustrating congenital œsophageal defect are the following, collected by Luton. A new-born child died on the fourth day, and on necropsy it was found that the œsophagus ended blindly near the tracheal bifurcation, and a ligamentous structure seemed to continue to the stomach. In another infant, the examination revealed the fact that the upper part of the œsophagus ended blindly at the middle of the canal; the part below opened into the trachea. In another child which died on the seventh day, there was found an absence of the œsophageal tube; and the stomach contained no cardiac orifice. In another infant, which died on the eleventh day, the œsophagus ended in a cul-de-sac an inch below the pharynx; the inferior end opened into the trachea above, and into the stomach below, so that fluid from the stomach regurgitated through the trachea; and the blind portion and the lower portion were connected by an imperforate cord. In another infant which died on the fifth day, there was closure found in the œsophagus two inches below its origin; the inferior section opened into the trachea on the posterior face of the latter. In another case, there was found closure of the œsophagus nearly two inches above the tracheal bifurcation; and thence downward the œsophagus was found obliterated to a cord, which pierced the diaphragm to reach the stomach; and the œsophagus communicated with the trachea, in this case. In another infant the pharynx was closed, and there existed a tracheo-œsophageal fistula; and with these defects coëxisted imperforate anus, club-foot, hare-lip, deformity of the fingers, and absence of the genital organs. In another infant, in which the universality of deformity rendered the child's body a miniature museum of teratology, the normal œsophagus was lacking, and, in its stead, the trachea consisted of two tube-like portions, of which one passed to the stomach and the other to the lungs.

Hence, as seen, the congenital defects of the œsophagus offer much diversity of form; in most cases the tube opens into, or communicates with, the trachea or a bronchus; and in a few infants the œsophagus is reduced to an impermeable cord. In both conditions life cannot continue, for in all the nutriment cannot properly reach the stomach; and in some starvation and asphyxia unite in the destruction of the victim.

Surgery seems to have seldom intervened to lend assistance

to such unfortunates; they have been permitted to perish by inanition, death occurring in from five to ten days, life usually ending within a week. Yet in this era, when operative surgery has accomplished so much in restitution to continuity of the intestinal tube, when occluded by neoplasm or other agency, would it not be well to make some essays in this unexplored field, which patiently awaits the advent of operative effort? While every cubic inch of the intra-abdominal space bristles with *ectomies, otomies* and *ostomies*, why not open the neck of the new-born infant, and seek for the deformed œsophagus, and, where viability is but slightly interrupted, restore permeability by some procedure suggested by operations done on the intestine and urethra? By such operative effort, let it be never so hazardous, there could not be added one unit to, but possibly one might be subtracted from, the chances of death which otherwise overhang the life of the little patient.

Stricture of the Œsophagus.—Stricture figures in many affections of the œsophagus; it is the causal agency of disphagia, or difficulty of swallowing.

From complete closure occurring in the new-born, the transition is easy to incomplete closure, which has been observed in the infant: a case was reported in 1833, by Æger. Should such defect be discovered, the appropriate treatment would be gradual dilatation by means of graduated sounds.

Of causal agencies whence stricture may originate a frequent one is the destruction of the inner surface by caustic action, which may be from a heated fluid or an escharotic; thence may arise gradual cicatricial closure.

Steiger, of Würzburg, in 1861, wrote on œsophageal stricture, and he claimed that the only certain means of diagnosing it is the use of the sound: this meeting an obstacle indicates stricture. Additional signs of such stricture are difficulty of swallowing, which commonly comes on imperceptibly. The trouble in deglutition is not always proportioned to the narrowing, since sometimes there is much difficulty when the stenosis is slight. In case the stricture be low down, the patient locates the trouble in the stomach. The symptom which usually first attracts the patient's attention is vomiting or a tendency to vomit. The vomiting may not be constant, but it may recur occasionally and especially when certain foods are used; and it is accompanied by violent retching and strangling, and the substances rejected are streaked with blood. There may be intervals when this tendency

to vomiting quite vanishes, and hence such symptoms are easily confounded with gastric ulcer or cancer.

Steiger used for the discovery of the site, or sites, and the determination of the size and extent of the stricture, a sound devised by Trousseau, which consists of a shaft, on the penetrating end of which are olive-shaped enlargements, which increase in size from the lower end upwards, so that if one enlargement passes, this or another enlargement may be arrested by a stricture lower down; and thus the site of stenosisis is found and its size determined. He finds that there may be more than one strictured point, with an intermediate space of normal calibre. As a rule, the stricture is only for a short distance, yet it may be a half inch or more in length. There may be a stricture near the stomach and one or more higher up. The sound touching and entering the stricture causes pain; and, in withdrawing the sound, particles of food, mucus and blood may be drawn up. Steiger depends mainly on the sound as a means of treatment. Should there be ulceration accompanying the stricture, Hoppe gave muriate of ammonia, one grain daily, mixed with sugar; he claimed thus to have cured œsophageal stricture.

Boiling water, steam, and heated fluid, as tea or coffee, from accident or inadvertent ingestion, have burned the inside of the upper part of the alimentary canal. Except in cases of [illegible]

enough. The structures so burned soon slough from the unburned tissues, and thus a raw surface remains, which, in healing, contracts and lessens the calibre of the pharynx and the upper portion of the œsophagus. And this contractile process, which is common to all parts of the buccal and pharyngeal cavities, and especially so in the lower part of the pharynx, continues in action long after the surface has healed, and may proceed to such an extent that the canal is reduced to a narrow fistula.

The treatment of such a burn should have two aims: one immediate, to counteract the early detachment of the burnt surface; and one later, to oppose the cicatricial narrowing of the canal. For the first purpose cold should be used in the form of ice water; and, to get the best effect of this, let fragments of ice be taken in the mouth and allowed to dissolve, and the water to be swallowed. To retard the detachment of the burnt mucous tissue, an astringent should be used; and for this the decoction of oak bark, or of Peruvian bark, may be locally applied, or tannin in iced water may be used.

As soon as the dead surface has detached itself, and the new-formed separative tissue commences to undergo the regressive action of the final stage of cicatrization, in which the canal will be narrowed, this must be counteracted by the introduction of a round sound, which may be solid or hollow. If a solid one be used, it should be passed several times daily; not less than once in every six hours; and should this not arrest the tendency to narrowing, then the sound should be used every three or four hours. For this work, a black rubber instrument, similar to the urethral sound, is the best. To introduce this, the head must be turned well backwards, the mouth well opened, when, the distal end of the sound being curved to correspond to the axis of the pharynx, it is passed into the œsophagus. Should the instrument catch on the posterior wall, it must be retracted and then the point being turned in another direction, the attempt to carry it down is repeated; and such manipulation, if not done with too much effort, will always succeed in carrying the instrument into the œsophagus. The patient, if an adult, can soon learn to do this himself.

These repeated introductions, however, of the sound are objectionable, since one may thus irritate the wounded surface, and cause it to bleed; to avoid such irritation, a permanently lying sound may be placed in the œsophagus; and this should be hollow, so that nutrient material may be passed through it

into the stomach. Such a tube should pass through the lower meatus of one nostril, and be fastened at the nostril, so that it cannot escape downwards. This tube must be of flexible rubber, and the portion which lies in the nose must be smaller than that which lies beyond; especially in the adult; but in the child, the tube may be of uniform calibre. That used in the adult of unequal calibre should have the large portion introduced first towards the stomach; then having passed a thread through the nostril by means of a looped wire, the end of the tube having been attached to the thread, it is drawn through the nostril from behind forwards, and secured in position by ligature and plaster. Through such a tube, nutrition can easily be maintained; and to successfully resist cicatricial contraction, the tube must be used for many weeks. It should be removed, cleansed, and reintroduced every week.

The swallowing of an escharotic liquid, for example, of a concentrated alkaline or acid solution, destroys the surface of the pharynx and œsophagus as quickly and extensively as does boiling water. In such a case the medical attendant should make speed to administer a neutralizing agent, viz., dilute acetic acid, in case caustic potash, soda or lime have been swallowed. Instead of an acid, one may use olive oil or any other oil which might be at hand. But in case an acid has been swallowed, then an alkaline basic agent should be used: for example, a solution of soda or potassa. By thus proceeding, the destructive action of the escharotic can be lessened; and probably, the exfoliation of the mucous membrane reduced to a thin stratum of structure. And, afterwards, the œsophageal tube above mentioned should be introduced, and the treatment pursued as described in case of burning by steam or hot water.

After the inner surface of the œsophagus has been healed, the process of contraction continues for a long period; so that the calibre of the tube gradually diminishes, and sometimes it is almost reduced to an impermeable condition; and not infrequently the patient only reaches the surgeon when this impermeable condition has arisen. Two such patients have been seen by the author; in one the contraction had arisen from the child attempting to swallow sulphuric acid; in the other case, the cauterizing agent was a solution of caustic potash; and the latter child did not remain under observation until the completion of the case. In the child whose mouth and pharynx had been severely burned by sulphuric acid, healing had occurred, and

the lower part of the pharynx was narrowed to a fissure so small, that only liquid material could pass slowly through it. The most narrow portion was where the pharynx merged into the œsophagus. The treatment consisted in the use of long-bladed forceps and assorted India rubber sounds. The forceps had long blades, which were of the same curve as the pharynx, and the blades could be separated beyond the normal diameter of the canal. When this instrument was introduced into the stenosed part, the handles were opened and retained so by a cork, which was placed between them; and thus the blades were separated and caused to press on the sides of the passage. After this had been continued for five or ten minutes, the instrument was removed and the round sound introduced. By this treatment continued for three months, a stricture that was nearly impermeable was overcome, and the child's throat restored to nearly normal condition.

Certain morbid agencies acting on the pharyngeal and œsophageal wall finally cause stricture; examples of such disease are syphilis and tubercular disease. Each of these may encroach on the canal through neoplastic development and lessen its calibre; thus the gummatous syphiloma and the tubercular growth may develop in the wall, and growing inwards, lessen the canal. After such encroaching neoplasm has existed for a time, it may ulcerate and the canal temporarily be restored to normal calibre; and later through cicatrization, strictural deformity may arise.

Cognate to the causal agency just described is that of epithelioma or sarcoma originating in the pharyngo-œsophageal wall; the former occurring much oftener than the latter. In the aged subject and where difficulty of swallowing has appeared, and is gradually increasing, malignant disease may rationally be suspected. As the disease proceeds, the patient will emaciate through insufficient nutrition, and finally present the characteristic countenance of malignant disease. The sound will be interrupted by a well-defined, resistant and unyielding induration. The swarthy or irregularly pigmented skin of the patient, his emaciation and general vital depression, the constantly increasing dysphagia and stenosis detected by the sound, are symptoms clearly indicating the existence of malignant disease in the œsophagus.

An occasional causal agency of stricture here is the polypoid neoplasm, which may develop from the inner wall of the pharynx or œsophagus. Such a neoplasm may be sessile or pedunculated

in its mode of origin, and may vary in volume from that of a pea to much larger dimensions. In a case of this kind reported to the writer, the growth obtained such dimensions that it wholly filled the œsophagus, and caused the death of the patient through starvation. It was discovered at the necropsy that the tumor was situated so near the pharynx that its removal could easily have been effected.

In the case of such polypoid growth, an appropriate treatment would be to remove it by means of forceps through the pharynx; and should this not be practicable, then an opening should be made through the neck by œsophagotomy, and the tumor reached and removed. Such operation would be a safer method than prolonged groping to seize an unseen object; and when seized the work of removal would probably be imperfectly done.

While these pages have been passing through the press, the writer has removed a growth, of suspected sarcomatous nature, from the lower part of the right lateral wall of the pharynx. This tumor had close connection with the anterior (upper) face of the epiglottis. It was an inch in its long diameter. The operation consisted in first performing tracheotomy, and the insertion of a tracheal canula; next the external carotid artery was tied, and then just behind the angle of the jaw an opening was made into the pharynx; and then the lower jaw was depressed, and retained so by an interdental gag, permitting one hand to enter the mouth and force the growth into the wound, so that it could be dissected out, and its removal safely effected. The case proceeded well until the fourteenth day, when bleeding occurred from the site of the ligated artery; and to control this hæmorrhage, the common carotid artery was tied. Ten days afterwards, there was severe bleeding again from the floor of the sloughing wound which penetrated into the pharynx; and this blood appeared to come from the internal jugular vein near its origin at the base of the skull. To arrest this, a piece of sponge was crowded into the bleeding cavity, and held there by digital pressure. After three days, the tamponing sponge was carefully removed and replaced by another. By a continuance of this course for three weeks, during which faithful fingers and a tractable patient mutually aided each other, the bleeding was controlled, the wound healed, and the life of the patient saved. The results obtained in this case renew the writer's grateful obligations to Otto Weber for the knowledge derived from him of the valuable properties of sponge as a mechanical hæmostatic.

The pharyngo-œsophageal tube may be partly or entirely occluded by the lodgment of a foreign body in it. The history of the case would indicate the nature of the causal agency and throw light on its nature; and verification of the same may be made with the sound. And to relieve the patient, an attempt must be made to remove the obstructing agent with properly-devised forceps, as will be more fully described hereafter.

Obstruction may arise from some growth encroaching on the wall of the canal; and the invading agent may be a solid neoplasm; or it may be an aneurismal or a cystoid tumor. A solid tumor may be of adenoid or goitrous character; also a carcinomatous or sarcomatous growth contiguous to the canal may so press on the latter as to interrupt its continuity. In the event of such tumor not contracting adhesion with the pharynx or œsophagus, the latter will recede before the pressing agent, and continuity remain, despite the encroachment on the canal; the involvement, however, of the wall in a malignant neoplasm inevitably leads to partial or complete occlusion of the canal.

One of the most dangerous of occlusive agencies acting parietally, is the aneurismal tumor, which may arise from the contiguous aorta in the thorax, or from the primitive carotid in the neck; the aortic aneurismal tumor being the more perilous on account of the magnitude and the inaccessibility of the vessel. The occlusion of the œsophagus by the aortic aneurism is less frequent than one might apprehend from the closeness of the vessel to the œsophagus. A number of cases have been recorded in which the aortic tumor burst into the œsophagus, causing speedy death. The case of the surgeon Liston is famous, in whom a thoracic aortic aneurism burst into the œsophagus, and after the loss of an enormous quantity of blood by vomiting, the patient had a respite for several months, when the tumor reopened and death soon occurred from hæmorrhage.

Narrowing of the pharyngeal or œsophageal canal may be caused by an abscess or collection of pus outside of the passage, which attains such a volume that it forces the wall adjacent to it against the opposite side. Such pus may have a prævertebral site; or it may be situated in the mediastinum, arising in the latter case from the suppuration of the mediastinal glands. Immediate relief may come in such cases from the abscess bursting into the canal and the pus thus escaping. The rupture of such abscess may be caused by the pressure of the dilating sound, or swallowed food; similarly to what occurs in periurethral abscess from the passage of the catheter or sound.

In the after treatment of cases of the kind mentioned, caution must be exercised in the ingestion of nutrient material, that the latter does not penetrate the cavity of the abscess, and lodging there, maintain the suppuration. To avoid this, the materials of food should be passed to the stomach through a tube.

A long-continued irritation of the œsophageal walls may end in their hypertrophy, which has been seen, in a case reported by Fontan, to proceed to such an extent, as to occlude the canal and destroy life by inanition.

Unexpected relief has sometimes come to the patient of pharyngeal or œsophageal stenosis through gangrene or sloughing of the narrowed part; such may occur in malignant disease, for example, epithelioma. Though relief occur in this way it can be but transient, since the advancing disease would probably soon appear in the adjacent structures, and thus induce narrowing above and below the ulcerated breach. Such cases would be but slightly amenable to treatment; the dilating sound could give only temporary aid, and its use must soon stimulate, rather than lessen the growth of the neoplasm.

As shown, stricture of the pharyngo-œsophageal canal may arise from a number of agencies, which, when studied as to site, may be grouped in three classes: one situated adjacent to but quite outside of the canal; a second class seated in the wall itself; and a third one, in which the causal agent arises from the inner wall; and a fourth class might be added, in which the occlusion is from a foreign body, lodged in the passage.

Certain general symptoms are common to stenosis arising from any of the causes comprised in these classes. These symptoms are greater or less difficulty of swallowing, pain or uneasiness in this act, emaciation from defective nutrition, and other conditions determined by, and dependent on, the nature of the cause.

The act of swallowing will be imperfect or embarrassed, according to the site of the stricture: for example, should this be high in the canal, the ingesta will scarcely enter the passage; but if the obstruction be low down, then the material will have normal passage through the pharynx, and suffer detention below. In the commencement of the trouble, there is merely a hesitation in swallowing, the act is prolonged. Presently, the patient is compelled to select his food; he eschews the solid and uses that which is liquid or semi-fluid; he is much more careful than formerly to masticate his food thoroughly. And if the narrowed

portion be low down, the ingested material may collect there in considerable quantity, and finally be regurgitated; and perhaps, as done by the ruminant, it is rechewed and reswallowed; or lying a long time in the canal, it undergoes a change, sometimes named œsophageal digestion.

The accumulation of the food in the œsophagus finally causes a dilatation above the stenosed portion, and, as a result of this, the muscular wall will become attenuated and less able to act on the contained matter. Should the lodgment be in the cervical portion of the œsophagus, the patient learns to aid the latter in its propulsive work by pressing the arrested mass downwards.

The increased work of the œsophagus induces uneasiness, fatigue, and, finally, pain. The effort to swallow may tear the wall, and thus lead to an ulcerative breach, which is painfully irritated by the contact and pressure of the pressing material.

And, besides the pain thus awakened in the œsophageal wall, the accumulated material pressing against the trachea can induce a sense of suffocation. Also, respiratory disturbance might arise from pressure on the vagi, of which the left rests on the front wall, and the right one on the posterior wall of the affected canal. And the proximity of the aorta in the thorax is such that the descending bolus may protrude against the vessel, and become a disturbing element in the movement of the blood, demanding a greater cardiac effort to overcome and pass the obstructing agency; and though this be slight, yet it must be mentioned in an enumeration of causes which trammel the free movement of the blood.

Spasm.—In 1870 Hamburger wrote extensively on spasm of the œsophagus, of which he makes a migrating or movable form and a fixed form.

Migrating spasmodic stenosis is the usual one; in this the spasm commences at some inferior point, and thence travels upwards, and seats itself in some special point. A mild form of this is globus hystericus, in which the spasm travels upwards, and is so mild in its character that it is painless and does not hinder swallowing. But in a more active form the spasm may continue for hours, and the effort to swallow is painful; and in such a case one may suspect organic trouble. In a third degree, the spasm is still more severe, and is attended by reflex disturbance, in which breathing is disturbed. In those cases, swallowing is quite impossible, and even the sight of food excites strangling movements.

Œsophageal spasm may be caused by erosion, catarrh, or worms; yet the cause may be quite outside of the œsophagus. It occasionally occurs in the nervous, anæmic, depressed, and chlorotic subject. As remote agencies are leucorrhea, ulceration of the cervix uteri, uterine fibroma, or some abnormal position of the fœtus in the uterus.

The migrating spasm is to be treated by baths, arsenic, quinine, atropine, opium and its derivatives.

Spasmodic stricture, which is localized, is much rarer than the movable form. The sound here finds an obstruction, which, under some pressure, gives way. From a small number of observations of Hamburger, he concludes that this localized form of stricture is the premonitory symptom of approaching cancer of the stomach; in a few cases of the kind necropsy discovered cancer in the stomach, though the œsophagus was found in sound condition.

There are phenomena present in the act of deglutition which are not alone perceptible to the patient, but it is claimed that they can be discovered by auscultation. The subject of stenosis feels that the material ingested successively halts and advances until it traverses the narrowed part of the canal. Hamburger has made a study of the sounds which are heard as material traverses the narrowed canal. He makes three stages or degrees of the stenosis. In the first degree, in the passage downward of fluids, there may be heard bubbles, which pass from below upwards through the descending fluids. In a greater degree of narrowness, there is heard a trickling or gurgling sound; and in the third stage, which approaches impermeability, there is detected the sound of materials ascending in the act of regurgitation. Hamburger claims that a study of these sounds will give more accurate information concerning the degree of narrowness than can be learned through using the sound; also that the site of the stricture can thus be located, and, further, that auscultation can be utilized to determine the progress that is being made in treatment. The writer will admit that long training of the ear might enable the auscultator to attain such power in discrimination; but if he persevere in the use of the sound, he will attain great diagnostic accuracy with far less labor, and, in fact, learn thus to discover, with approximate certainty, the character, nature, and extent of the stricture. And this leads to a consideration of this method of exploration.

The œsophageal sound should measure in its entire length

twenty-four inches, of which five inches will serve for the handle. Inventive genius has produced sounds of various forms and of diverse materials. A not infrequent one is that constructed of soft flexible rubber, similar to that of the urethral sound. That of black rubber is preferable, since the vulcanized rubber finally hardens and is liable to break, while the former is more permanent in its structure and elasticity. A good instrument is a sound with a waxed end, which will receive and retain an impression of the narrowed part. One of the most convenient sounds is that of which the shaft is whalebone, and the exploring end is armed with an olive-shaped body, in which the shaft is fastened. There is a screw-like thread on the end of the shaft, which is received in a spirally grooved hollow in the olive-shaped body; that is, the staff ends in a screw which is received in a nut formed by the olivary body. The staff is of whalebone, and thin enough to be somewhat flexible. There should be an assortment of the olive-shaped bodies, varying from a small size to that approaching the normal thickness of the œsophagus.

Instead of a whalebone staff, the latter may be of silver, which is flexible enough to adapt itself to the pharyngo-œsophageal canal. The writer prefers the elastic staff of whalebone, since, when this has been bent so as to pass through the curved part of the pharynx, it becomes straight again, while a staff of silver or copper being curved remains so, and the end thus bent must press on one side of the canal as it descends.

To introduce the sound, let the patient sit in a strong, low-backed chair, and recline his head backwards as far as he can, with chin uplifted and mouth well open. The right-handed surgeon stands at the patient's left side, and then, slightly bending the lower end of the whalebone shaft, he inserts this into the pharynx; and as this is done, the patient should be directed to swallow the terminal olivary bulb. The bulb is often caught in the wall of the pharynx or larynx, and, when this occurs, the instrument must be withdrawn and inserted again. The cardinal rule is that the sound must be passed without being forced. The first few times that the instrument is used the canal resists and prevents the onward movement; but with patient perseverance and some address, the instrument can be moved downwards, provided the bulb is not thicker than the canal to be traversed. A spasmodic action of the muscular wall may catch and hold the instrument temporarily, and then the wall, relaxing,

allows the sound to proceed. Such spasmodic constriction resembles true stricture, yet its sudden disappearance reveals the actual condition.

The sound should be passed slowly; thus going it explores and learns the nature of the structures which it traverses: and imparts this knowledge to the guiding hand. Thus an abrupt stenosis or a gradual one is discovered; also, the handle, deviating in any direction, denotes induration of the opposite side of the canal.

Besides one constriction, there may be two or more; and these may differ in length and breadth. To learn the characteristics of multiple stricture, bulbs of different sizes must be affixed to the staff; and by thus using assorted bulbs, the size of different strictured points in the canal can be determined.

Besides the determination of the site, number and breadth of the strictures, other knowledge can be obtained through the use of the sound. Thus, the dense, unyielding structure of cicatricial tissue, can be felt and diagnosticated; or if the structure be inflamed and painful, the touch of the sound will reveal this; and lastly, hardness on one side, while the opposite wall remains unaffected, can be detected with the sound. And, in a limited portion of the neck, the palpating hand may follow the descending bulb, and verify somewhat the obstacles which the latter encounters.

Treatment.—The treatment of a case of stricture at some point in the pharyngo-œsophageal canal varies according to its nature or causal agency; and accordingly, it may be placed under one of the following heads: medical, dilating, escharotic or operative.

In case of narrowing from syphilis, in the form of gummatous infiltration of the wall, the stenosis may rapidly recede before the administration of mercury and iodine. A case is described by Luton, in which there was a stenosis almost occluding the œsophagus, in a man aged forty; the suspicion of specific disease led to the administration of fifteen grains of iodide of potassium, three times a day. Under this treatment, the patient was permanently relieved, though dilatation by sounds had been tried. And should the stricture depend on malignant disease, the use of the iodide of mercury has retarded the growth; and in the experience of the writer, the growth has seemed to be lessened; and his repeated observation would justify him in the general statement that neoplastic development, irrespective of nature, is lessened by the use of the mixture of iodine and mercury.

The dilating method has already received such exhaustive consideration that but little more remains to be said, than to add, that besides the ivory-bulbed sound mentioned, instrumental means akin to this have been resorted to. Thus one surgeon dropped a leaden ball attached to a cord to the narrow point, and allowed this to lie there for some time; one sees in this the peril of detachment of the leaden body; and it is clear that a substitute for such compression might be devised by affixing the leaden body to the handle of the sound which has been introduced to the stricture.

In case the stricture be yet permeable, the ingenious device of Baillarger may be used: this consists of an elongated narrow sac that is fastened to the end of the sound, and passed beyond the narrowed part; this done, the sack is inflated and the staff then withdrawn; by such compression the narrowed calibre may be widened. This procedure is reported to have cured a case. These devices, intended to replace the ordinary sound, have not been generally accepted; the simple sound, as in the treatment of stenosis elsewhere, still holds its place as one of the most satisfactory means of treatment in many cases of œsophageal stricture. In the use of the sound gradual and progressive dilatation should be aimed at, rather than immediate widening.

Potential cauterization has been done as aid in œsophageal stricture; and for this purpose potassa fusa has been employed. This is done by taking a narrow tube, open at the lower end, and when this is passed to the stricture, a small fragment of the fused potash, as large as the half of a small pea, is dropped into the tube, and forced by a wire through the lower opening into the narrowed part, and let dissolve there, and do its escharotic work; thus an opening is made into the cicatricial structure, which becomes an aid in the use of progressive dilatation with a sound. A less active agent is nitrate of silver, which has been employed in the same way.

Pharyngotomy and œsophagotomy have been done, both from the inside and the outside. When the narrowing is in the pharynx, incisions can be made into the inner wall with a bistoury. This work, as the author has found, can be done with almost any cutting instrument, the finger serving as guide. After such incision, dilating forceps may be introduced, widened and withdrawn, and thus narrowness can be temporarily overcome. And the work can be continued with large sounds.

If the stenosis be lower down, then an instrument similar to

that used in internal urethrotomy might be employed, in fact, any of the modern urethrotomes might be used. And similar to urethral cutting, the work can be done by cutting from above downwards; or reversely, the instrument having been carried with its concealed blade through the stenosed part, the blade can then be uplifted and made to cut, as the shaft is withdrawn. Such cutting is better done laterally, that is, on the right and left sides, than on the front and posterior walls; for the close proximity of the vagi to the latter walls renders deep section of the same perilous to these nerves. And besides the pneumogastric nerve, the aorta is close to the posterior wall, so that the blade of the œsophagotome penetrating deeply might open this vessel: a wound that would quickly end life. Hence, the cutting should be towards the right or the left side; or if done on the front or posterior wall, it should be merely superficial.

To be of advantage, this internal œsophagotomy must be accompanied by gradual dilatation by means of assorted sounds, as has been described.

Should the dilatation not be practicable by the methods named, as ultimate aid a resort may be to external œsophagotomy. Cases in which this operation is indicated are patients in whom the pharynx or œsophagus is the site of sarcoma or epithelioma, through which occlusion has occurred; or in those cases of cicatricial stricture in which relief cannot be obtained by internal incision and progressive dilatation; and finally, it may be done to extract a foreign body lodged in the lower part of the pharynx, or in the œsophagus.

External œsophagotomy was first done by Goursauld, in 1738. This operation, for a long time, was only resorted to, to form a way by which bodies lodged in the passage could be extracted; and in such cases, it was not unfrequently done many weeks or months after the occurrence of the accident which demanded it. Later in the history of œsophagotomy, the operation was done to give a respite of life to those in whom death from starvation was impending: such respite being gained through the formation of a way by which food can be introduced; or, perhaps, through such an opening the occluding obstacle may be removed.

To perform this operation, in consequence of the deviation of the œsophagus towards the left, the opening is made on the left side of the trachea. As aid in the work, a sound curved at the lower end, should be passed through the mouth down to the

strictured portion, and then the bent part of the sound must be turned towards the left and somewhat forwards. On the structure thus uplifted, an incision is to be made through the skin. Such cut should lie vertical, close to the trachea, in the space bounded by the trachea and the left sterno-cleido-mastoid. The cut is to be continued deeper until it penetrates the space between the trachea and the left carotid artery. To aid in the work the trachea and artery should be separated by means of retractors. In this dissection, the fascial sheath of the vessels and nerves should be left as nearly intact as possible: since, being opened, excreta from the wound might enter and gravitate. The site, hue and structure of the œsophagus will distinguish it from the trachea; and the contained sound being moved, will aid as a guide. The point of a tenaculum being inserted into the œsophagus, it is thus uplifted, or pulled laterally, at the will of the surgeon, who then penetrates into the canal by a short vertical cut. In incising to the œsophagus, as well as in the work of cutting into it, the left recurrent laryngeal nerve must be avoided. As soon as the sound has been reached, a grooved director should be passed through the wound, and the incision elongated to the extent required. This method is known as that of Verduc-Guattani; and the cut made is from two and a half to three inches long in the skin.

The plan of Eckholdt is to make a cut somewhat oblique over the lower part of the sterno-cleido-mastoid muscle, and having split the muscle there enter the space between the sternal and clavicular legs of the muscle; thus opening backwards and towards the trachea, one reaches the œsophagus. The author admits that the work might be done in this way, yet it would not be a very direct route to the œsophagus.

Bégin says that the procedure of Verduc-Guattani is an impracticable one, and he substitutes for it another, which is done as follows: the patient must lie on a narrow bed, with the head and shoulders slightly uplifted, and the head turned backwards; thus placed, the neck is uplifted and easily accessible to the operator, who makes an incision through the skin between the trachea and the sterno-cleido-mastoid muscle, extending from the sterno-clavicular joint to the thyroid cartilage. As this incision penetrates, an aid with a retracting instrument pulls the trachea inwards, while the surgeon inserts his fingers underneath the margin of the sterno-cleido-mastoid, and pulls it laterally outwards, and, in so doing, he displaces the vessels outwards, and

gives them security from his knife. The omo-hyoidean muscle will be met in the middle of the incision, and must be uplifted on a grooved director, and divided. The œsophagus will now present itself; and the further work proceeds differently, according as the operation is to relieve stricture, or to remove a foreign body, or a growth in the œsophagus.

The œsophagus when reached is recognized by its rounded form, and especially, by the movements which it makes when the patient is made to swallow. If the sound be moved in the passage this will indicate its site. Besides the sound mentioned by the writer, which can be extemporized from a catheter, a urethral sound of any flexible metal, or a thick wire that has been so doubled as to form a loop, a special instrument has been devised by Vacca Berlinghieri. This œsophageal guide, shown in Figure 99, is provided with a spring that can be

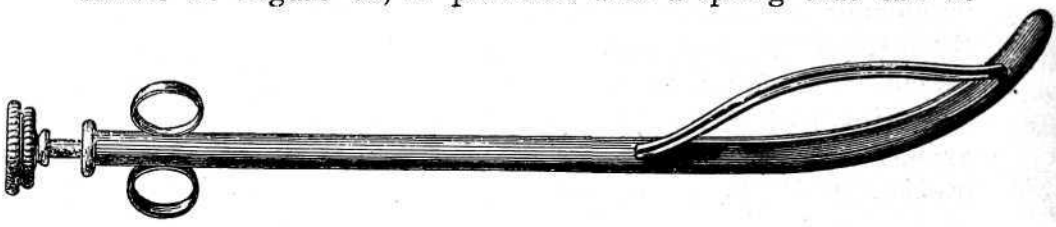

FIGURE 99. Representing the instrument invented by Vacca Berlinghiera as guide in the work of opening the œsophagus. The spring is shown uplifted.

uplifted so as to render the wall of the passage prominent. When the instrument is passed down, the side containing the spring is directed towards the incision, and then the spring is made prominent by the aid of a device at the handle. That the operator has opened the canal will be shown by the appearance of mucous material in the wound.

The purposes of the operation here considered, are primarily to open a way by which food can reach the stomach, and the patient rescued from death by starvation; and subsequently, to restore the continuity of the canal, and to attain these ends, the course to be pursued must vary according to the causal agency, which obstructs the canal.

If the pharynx or œsophagus be occluded by malignant disease which has arisen there primarily, or which has appeared there by propagation, then the aim will be to add a few months to the patient's life by an opening into the alimentary canal below the diseased part. Should the disease be high in the passage, the work is easily done; an opening is made in the sound part below, and a permanently lying tube is inserted, and fixed

there by being securely fastened. Such a tube should be of flexible rubber; and to prevent its accidental escape, the outer end may be transfixed by a thread which is tied or fastened to some outside object; or the tube may be transfixed by a safety-pin. Such a tube must remain in the passage during the remainder of the patient's life, if he have inoperable or incurable disease of the part. In case the stricture is dependent on contracted cicatricial structure, then the insertion of the tube may be accompanied by some operation looking to restoration of the canal. And such operation may consist, in cases of slight constriction, of simple longitudinal incisions on the inner surface; and then having effected some dilatation through the use of sounds, let a tube be introduced which will prevent recontraction, and also serve for the passage of nutrient fluids.

In such a patient progressive dilatation should be continued, in which the sound is passed down through the mouth. In the event that the canal has been converted into a hard fibrous cord of limited extent, then an effort may be made to restore continuity by excising the affected part, and reuniting the ends by suture; and through this sutured part a tube should be passed and let remain for some weeks. And from experience it has been found better, that this tube enter an opening made in the sound wall above the narrowed part; and such opening may be formed by a continuation upward of the wound which was made in the work of excision. After healing and union of the ends, the tube may be removed, and the work of maintenance of calibre be continued by the use of sounds passed through the mouth.

There remain to be considered certain cases of stricture which do not fall within any of the classes which have been described, and among those may be mentioned dysphagia lusoria, dysphagia spasmodica and dysphagia paralytica.

Dysphagia lusoria was first described by Bayford, and it has been observed by Richter, Valentin and others. It arises from an arterial anomaly, in which the subclavian artery passes between the œsophagus and the spinal column. It appears at the time of puberty, and is manifested by cardiac palpitation, a sense of threatening suffocation, and the pulse in the right hand is weak and intermittent; the right arm is weak and shrunken, and there is trouble in swallowing; and this may be constant. The treatment as counseled by Autenrieth consists in the frequent introduction of the sound; and his advice to divert the blood from the upper to the lower part of the body is a matter easier in precept than in practice.

Spasmodic dysphagia depends on some perversion of the innervation of the pharynx and œsophagus. This trouble is usually seated in the lower portion of the œsophagus; and it is so often associated with impetiginous cutaneous disease, that Chelius designates it an impetiginous angina. It may appear after some catarrhal affection of the throat. The writer, however, has observed cases of spasmodic stricture, in which there was no cutaneous disease. In the patients, the most of whom were females, the pharyngeal and œsophageal muscles were unduly sensitive, and became the site of constrictive action from slight cause. The attempt to swallow, especially cold drinks, awakened such movement. The spasmodic contraction often ends in a regurgitant movement, in which the material ingested is expelled upwards. There is an excessive watery or mucous secretion from the canal, which may cause nausea. This spasmodic stricture is to be treated with the sound, and the administration of remedies of a nature calculated to control the irregular action. The chief curative means, however, is the daily introduction of the sound, of which the frequent contact with the wall of the passage will render it less sensitive and irritable. In this work, sounds should be used of gradually increasing thickness; and often, at one sitting, the surgeon may rise from one of small, to one of much greater thickness; and in this mechanical treatment, it is the contact of the instrument rather than its dilating action, which accomplishes the cure.

Finally, there is a form of paralysis, or rather inertia, of the pharynx and œsophagus which simulates stricture. This has been observed in the aged subject: also in the apoplectic patient; and this condition is indicative of grave intra-cranial disease, or of affection of the upper part of the spinal cord. A viscid mucus is often excreted from the surface, and harasses the patient by its presence. Solid matters are passed more readily than fluids. Such patient swallows more readily, when he is erect, and has the advantage of gravitation; and this condition is a hint to the diagnostician to search for the cause intra-cranially, or in the spinal canal where it may arise from meningeal or vertebral disease.

When dependent on osseous disease or affection of the meninges, a rational medication would be the use of iodine locally and internally: also pungent gargles; for example, those prepared from capsicum, zingiber and pyrethrum. The œsophageal sound should be used; yet when the causation is considered, it is

evident that the recovery must be doubtful; and should no relief follow the use of the means mentioned, then the patient's nutrition must be maintained by the introduction of liquid food through a tube, which, provided with an infundibuliform mouthpiece, is passed to the stomach. In the palsied throat, care must be taken that the instrument does not, in its introduction, stray into the air-passage, which mistake might lead to drowning the patient. That the material has reached the stomach will be manifested by the warm or cold sensation which it will awaken there.

CHAPTER XXX.

FOREIGN BODIES IN THE PHARYNX AND ŒSOPHAGUS.

BODIES of every conceivable variety may find lodgment in the pharynx and œsophagus: and these in volume exceed, as a rule, the diameter of these passages; yet the body may not equal this diameter, and still remain there through the spasmodic contraction of the containing walls.

The symptoms of such lodgment are choking, strangling and involuntary efforts to expel the body. There is a sense of suffocation due to the contraction of the glottis, the actual closure of the larynx, or to the pressure over the trachea from the body in the contiguous œsophagus.

The foreign body may be arrested at any point; yet this occurs oftenest at the upper or lower end of the œsophagus, the narrowest portions of the passage; so that if it be not found in the upper end, it may be sought for at the lower one.

The nature of the material of which the body consists, as well as the form of the body, have a bearing on the trouble which may thence arise. Thus a hard or insoluble body lodged in the œsophagus, and especially if its surface be irregular, causes much more trouble than one which is soft, or has a smooth surface; if the lodgment, however, be at the pharyngeal entrance of the canal, these distinctions vanish; since occlusion there from a soft body may imperil, or even destroy life. Thus South mentions a necropsy which he made of a man who, while at his supper, rose quickly and ran out of the room and suddenly died; the examination revealed a lump of beef which had completely closed the pharynx. Death at the time was supposed to be from apoplexy. Another case is reported by South, in which suffocation from similar cause was happily averted by the patient himself extracting the body that had caught in his pharynx. Such soft body descending lower might have harmless lodgment, until it was loosened spontaneously, and escaped into the stomach;

but one which is insoluble erodes the wall on which it presses; and especially if the surface be rough.

Among the numerous objects which have lodged in the pharynx and œsophagus, the following have often been seen: coins, fish-bones, the crushed bones contained in meat of different kinds, ill-chewed articles of food, the mesocarp of fruits, fragments of wood and of metal, and needles, fish-hooks, knives, especially the clasp-knife, and blades and other objects with which jugglers disport for the amusement of audiences; and to complete the enumeration, there should be added the toys of children, which intentionally or accidentally have found a resting-place in the pharynx or œsophagus; and, finally, no small contingent of these objects have been furnished by the dentist's hand, in the different forms of artificial teeth, which, being detached from their place in the mouth, have passed downwards.

The surgeon is sometimes consulted in reference to the removal from this passage, of a foreign body which he fails to discover; in such cases, the body has found only temporary lodgment, and during its sojourn, it wounded the wall; this has been seen where a pin or fish-bone has been swallowed. Such irritation of surface is oftenest observed in the upper part of the passage, where visible inspection can be made. Such patients are hard to convince that the body is not present of which there is so clear a sensation. And the sensation remaining after a body has been removed may continue to annoy the patient for some time. Thus suppuration has arisen and stricture of the passage resulted.

The foreign body has caused death; Créquy in 1860, reported eight cases of death from this cause. Death was partly due to hunger; in some cases it was caused by suppuration, and in others, by hæmorrhage through sloughing which opened vessels. Lavacherie reported twelve fatal cases from sloughing and hæmorrhage. Death occurred between the sixth and tenth day To avert such an ending Créquy recommends that the œsophagus be opened early, viz., on the second or third day.

In 1868, Adelmann of Prague, and Martin of Paris, wrote on foreign bodies in the œsophagus. The report is given of three hundred and fourteen cases; one-third of these were bones, and the remainder were chiefly needles and coins. When the bodies were classified in reference to character of surface, the number of rough ones exceeded that of the smooth ones. Recovery occurred in one hundred and ninety-one cases. Spontaneous recovery occurred in several cases through vomiting; and in a few patients,

expulsion occurred through sneezing or laughing. Death occurred in twelve cases by the body penetrating to, and piercing the aorta. The carotid artery was fatally opened in three cases; the subclavian in one, and the pulmonary artery in one case, causing death in each patient.

Kreyser, in 1847, reported a death from a body penetrating the aorta. The body was a bone, an inch long, which lay across the œsophagus. The hæmorrhage from the aorta was into the left pleural cavity.

Inasmuch as spontaneous recovery occurred in but a small number of patients, Adelmann teaches that instrumental interference should be resorted to at an early period; instruments designed to catch the body, should first be tried; and these failing to relieve, œsophagotomy should be done. Adelmann finds of sixteen œsophagotomies, that eleven recovered.

Before resorting to the knife simpler measures should be tried. Titillation of the fauces which provokes emesis may dislodge and remove the body by the mouth; thus a barbed vertebra of a fish was removed by the writer. And vomiting caused by the introduction of forceps to catch the body, has evacuated the latter.

Where the body is of a harmless character, and cannot be removed upwards, Brodie counsels to force it downwards to the stomach; and if this is found impracticable, then he allows it to remain in place, when the body will often slowly pass downwards. Few patients, the writer suspects, would accept so conservative a plan; the victim of a body in the œsophagus is frightened and anxious for its removal; he is in no mood to brook delay in the work; and such advice would but speed him to a less conservative counselor.

Any article of food which has lodged, and of which the texture is not hard, can be caused to pass to the stomach by pressure from above; and this can be done by means of a piece of whalebone to which a portion of sponge has been securely tied. The usual probang employed in pharyngeal treatment may be made to do such service. And sometimes, the propelling sound can be aided by pressure with the hand on the outside, in cases in which the body can be felt externally.

In case the arrested object be a pin, needle, fish-bone, or any similar thing, it should be extracted, and not pushed downwards; and to accomplish this, various instrumental devices have been invented, or extemporized by the ingenuity of the medical

attendant. Such a device was that of Mütter, who attached a number of looped threads to the end of a probang, which being passed down and twirled around, caught the object in its meshes. The writer would suggest that a small balloon fastened to a hollow tube could be passed down, inflated with air, and then being withdrawn, the object might be caught and removed. The effort should always be made to remove such body upwards; thus done the patient is relieved of further anxiety.

The pricking body extracted, there remains pain in the œsophagus for some hours; and if this does not abate soon, it indicates ulcerative or suppurative action; or what has been seen in a few cases, there was another body which, remaining, maintained the irritation, until the object was removed.

Coins frequently find lodgment in the œsophagus: it is sometimes seen in the adult, though oftener in the child. Among such cases recorded, that told by Habicot is remarkable. A boy swallowed nine pieces of gold (pistoles) wrapped in a piece of cloth; the package lodged in the narrow part of the pharynx, and caused suffocation, so that to save life, tracheotomy was done; impending death being thus averted, the pistoles were thrust down with a sound, and finally passed by the rectum. The epigrammatic comment of Habicot was that the boy's life was saved, and the gold was not lost.

A case was seen by the writer, of an old man who had swallowed a silver half dollar, which lodged in the œsophagus. An exploratory search with a sound provoked vomiting, in which the coin was expelled. During its sojourn of thirty days the silver had become well blackened. The man suffered no subsequent inconvenience.

To remove coins the elder Graefe invented an instrument which consisted of a long slender hollow handle, to the end of which were fastened rings, one of which could be turned about at right angles to the other; and in this form the instrument was withdrawn, and the coin caught by it and extracted. It may be suggested that looped wires passed through a flexible catheter could be made to act in the same manner as the coin-catcher here mentioned. Such an instrument might be employed to remove other bodies.

Long-bladed forceps may be used for the extraction. Such forceps should have a curve corresponding to the axis of the pharynx; and the joint of the blades should be near the lower end. With such an instrument, by careful manipulation, the body may sometimes be found and extracted.

An ingenious instrument has been invented by Mathieu of Paris, which may be named a many-jointed forceps, and is shown in Figure 100. This handled forceps consists of a number of

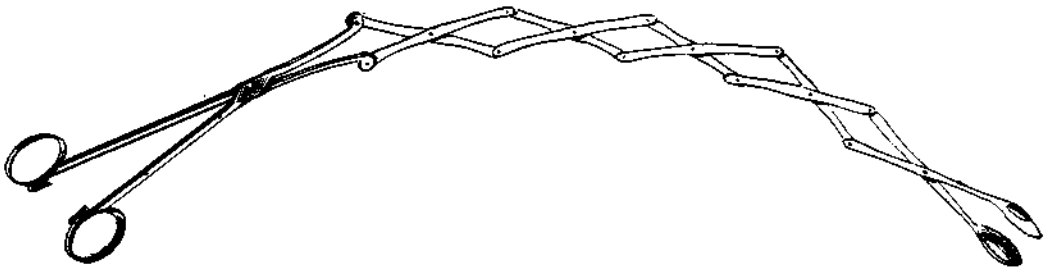

FIGURE 100. Exhibiting Mathieu's œsophageal forceps.

articulated sections, the whole so disposed that when the handles are opened or closed the grasping end will open or close. The jointed sections permit some flexibility of the shaft of the instrument. With this instrument one can enter the stomach, and thence remove an object; it was first devised to remove a key from the stomach of an insane man, and the extraction of the key was thus successfully accomplished. The writer removed with it a large forked fish-bone that was lodged in the lower part of the œsophagus; this was done by passing it down to the lower end of the œsophagus, then opening and withdrawing it, when the bone was caught and drawn upwards. With this instrument almost any object lodged in the passage might be caught and withdrawn.

The fisherman has been so maladroit as to cast his hook into his own throat, and to become the subject of the surgeon. In such a case Mütter, of Philadelphia, succeeded in detaching and removing the hook by passing the cord through a cork of suitable size, and then forcing the cork down with a sound until it reached the hook, which was thus unhooked from the wall, then the cord being pulled on, the hook, cork and all were drawn out through the mouth. In a case reported by South the subject was relieved similarly of his hook by passing a perforated bullet down the cord until it became engaged in the hook, when the latter was thus successfully withdrawn.

An object of less gravity than the preceding is the bristle from the tooth-brush, which, passing into the pharynx, becomes fixed there, through one end penetrating the mucous membrane. A small fish-bone may act similarly; and the object so lodged, though innocuous, may greatly distress the patient, and the

reflex movements which it awakens in the throat, instead of releasing the object, tend to fix it more firmly in its place. A careful exploration of the pharynx will usually bring the object to view; or, failing to see it, the surgeon may find it by a search with his finger. If visible, the object can be seized with forceps and extracted. Should it elude sight or touch, the object may sometimes be caught and removed by means of a probang, to which there is attached a piece of sponge; by twirling and making various movements with this, the object may sometimes be caught and removed.

Artificial teeth have frequently escaped from their place in the mouth and lodged in the pharynx or œsophagus. Among the earliest cases of this kind reported is one contained in Froriep's Notizen, in 1845; the false teeth swallowed remained in the œsophagus until the containing wall was penetrated, the aorta opened, and fatal hæmorrhage ensued, ten pounds of blood were found in the stomach at the necropsy. In 1856 Cock, of Guy's Hospital, reported a case in which a dental plate was swallowed; a tube was introduced alongside of it, and the patient then given an emetic; this failing to expel the plate, Cock performed œsophagotomy and removed the body; the patient recovered. In 1858 Buisl made a necropsy on a drunkard who had swallowed a dental plate with two artificial teeth; it was nearly two inches long and one inch broad. This had lodged near the cardia, and had penetrated the wall of the gullet, and made an opening into the pericardial sack, which was found distended with ill-smelling pus and gas. In 1878, Maclean, of New York, reported two cases in which artificial teeth had been swallowed and had remained in the œsophagus. In one patient the plate was swallowed during sleep; a sound was passed down and used as a guide in opening the œsophagus; the opening was made on the left side, and the plate extracted. In the second case the teeth remained lodged some months. Œsophagotomy was performed, and, to shun the recurrent nerve, the opening was made more posteriorly than was done in the former case, in which the nerve was wounded. In each case the wound was left open, yet food only escaped through it for a short time, and the wound soon closed.

This chapter may conclude with the advice that when a foreign body has lodged in the pharynx or œsophagus, an attempt should be made to remove it by some of the non-operative procedures which have been described; and, if these prove ineffec-

tual, then a resort should be had to œsophagotomy; and in the performance of this operation the writer desires to enforce the fact that anatomical perils are close to the knife on every side; for the field of work is crossed above by the superior thyroid artery, and below by the inferior thyroid; the deep position of the latter especially endangers it; and on the inside lie the trachea and the inferior recurrent nerve, so much concerned in phonation; and on the outer side, close to the knife, lies the common carotid artery. These imperiled structures may be avoided by the diligent use of the blunt dissector and the blunt retractor.

Should the body lie in the lower end of the œsophagus, and be so impacted or impaled in the structures that it cannot be extracted by a route above the diaphragm, then a resort must be had to gastrotomy, in which, an opening being made through the stomach, the body is extracted and the wound closed, according to rules derived from experience in the treatment of wounds which open the stomach or bowel—a subject which cannot properly be treated of here.

CHAPTER XXXI.

PHARYNGEAL AND ŒSOPHAGEAL NEOPLASMS.

NEOPLASTIC disease of the pharynx and œsophagus may appear in benign or malignant form.

Benign growths have frequently been seen seated in the posterior wall of the pharynx; and in that case springing from the retro-pharyngeal fascia, the anterior vertebral ligament, the periosteum of the upper cervical vertebræ, or from the anterior face of the vertebræ. Such benign growth is constituted of fibrous tissue, and, classified pathologically, it is a fibroma.

The retro-pharyngeal fibroma, following the usual course of an enlarging tumor, develops in the direction in which it finds the least resistance; and hence, should it arise behind the easily receding structures of the pharyngeal wall, the tumor will protrude prominently into the pharynx. But if the origin be behind the anterior vertebral ligament, or the periosteum, then the neoplasm will be flat in its form, and will develop less forwards than in the previous case. Again, the tumor may arise in contiguous structures and appear secondarily in the pharynx. And this immigrant may then come from the palatal or the laryngeal region.

Such growth seated in the posterior pharyngeal region may displace the tonsils, invade and, partly or wholly, occlude the entrance of the Eustachian tube, and cause deafness; or it may enter the choanæ and interfere with the voice and nasal breathing. A yet more perilous encroachment is that in which the fibroma obstructs the opening of the larynx.

Another important functional disturbance is that of dysphagia; the patient has trouble in swallowing, greater or less according to the site and volume of the growth. In a case seen by the writer the canal of the throat was so attenuated that the patient swallowed with extreme difficulty, and, through insufficient nourishment, death by starvation was imminent.

The tumor, through lateral extension, may press on the internal jugular vein and the internal carotid artery, and thus disturb the intra-cranial circulation through inducing anæmia or hyperæmia.

Treatment.—Such tumor must be removed; and this may usually be done through the mouth, if the tumor be discovered before it has grown to large dimensions, or before it has entwined its root-like processes about the adjacent vessels. Through the mouth the writer has removed three retro-pharyngeal tumors. The three subjects were adult males. In one the tumor had so nearly filled the passage of the throat, that as an aid in the work, tracheotomy was preliminarily done. In a second, the Rose position, in which the recumbent head is dependent, was used; and in a third, the patient lay recumbent, with the head somewhat elevated. The experience had in these cases induces the writer to advise preliminary tracheotomy; thus fortified, the operator proceeds without apprehension that the patient will be drowned by his blood entering the air-passages.

The mouth being well opened, and the jaws retained asunder by an interdental wedge, a vertical cut is made through the mucous covering of the growth, and the latter then detached with a blunt dissector from the adjacent structures. After the removal, the wound should be brushed with pure alcohol, and left unsutured. Nutrition should be maintained per rectum, or through the stomach tube; and nothing except water be permitted to come in contact with the wound.

In case the growth is inaccessible by the oral and buccal route, a more direct one has been proposed by Malgaigne, and named by him sub-hyoid laryngotomy; but by Langenbeck it is called sub-hyoid pharyngotomy.

Sub-hyoid pharyngotomy has been done for the removal of both vessels and pedunculated growths in the opening of the larynx, and also in the lower part of the pharynx. And in case it be done, tracheotomy at some lower point is sometimes necessary to insure uninterrupted respiration during the removal of a tumor, and, also, to permit the tamponing of the upper portion of the trachea, so that blood cannot descend to the lungs.

To perform sub-hyoid pharyngotomy, a transverse incision is made, two inches long, along the lower border of the body of the hyoid bone. After division of the skin, platysma myoid and sterno-hyoid muscles, the thyro-hyodean membrane is reached, and to aid in the incision through this structure, it is seized with

a pair of forceps, uplifted and divided. The mucous membrane is next severed; and in doing this, caution is to be used not to split or penetrate the epiglottis, which is attached to the body of the hyoid bone. At the termination of the cut on each side, lie the superior laryngeal artery, and a branch of the superior laryngeal nerve; those parts, however, are situated so far to the side that the opening into the pharynx can easily be made without peril to them. When this opening is made, the epiglottis should be seized and drawn out through the cut. As soon as the thyrohyoidean membrane has been well severed by this transverse incision, the larynx descends so as to widen the cut to an extent that will allow of attacking the growth which is sought to be removed. After the growth has been removed, the wound should be closed by sutures, and the head bent forwards and retained so by a proper bandage.

Warts, Cysts and Polypoid Growths in the Œsophagus.—Besides large neoplasms, small growths of wart-like conformation occur here, gathered in groups, or isolated in situation; and these are oftenest seen in the aged subject. In the act of deglutition, the frequent passage of materials over these prominences finally erodes them, and causes a burning pain in the part.

A cyst may arise here from the closure of one or more mucous follicles, and the accumulation of the retained fluid.

The polypoid growth has frequently been observed in the œsophagus. Such neoplasm appears oftenest in the lower part of the pharynx, and in the wall next to the larynx. The frequent action of swallowing tends to displace such tumor downwards, and to elongate its pedicle. And, in time, it may thus acquire considerable length; an instance was seen by Rokitansky, in which the growth had attained the length of seven inches; and it was two and a half inches broad. And such tumors may be multiple; or rising from a common point, it may divide into two or more branches. Dermoid cyst has been seen here; and cases of lipoma have been reported by Klebs.

Such pendent tumor becomes ulcerated from repeated irritation; and it has been known to be detached, and the patient thus freed from his trouble.

The subjective phenomena of the œsophageal polypoid tumor are the sensation of a foreign body in the passage; and the patient makes repeated efforts to reject the same. In consequence of the difficulty of swallowing, the patient confines himself to liquid or semi-liquid food; and this is often swallowed

with effort, a part of it regurgitating and escaping through the mouth or nose.

Respiratory disturbance may be produced through the tumor pressing against the trachea; such pressure attenuating the calibre of the air-canal. A more dangerous condition is present when the growth, being seated in the upper part of the œsophagus, is carried upwards and falls, like a closing valve, on the opening of the air-passage. In such state, the patient has speedily perished from strangulation. Blood-tinged mucus is sometimes vomited. When of unusual volume, the tumor may cause a swelling which is visible on the neck.

Besides the respiratory trouble which such polypoid growth can cause, the partial closure of the alimentary tube interferes with the digestion of the normal quantity of food, and, consequently, such patient is inadequately nourished.

In the diagnosis of these growths, the œsophageal sound can assist; an obstruction may be detected with it, and the movable or immovable nature of the tumor can thus be determined to some extent.

The proper treatment of these growths is extirpation; and this should be done radically; for if a peduncular fragment be left behind, the growth will reappear. Different ways have been proposed to do this work. In the earliest essays at removal, this was done by ligating the pedicle and permitting the tumor to slough off. A second way was to seize the growth with forceps, and then twist it off, or pluck it from its attachment to the wall. The growth has also been cut off, without ligature: a method not to be pursued, since troublesome bleeding may thus ensue. The thermal cautery has been used: the loop of the heated wire including the pedicle and cutting it off. Or if the removal is not possible by any of these ways, then a direct route may be cut to the growth, either through the interspace between the hyoid bone and the larynx; or by external œsophagotomy.

Malignant Growths in the Pharynx and Œsophagus.—Epithelioma, the form in which cancerous disease here presents itself, has often been observed in the œsophagus; but as to its location there, surgical opinion varies. Zenker, from a series of cases too limited for a proper induction, finds that the disease occurs in the upper part of the canal in nearly fifteen per cent of the cases; and in the middle portion, in fifty-one per cent of the cases; and in the lower third, in sixty-three per cent; thus, as would appear from these figures, the disease increases in frequency

as one descends. Mackenzie, in a series of one hundred cases, finds the order of occurrence nearly reversed: to wit, he finds forty-four per cent in the upper third, twenty-eight per cent in the middle, and twenty-two per cent in the lower third, and six cases in the lower half of the canal.

The most usual sites of the disease are where the canal passes behind the bronchus, and where it traverses the diaphragm; for at these points, the canal, in its functional action, is more apt to be irritated; especially so, where the œsophagus passes through the diaphragm.

The disease occurs oftenest in ring form, in which a transverse section of the canal is involved; and such circular segment may vary in height from a half inch to three inches. In some cases, this ring-like invasion does not include the whole circumference; a small segment of the mucous membrane may be found not diseased. And instead of this regular form, the disease may be situated at different points; that is, there is interruption in its continuity. The disease is sometimes diffused over a larger surface: sometimes extending through the whole extent of the canal.

The epithelioma, whether on a small or large scale, tends to narrow the œsophageal canal; and this stenosis is greatest when the neoplasm exists in narrow circular form; for then the disease reaching the inner circular muscular fibres, shortens them. The disease having involved the entire thickness of the wall may invade structures contiguous. Ulceration appearing in the surface of the affected structure, the stenosis is lessened, and the functional trouble seemingly diminished. The extension of the disease to neighboring parts may so fix the œsophagus, through adhesions, that the movement of swallowing is impeded: solid food may lodge and afterwards be regurgitated. Also, from prolonged sojourn at one point, the alimentary matter may produce erosion: or cause an extension of the ulceration, which already exists. By penetration through the wall, an opening may be made into the trachea, bronchus, pleural or pericardial cavity; such penetration must soon end the patient's life; and life would end most speedily if the ulceration extended to and opened the aorta. Above the narrowed point there is dilatation: due to the collection and accumulation of the ingested material above the strictured part.

Metastatic propagation of the disease has been observed, according to Petri, in nearly sixty per cent of the cases; thus the

disease has reappeared in the glands which had anatomical connection with the diseased site; and it has been seen in much more distant situations: viz., in the lungs, liver, brain and bones.

The remote reappearance of the disease in glands, as well as in non-glandular structures, has been underrated; and according to Zenker, metastatic development is oftenest in the tracheal, bronchial and epigastric glands. If the disease be in the upper third of the œsophagus, the cervical glands may be implicated; the glands which are especially infected are those situated near the bifurcation of the carotid artery; also, the glands which lie above and near the clavicle, on the constituent nerve trunks of the brachial plexus. Such swollen, indurated gland, like an index, points to the cancer, and its situation in the œsophagus.

The general symptoms of cancer in the œsophagus vary in different patients: some emaciate and present poor health without marked local symptoms; in others the stenosis is the leading symptom. The pain is variable; its site is not so fixed that the surgeon can locate the cancerous point through the pain, since, often, the chief symptom is a disagreeable feeling at the pit of the stomach.

Betz, in 1853, gives the following as signs indicative of epithelial cancer in the œsophagus: when the disease is at the lower end, there is pain near the ensiform cartilage, or in the præcordia; but if in the upper part, then the pain will be in the throat; and in the middle portion, the pain will be felt in the middle of the chest. But if the entire canal be affected, then there will be the sense of a hot cord stretched from the throat to the stomach. Pain, wherever it may be, is awakened and increased by swallowing. Betz found the cancer in its structure to be medullary or fasciculated.

Ziemssen finds that the pain from œsophageal cancer is more severe at night. The canal becoming stiffened in its walls, and likewise narrowed, the difficulty of swallowing soon results. There is muscular unrest of the part, and the patient makes continuous efforts to swallow; or there is a retrograde action of the parts, manifested in retching and regurgitation. According to the site, the symptoms will vary; if the disease be situated low down, a considerable dilatation may take place above the narrowed portion, in which the solid ingesta may find lodgment; and then the retained content may only, now and then, be rejected. In the regurgitated material there is seen a thick gelatinous mucus,—a secretion from the irritated glands; and this has been compared to thickened milk.

After the epitheliomatous disease has lasted some time, and has caused almost entire closure of the canal, there may occur extensive disintegration and sloughing, by which the canal is reopened, and the calibre so restored that deglutition becomes easy, and the patient is cheered with the temporary illusion that his disease has vanished.

The recurrent nerve which lies close to the œsophagus may be implicated in the growth, and thus the laryngeal muscles, on one or both sides, may be disturbed in their function: a condition revealed by the suppressed or altered voice.

The sound can aid in determining the fact that the canal is obstructed, or narrowed. Any instrument, whether used for exploratory or alimentary purposes, must be introduced with cautious care; for the unseen point may stray from its proper route, and a false passage be bored into the wall. Surgical history abounds in accidents of this kind; and the swallowing of food, by the victim of such false passage, has precipitated the death which the cancer was more slowly bringing.

Matters vomited, or caught in the ear of the sound, subjected to microscopic study, may furnish additional proof of the presence of cancer.

The dry, swarthy skin of the patient, his rapid emaciation, reaching to the extreme of corporeal waste, the sunken abdominal wall, through which can be seen and felt the contained viscera, are symptomatic accompaniments of epithelial cancer of the œsophagus; and these are the visible expression of continued hunger, and progressing cancerous infection. The patient's scanty food is vitiated by the ichorous excreta of his disease.

The regurgitated matter can easily enter the air-passages, and become the cause of profuse bronchial discharge, and finally, ichorous pneumonia: a complication which will soon end life. In some reported cases, an opening has occurred into the pleural or pericardial cavities, with speedy death.

If unrelieved, the subject of œsophageal cancer dies within two years; Mackenzie places the average duration of the disease at eight months. The author, who has seen a number of cases, would place the medium duration at not less than one year; and as the time when the disease began is always unknown, it is probable that the disease has a longer duration than the figures here given.

Epithelial cancer in the œsophagus occurs oftenest in persons at the middle period of life; according to Mackenzie, the average

period in man is about fifty-two and a half years; in woman, forty-five and a half years. In forty-four cases seen in Berlin, only three were females.

The reason for the greater frequency in man may be found in his habits of drinking stimulating drinks: also his irregularities in eating food rapidly, or too hot. The subject of chronic dyspepsia is predisposed to cancer in the œsophagus, through the frequent eructations of acid or irritating matters from the stomach. Chronic catarrhal affection of the œsophagus or stomach favors cancerous development. A scar which has altered the form of the canal, and which impedes swallowing, furnishes the leading causal element in the evolution of cancer, viz., continuous irritation.

The disease is one which appeals most strongly for aid to the hands of the surgeon: for unrelieved, it slowly and surely destroys life; yet surgery with all its advances, can only offer uncertain relief. Epithelioma here, as at the threshold of the alimentary canal, is, for a period, a purely local affection; and if so situated that it can be wholly excised, a cure may be safely reckoned on. Unfortunately, the lower portion of the œsophageal canal is so located that disease there has a safe refuge from the surgeon's knife. Though the walls of the thorax have been opened, and its interior with impunity invaded, yet no hand has yet had the hardihood to lay bare the œsophagus in this recondite site, and make it the subject of operative attack. But when the disease is situated in the upper portion of the canal, it is within reach of some curative procedure, which may be cauterization or excision. Excision is the preferable method, and this might possibly, if the disease were high in the canal, be done through the mouth; a better way is to open a route from the outside, and remove the part when brought openly before the eye. Such an operation was proposed by Billroth, in 1870; but was done at a later period by Czerny. As preparatory work to œsophageal excision, Czerny first did the experiment of operating on a dog: he removed two inches from the œsophagus, and stitched the inferior part of the canal in the cervical wound. A sound was occasionally passed. The dog was soon allowed to take food by his mouth; but deglutition was not wholly satisfactory, since not long afterwards, a large piece of food lodged in the pharynx, and required removal. The wound rapidly healed, and to maintain proper permeability, a sound was passed from time to time; and while the dilatation was continued, the dog swallowed his accus-

tomed food, and remained well nourished. Later, the dog was killed, and there was found remaining a scar, which was not more than a half line broad, and this could readily be dilated and traversed by a sound.

This fortunate operation on the dog emboldened this ingenious surgeon to make a trial of the operation on a woman, aged fifty-one years, who was the subject of œsophageal cancer. For this purpose, on the left side of the trachea, Czerny made a cut from the hyoid bone to near the sternum, along the inner border of the sterno-cleido-mastoid muscle. The omo-hyoid muscle was severed; and the thyroid vessels, which were encountered, were caught, doubly tied and divided. The diseased œsophagus fortunately had contracted no adhesions to the contiguous parts. There was removed about two and a half inches of the œsophagus, which was the site of a cancerous growth, of circular form. The inferior portion of the canal was brought into the wound and fixed to the skin by eight sutures; a soft catheter was inserted into this, and the patient fed through this tube. The wound healed rapidly, and some months after the operation, the woman recovered, and was able to do her accustomed work. The patient preferred to retain the fistula, rather than to have an attempt made to restore the continuity of the canal.

Czerny has demonstrated by his work that a portion of the œsophagus can be excised: and hence, such an exsection is indicated in cases in which the cancerous disease is limited to an accessible portion of the canal. For example, if the affection be insulated or circular in site; but if it be diffused over an extensive tract of the canal, then such excision would be impracticable. Also, if the larynx were implicated, the exsection of the air-passage and the œsophagus would be a formidable or impossible operation. And whatever the site or extent of the disease might be, as long as deglutition were possible, the patient would reluctantly consent to an operation, which would exchange the site of entrance of his aliment from the mouth to an opening in the side of the neck. An operation to be effective should be done early: a condition too often excluded through the patient's preferring to abide with evils with which he is familiar rather than to take refuge in those unknown. And to this hesitancy may often be referred the lack of success of the deferred operation: for if the powers of repair are nearly exhausted, the surgeon's wound may only be an added factor in the destruction of life.

In the cases unfitted for total excision of the affected portion

of the œsophagus, it may still be possible sometimes to open the occluded canal, so that a tube for nutrition may be introduced, and the patient thus fed: thus a brief reprieve from impending death may be obtained.

In cases unsuited for resection, by the prudent use of the sound, the closed canal has been reopened, so that normal deglutition was possible for a short time; in such dilatation, force must be avoided, and the fatal consequences of a false passage must be borne in mind.

If the closure of the œsophagus be in the thorax, then life may be prolonged by the use of a gastric fistula, through which food can be introduced. The work done in this field by Sydney Jones, Schönborn and Verneuil has shown that it is possible to form a mouth directly into the stomach, and that life thus may be prolonged. As a rule, the respite gained has been so brief, that many authorities are undecided as to the value of the procedure. A patient seen by the writer, on whom gastrostomy was performed by Verneuil, was an example of the benefit of the procedure, in a properly selected subject; the patient was a youth, who was in good health in every way, except that his œsophagus was occluded by a neoplasm; this young man received permanent relief from gastrostomy.

Wounds of the Œsophagus.—Among the wounds of the œsophgus must be mentioned those of which the surgeon's knife has been the cause: as in resection of the canal, or œsophagotomy, done from the inside or outside. And, again, this canal has inadvertently been opened in tracheotomy, in which the knife wandered from its tracheal field, and implicated the œsophagus.

The accident of opening the œsophagus in tracheotomy is apt to occur in cases in which there has been much haste in opening the trachea: as may be demanded in the subject who is moribund from asphyxia arising from closure of the air-passage. Also, if tracheotomy be done by one stroke, instead of by successive steps of dissection, there is danger that the knife will reach the subjacent œsophagus: such an error can only be shunned by the experienced and well-disciplined hand. Where this accident has occurred, to prevent the entrance of materials from the œsophagus into the trachea, the patient should be fed through a tube reaching to a point beyond the wound. This tube should pass through the inferior nasal meatus, and be fixed permanently in its site. Wounds may be inflicted by an assailant, or by the subject himself: and such may be large, in which the œsophagus

is wholly or partly divided; or it may be a small penetrating wound. When small, the escape of mucus and saliva would denote perforation of the canal; and in a large wound, the character would be evident to sight and touch.

The treatment of a large wound usually consists in partial closure by suture, and alimentation through an œsophageal tube; but the small wound should be completely sutured, and the patient afterwards fed through a tube.

Gunshot wounds involving the œsophagus were the subject of study by Wolzendorf in 1880; of one hundred and forty-five wounds seen by him the most were produced by the gunshot missile. In eight cases, the external jugular vein was wounded, the internal jugular once, and the carotid artery in five cases. The spinal canal and cord were injured in three; and in three others, the brachial plexus was wounded. In seven cases, the windpipe was opened to save life, and in but one patient was this successful.

Pernicious, or ichorous suppuration may arise from opening the posterior wall of the œsophagus. Fifty-two cases of such wounds have been recorded: ichorous pneumonia was thus caused; and six patients died from this complication.

Wolzendorf finds that gunshot wounds of the œsophagus are twice as frequent as incised wounds: death from the former occurred in forty-four and two-tenths per cent of the cases; but from the latter twenty-two and five-tenths per cent died.

Stricture occurs oftener after gunshot wounds than after incised ones; yet fistula oftener follows the incised wounds.

When the œsophagus is entirely severed, mortality is twice as great as when the canal is but partially divided. And cases in which the thyroid cartilage is also wounded, are much more dangerous than those confined to the œsophagus.

Death from such wounds is caused most frequently by suffocation; yet it may come from general exhaustion. The fatal result can be accelerated by emphysema of the mediastinum, swelling of the larynx, or the entrance of fluids into the air-passages; and finally, hæmorrhage, or palsy of the vagus, may destroy life.

The local treatment consists in arresting the bleeding, providing for respiration, nutrition and the escape of the excreted matters. One should not attempt complete closure of the wound, either of the œsophagus or larynx; yet Wolzendorf advises partia closure: and for this, he employs deep sutures; and such deep

stitch should include both the œsophagus and air-passage, if these both be wounded. If the œsophagus be wholly severed, and the ends not freely movable, then one may loosen the ends, and approximate them by looped threads attached to the ends.

During the treatment of the œsophageal wound, the nutrition may be maintained through the rectum by nutrient injections; and as the wound sometimes has healed in a few days, the entire nourishment may be introduced in this way. Should the period of healing be prolonged, then Wolzendorf would not depend on rectal nutrition, but he would introduce a tube through the mouth; and if this could not be done, then it should be passed through the wound, and permitted to remain in the canal, for some time. Nutrition was less embarrassed by the gunshot wound than by the incised one.

In cases in which nutrition cannot be maintained by the rectum, nor by means of a tube passed through the mouth or the wound, then an opening should be made, lower down, into the œsophagus, and a tube introduced there.

The usual result of wounds of the œsophagus is narrowing of the normal calibre; to prevent this, a resort should be had to dilating sounds, which will counteract the tendency to stenosis. The daily use of such sounds should be continued, until the tendency to contraction has ceased: a period usually reaching through several months.

TRACHEOTOMY; BRONCHOTOMY.

Many generations of physicians and surgeons have read and adopted the writings of Hippocrates as articles of faith which should not be questioned; unfortunately for the advance of Medicine, these doctrines contained some serious errors: as an example of this may be cited the aphorism in which it is stated that section of cartilage or bone will not be repaired. And this erroneous belief retarded surgical advance, since it condemned as incurable, cases in which interference with these structures was demanded. For who would venture to wound cartilage, if such wound would not heal? Men, however, had eyes, and wounds of these structures came under their observation, in which repair did take place; but the error was planted so firmly by the Father of Medicine, that the hands of many generations of medical men were required to pluck it up, and to plant in its place, the fact that cartilage when wounded will heal. The studies of Goodsir, Vir-

chow and Billroth have discovered that the repair is mainly accomplished by cells that are the offspring of the maternal tissue.

The trachea was opened long before the knowledge had been gained that cartilage, when divided, would reunite; yet the work was so done as to avoid the cartilaginous element of the tracheal wall. Thus Paul of Ægina, in the fourth century, relates that Antyllus opened the trachea for relief where suffocation was impending, or a foreign body had entered the air-passages: and his plan was to make a transverse incision, between the third and fourth tracheal rings. In thus cutting, the cartilage was spared. The sudden exit of the air, and the extinction of the voice, proved that the air-canal had been opened. The wound was maintained open by means of two hooks. As soon as the patient could breathe easily, the wound was closed by sutures.

From the time of Paul of Ægina to the sixteenth century, one finds in the annals of medicine, references to this operation of Antyllus; the Arabians, as Avicenna, and the early French surgeons, also mention it; but it appears to have only been resorted to, in cases of emergency, in which life was imperiled by impending suffocation.

The operation was done by the Italian surgeons in the sixteenth century. Fabricius d'Aquapendente operated by first making a vertical cut through the skin; then he entered the trachea transversely between two rings. He used a canula to permit the passage of air, and his pupil Casserius gave the canula a curved form; and he held this in place by cords which passed around the neck. In the latter part of the sixteenth century Sanctorius, of Padua, made the opening into the air-canal by means of a trocar, which, being thrust in, the ensheathing canula was left in place.

In the seventeenth century the operation was done in Germany, France, Italy and Portugal. In France it was done by Habicot on a boy who had swallowed coin; and to save his life, the trachea was opened.

In the eighteenth century there were two methods pursued in the work: in one the operation was done by a trocar, which was plunged into the trachea at one thrust; thus Richter and Decker operated; and, as will later be seen, this old plan of Sanctorius has had its advocates in the nineteenth century. But as anatomy was more studied, and operative work became more accurate and adroit through preliminary exercise of the hand on

the cadaver, then the surgeon preferred to open the air-passage by methodical dissection; and then, the fear having been discarded that wounded cartilage would not heal, a vertical incision was boldly made through the anterior wall of the trachea. And the error taught by Hippocrates ceased to exist after its long course through the centuries: a circumstance which finds a semblance in the two great rivers of the Western World, of which the clear waters of the one receiving the turbid waves of the other, the current of the two remains clouded afterwards, and the turbid pollution of the water only vanishes when the great stream has traversed a continent: a lesson to medical or surgical authority to avoid adding perturbing error to the ever changing and yet enduring course of our venerated science.

The operation was originally named bronchotomy, but in the eighteenth century it was given the name of tracheotomy, which name gradually superseded the older one.

The single canula was used for a long time; a double one was introduced by Martin, which device offered the advantage that when one canula was removed the other remained in place.

Despite the brilliant successes which were obtained through the operation, it did not become popular until Louis, an eminent authority, wrote a monograph on the subject, which tended to generalize the procedure. Louis claimed that in some cases the operator had not penetrated the tracheal canal; and that this fatal mistake was not confined to Louis' times, but is sometimes committed to-day, lies within the writer's observation.

The operation was first done for the purpose of removing foreign bodies, which, having entered the air-passages, caused suffocation; later, tracheotomy was done for relief in cases in which asphyxia was induced by other causes: for example, by fracture of the larynx, or in wounds of the throat which led to tumefaction and closure of the air-canal. In the eighteenth century the sphere of the operation was yet further widened through its employment for relief of suffocation originating in anginous disease of the throat. Thus in cynanche trachealis, to-day designated croup, it was proposed by Home to open the trachea, and thus permit ingress of air below the site of the occluding disease.

Such an operation was successfully done by John Andrew, in London, in 1782. The operation at first found but few advocates; in fact, though advocated by Crawford, Stoll and other eminent authorities, it was generally opposed. Tracheotomy, for relief in croup, found in the nineteenth century earnest advo-

cates in Bretonneau and Trousseau, in France, and in Pitha, Roser, Langenbeck and Hueter, in Germany; the greatest credit is due to Trousseau, whose able pen pleaded eloquently for it, and whose scalpel achieved a success for the operation, which place it among the truly life-saving procedures; and as tracheotomy is usually done on the young subject, surgery is able to point with satisfaction to achievements here in which many years of existence are given to the rescued patient.

In recent times tracheotomy has obtained a still wider sphere of application. An enumeration of the various cases in which the operation may be resorted to as a remote aid, or as one at once necessary to save life, are the following:—

1. Foreign bodies which have entered the air-passages, and which, unremoved, will destroy life.

2. Scalding from steam, hot water, or an acid or alkaline solution, which cauterizes or destroys the mucous surface with which it comes in contact.

3. Injuries of the larynx, as fracture of the thyroid or cricoid cartilage, fracture of the os hyoides; also, for relief after incised, lacerated, or gunshot wounds of these parts.

4. Inflammatory or œdematous processes in which, through cell-growth or local hyperæmia of the parts, the air-passage is rendered too narrow for the transit of air in respiration. An abscess at the entrance of the larynx or in the cervical structures, so situated as to compress the air-canal, may demand tracheotomy to save life. Likewise, a neoplasm, benign or malignant, by encroachment on the air-canal, may lessen its calibre and become an indication for the operation.

5. Œdema, or inflammation in the lower part of the trachea, may so narrow the canal that a sufficient amount of air cannot be received to maintain life; through an opening, made into the upper part of the trachea, air may be admitted, and a way opened by which the affected part can be reached and treated.

6. In cases of apparent death from an anæsthetic or from hanging, submersion in water or other asphyxiating medium, tracheotomy furnishes the most direct route by which air can be introduced into the lungs. Also, when apparent death has arisen from immersion in carbonic acid or other asphyxiating gas, then a tracheal opening furnishes the shortest way by which air can reach the lungs for restoration of the patient.

7. Laryngeal and tracheal stricture from some chronic morbid process seated in the wall of the air-passages may require tracheotomy.

8. Tracheotomy may be demanded by aneurism or by some body lodged in the œsophagus.

9. Neoplasm springing from the inner wall of the trachea or larynx may be reached by tracheotomy.

10. In palsy of the recurrent nerves which supply motor innervation to the muscles which maintain the glottis open, the operation may be done.

11. As a preparatory act to some operation on the pharynx or larynx, or as an aid in the removal of growths from the neck, tracheotomy is sometimes preliminarily performed.

12. Croup and diphtheria: for the relief of the patient suffocating from these diseases, tracheotomy is oftenest resorted to; and under this head the instrumental apparatus for, as well as the methods pursued in, the operation of tracheotomy will be fully considered.

Foreign bodies in the air-passages: this accident has been treated of, and it remains here to say that after the non-operative means have been fruitlessly tried, then tracheotomy, or laryngotomy, as the case may indicate, should not be deferred. Promptness, and not delay, should be the rule of action; for by procrastination the foreign agent may irritate and inflame the parts with which it lies in contact; and, besides, during the lodgment, the subject is deprived of the normal amount of air.

Scalding from steam, hot liquid, or the swallowing of acids, alkalies or other escharotic agents: the injury from any of the agencies here named may excite an œdema or inflammatory swelling of the interior of the larynx, which may suddenly close the glottis and cause death; in such emergency, if suffocation seems imminent, tracheotomy should be resorted to; and a canula being introduced must be worn until the patient has recovered from the effects of the injury. And should the injury have been inflicted by an escharotic agent which can be neutralized by some counter agent, then the tracheal opening will serve as a way by which the corrective means can be introduced: thus oil may enter and check the destructive alkali; or an inert alkali may arrest the action of an acid. And should subsequent stricture impend through cicatricial contraction, then the surgeon must not be in haste to remove the canula, but this must remain in place, while the mechanical treatment is being carried out, to prevent the formation of a stricture, or for the removal of a stricture already formed. Such treatment consists in the occasional introduction of graduated sounds into the larynx or trachea,

as the case may demand. If it be probable that the heat or escharotic has penetrated below the larynx, then the opening should be made as low as possible in the trachea. The tracheal opening may sometimes be utilized for the admission of instruments in the treatment of the stricture.

Injuries of the larynx, as fracture of its component cartilages, with or without fracture of the hyoid bone, may so close the air-passages that death may speedily occur. Gurlt has collected a series of forty-two cases of such injury; in the most of these, the larynx alone was fractured; yet in a small number, along with this there was also fracture of the hyoid bone, or of the trachea. Death occurred in nearly all these patients in whom tracheotomy was not performed. Hunt has reported twenty-seven cases of such fracture, of whom seventeen died, ten recovered, and in six of the latter tracheotomy was performed. Durham has collected a series of sixty-two cases of such injury, of whom fifty died; only twelve recovered, and in eight of the recoveries tracheotomy was performed.

A result of such injury is dislocation of the fragments, causing occlusion; or there may be effusion of blood in the submucous tissue, and swelling, which closes the canal. Or the fracture may lacerate the mucous membrane, and lead to emphysematous infiltration of the soft parts: in respiration, the inspired or expired air being pumped into the tissues, until fatal occlusion of the passage is produced. The facts stated show the gravity of laryngeal and tracheal fracture; and so greatly are the chances of life increased by tracheotomy, that it has been advised to perform it, when the diagnosis of fracture has not been clearly established. After the trachea has been opened, there is offered an opportunity for replacing the ill-placed fragments; also facility is thus offered for checking subsequent strictural encroachment of the broken parts on the canal.

Langenbeck counsels tracheotomy in all cases in which a wound has been made which involves the glottis or epiglottis; for such wounds may end fatally, as was seen in the young assassin Blind, who attempted to kill Bismarck, and afterwards tried to kill himself by thrusting a penknife into his neck; the instrument penetrated the base of the epiglottis and produced an extravasation of blood into the tissues, which caused fatal suffocation.

In cut-throat, in which the trachea, larynx or pharynx is wounded, tracheotomy is often demanded as prophylaxis against

the suffocation which may arise from the wound; for in such injury, a portion of the laryngeal wall may be sliced off, and act as a valve which can close the passage, and speedily suffocate; and the knife of the suicide has done similar work in splitting the epiglottis, and converting it into a fatal valve.

In case of an incised wound that completely sunders the trachea, permitting the lower end to bury itself in the cervical structures, then the divided ends should be reunited, and a canula, shown in the subjacent figure 101, may be inserted at the site of

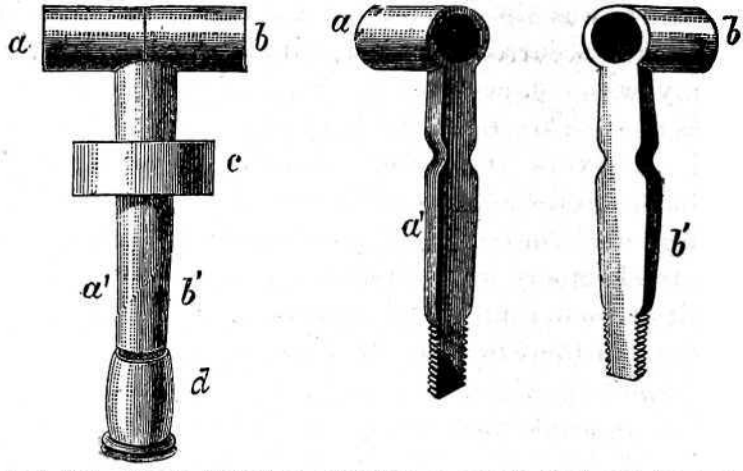

FIGURE 101. From Schüller, showing a canula that can be inserted in sections *a* and *b;* and when placed in site, the sections can be locked, as shown at the left, *abd*.

the wound; or, what would be preferable, should the space permit it, an opening should be made into the trachea below the wound, and an ordinary canula inserted there: thus done, there would be less interference with the union of the divided ends.

Among the indications given for the performance of tracheotomy, an important one is that under the fourth head, in which the air-passage is obstructed by œdema, or some inflammatory process. Œdema, in which serum is effused beneath the mucous membrane, when situated in the aryteno-epiglottidean folds of this membrane, may fatally close the entrance of the larynx; also, œdema invading the glottis itself, may early close that narrow passage. The loose adherence of the mucous membrane to the vocal chords is an anatomical condition which disposes to serous accumulation here, in case the efferent veins of the laryngeal or cervical structures are compressed, through some enlargement or tumefaction. And this causal agency is sometimes

present in diffuse pharyngitis or tonsillitis, which ends in suppuration. Or such inflammatory and suppurative process may arise in the tissues which lie outside of, but close to, the larynx; such affection not unfrequently travels and climbs over the thoroidean walls, and entering the cavity of the larynx, obstructs the passage.

Instead of arising passively through obstruction of the veins, as simple œdema, it is probable that, quite as often, the process is an active one, in which through inflammation a cell-growth is formed, which, as an interstitial element, adds to and so thickens the normal tissues as to diminish the normal calibre to a degree that breathing is interfered with.

In these cases, whether from passive œdema, or active inflammatory swelling, tracheotomy is given high rank as a life-saving operation by Pitha, who, in 1857, wrote on the subject. He claims that it is of signal service in both œdema of the glottis and laryngeal stenosis from other cause; and that the tracheal opening tends to dissipate the obstruction. Even cicatricial narrowing above the tracheal opening seems to gradually widen. And he observed that where the respiration is hampered, the tracheal mucous membrane, as well as that of the passage above, becomes swollen; in such cases, tracheotomy, like a charm, removes the turgid state of the parts, and the cyanosis from venous blood, soon passes away. Also, when, from ulcerative action in the larynx, catarrhal excretion menaces suffocation, then tracheotomy gives relief.

If an abscess by its pressure occludes the air-passage, the former should be freely opened; and this will usually suffice for the removal of the dyspnœa; should it not do so, then the trachea should be opened below the constricted part. Also a tumor, lymphomatous, goitrous, sarcomatous or carcinomatous in nature, may encroach on the air-canal and diminish its calibre; in such cases the difficulty of breathing can commonly be alleviated by extirpating the growth; but should the growth recur, then a recourse must be had to tracheotomy for further relief.

In the cases here cited, an invariable rule for guidance can scarcely be established; whether tracheotomy should be performed will depend on the amount of dyspnœa that is present; and, also, whether this is increasing or lessening; and if it be increasing, the surgeon should not delay to furnish relief by a tracheal opening, even though the alleviation be transient.

Another indication for tracheotomy is that in which the tra-

chea is narrowed below the site where section can be made, by œdematous or inflammatory change, or by the pressure of a growth; in such cases, relief can be given through tracheotomy which permits the introduction of a long canula through the narrowed canal. Such a canula may reach into the chest; and can maintain patency sufficient for respiration, despite the encroachment of the constricting agency. An example of such use of tracheotomy was seen by the writer in a case of lymphomatous enlargement of the glands, in which the neoplastic development involved the glands around the trachea in the upper part of the mediastinum. Though the disease was incurable in the patient referred to, yet signal relief was obtained by the operation, and life prolonged.

Tracheotomy is a means of relief in cases of asphyxiation through chloroform and narcotizing gases; as well as an aid in resuscitation of those who have been suffocated through submersion in a liquid or semi-liquid medium, or who have been buried in sand, earth or other pulverulent material.

In a case of apparent death from a mixture of ether and chloroform, used as an anæsthetic, the writer recalled the man to life, by rapidly opening the trachea and blowing air into the lungs. It was necessary to continue the insufflation of air for some time, before normal breathing was resumed by the patient.

An objection has been offered against such insufflation of air into the lungs, that the thoracic walls remaining stationary, there is not room for expansion of the lungs; and that the air being forced into them would rupture the air-cells. This risk might be avoided, and the work done better, if insufflation were combined with artificial respiration, done according to Silvester's plan; that is, the air should be blown into the lungs when the arms are uplifted, corresponding to the inspiratory act; and the insufflation should be suspended during the expiratory act of lowering the arms, and compressing the chest. Done in this way, the air blown in would not injure the pulmonary tissue. This procedure may be done in all cases in which there is apparent death from a poisonous gas, or from suffocation by submersion in sand or some agent which would close the entrance to the air-passages.

In case the asphyxiating agent which has entered the air-passages, be a liquid or a semi-liquid material, then tracheotomy is urgently demanded as an aid in restoration; since it opens a more direct way by which the material may be removed. This

subject has been studied by Schüller, of Greifswald. After the entrance of such matter, he finds that it is in vain to attempt removal by emetics, since the patient is so nearly dead that these cannot act; it is better to make a tracheal opening as Hueter has practiced, and through this pass a flexible tube, and by suction extract the matter.

Schüller experimented on animals to determine to what extent the presence in the air-passages of such materials can be tolerated. He found that if water were slowly admitted along with air, a large quantity could be borne with impunity; in twenty-five minutes, there was admitted an amount of water equal to one-thirtieth of the rabbit's body. The animal lived for some days, after such addition of water to the blood. An examination of the lungs did not reveal any special changes in their tissue; the water had disappeared through absorption. The animals thus treated, as a rule, lived but a few days; proving that the sudden introduction into the blood of such large quantities of water imperils or destroys life. Milk was also injected, and considerable quantities of it were tolerated; and, on necropsy, it was found that the most of it had been absorbed; yet milk globules were found in the interstitial tissue of the lungs. The lungs were found to possess the power of absorbing a considerable quantity of milk; but if a thicker or semi-liquid material was thrown in, but a small quantity of it was tolerated. Thus of a mixture of milk and flour, or of flour and water, not more than three cubic centimetres could be tolerated, while of pure water thirty-two cubic centimetres could be borne. After the injection of the mixture of flour in limited amount, the animal continued to live; and afterwards when killed, remains of the flour were found in the alveolar tissue of the lungs.

Schüller concludes that simple artificial respiration does not aid in restoring the patient suffocated by semi-fluid material; in fact, it tends to imbed such matter more deeply in the branches of the bronchi; but more effectual aid will be rendered the subject of such asphyxiation, if a tracheal opening be made, and through this a tube be introduced and the material directly drawn out through suction through the tube. But if the material be a thin liquid, then artificial respiration, unaided by such aspiration, will suffice to cause the expulsion of the matter.

Schüller discovered that the amount of the liquid or semi-liquid material which could be introduced varied according to the kind of animal experimented on; thus the rabbit was less

tolerant than the dog; the dog would bear the introduction of a quantity of water equal to one-fourth the weight of his body. Also, the manner in which the material was introduced had an influence on the amount which could be borne: thus, if slowly introduced, a much greater amount was borne than if it were injected rapidly.

Along with this work of aspiration that of artificial respiration should be done; and this may be done synchronously through traction on the limbs; or it may be done alternately with aspiration done through the tracheal opening.

In all these cases of restoration from apparent death, in which tracheotomy is done, it will not be necessary to retain the tube in place for a long time; for as soon as restoration has been fully accomplished, the canula can be removed, and the wound closed.

An important indication for tracheotomy is constriction of the tracheal or laryngeal canal through some disease seated in the walls of these passages; and such disease is oftenest tubercular or syphilitic: more frequently, syphilitic. This has been studied by Trélat, who, in 1869, wrote on the subject from the observation of two cases, and from the history of twenty-five others found in surgical literature.

Trélat finds that the ravages of syphilis in the air-passages diminish as one descends towards the lungs. The morbid changes occur oftenest in the larynx; and the points usually ulcerated are the aryteno-epiglottidean folds, and the base of the epiglottis. In only five cases was the ulceration found in the trachea. Stenosis from such lesion occurs only in the later stages of the disease. The primary gummy infiltration continues for a longer or shorter time; then ulceration succeeds; and finally, this cicatrizes, and narrows the passage. Some four or five years are required to reach this contractile period. As verifying this, in seventeen cases tracheotomy was done only after five years and a half had elapsed from the beginning of the syphilitic disease. Of these seventeen cases four died.

Demarquay made a study of this subject, and found that syphilitic ulceration in the adult often leads to stricture. Symptoms of such narrowing are impeded respiration without loss of voice the breathing is labored, and, in inspiration, the larynx is drawn down towards the sternum. There is immobility of the larynx and trachea during swallowing; and, finally, the trachea and the tissues about it seem thickened. When such symptoms appear, Demarquay performs tracheotomy.

In case the stricture lies deep, the tracheal opening should be made just below it; thus, the stricture is accessible from underneath, and in some cases, its dilatation has been accomplished. For the work of widening, special instruments in graded dimensions are needed. One which Trélat used was a canula consisting of four blades, so divided that the blades could be separated or spread apart; and thus dilatation could be slowly or rapidly done. Such dilatation, to be successful, must be patiently continued many months.

It has fallen within the experience of the writer that there are cases in which the dilatation cannot be satisfactorily accomplished; and in such the canula must be continuously carried. The patient finally tolerates the instrument, and becomes oblivious of the annoyance which it gave in the commencement of its use. When the canula must remain permanently in the trachea, it should be provided with a fenestra, through which enough air can pass to awaken the vocal chords to vibration; and, thus provided, the patient can, at will, close the outlet of the canula with his fingers, and force the expired air to pass through the glottis, and do the service of phonation. A canula which must remain long in place is better constructed of hard rubber than of metal: since the latter corrodes, or is tarnished by the excreta which constantly come in contact with it.

An occasional demand for the operation is an aneurism pressing on some portion of the air-canal, and which is so located that the trachea can be opened below it. Such an aneurism might arise from the primitive or secondary carotids, and possibly from a branch of the subclavian artery. This indication, according to the writer's experience, is rare.

A body entering the œsophagus, and too large to be swallowed, has pressed on the trachea and nearly closed it. In such a case, should the attempt to remove the body fail, and suffocation be impending, or apparent death have supervened, then tracheotomy should be speedily done; and the emergency having passed, steps may be taken for removing the compressing object; and when this has been accomplished, remove the canula and close the wound.

A neoplasm may spring from the inner wall of the larynx or trachea, and interfere with respiration; if in the trachea, such growth is most easily removed through an opening made into the trachea; and afterwards, a canula may be worn for a short time, or the wound may be closed at once. Such opening should

be made at a point which will render the growth most accessible. The adept in tracheoscopy, and who is expert in the manipulation of instruments in the air-passages, might possibly reach the growth *per vias naturales*, and extirpate it; yet such visual and manual art is too infrequent to render it probable that the work will ever be withdrawn from the province of the general surgeon. There is a winged insect which the writer once heard Milne-Edwards describe, which bores through the base of the corolla to the treasure to which the long tube denies access; in a similar way, the surgeon makes a short route to the growth by opening the trachea.

A necessity for the operation may occur from the palsy of the inferior laryngeal nerve, whereby the posterior arytenoid muscles lose their function of maintaining patency of the glottis. Such indication is rare, since it will rarely happen that the two are palsied; unilateral palsy would cause but partial closure; nevertheless, Ziemssen has collected a few cases of the so-named recurrent palsy, and in six cases tracheotomy was done to save life. Mackenzie saw cases of palsy of the outer muscle of the larynx which caused stenosis of the glottis. The posterior arytenoid muscle may be temporarily paralyzed by hysteria; in such patient to open the trachea would be an error; electrization should be resorted to; or the cold douche, if continued long enough, will conquer the rebellious muscles, Skey quaintly remarks.

The recurrent nerve, on one side curving around the aorta, and on the other, around the right subclavian artery, may be compressed by aneurism at these sites; thus recurrent palsy arising, some relief of the consequent dyspnœa has been obtained by tracheotomy.

In tetanus, the dyspnœa which arises from spasmodic contraction of the laryngeal muscles, may have palliation through tracheotomy. In such a case the author performed it, and though the patient's life was not saved, yet it was prolonged, and his condition made more tolerable.

Tracheotomy is sometimes done as a prophylactic preliminary against the entrance of blood into the windpipe, during operations on the tongue, floor of the mouth, maxillæ and pharynx. For this purpose it was done by Nussbaum prior to 1870; but in 1870, an improved method of doing the work was proposed by Below and Trendelenberg. Below's plan was to open the trachea, and pass in, and inflate an elastic balloon above the wound; thus done, blood descending from the parts above could not pass

beyond. Trendelenberg made a study of such tamponing, and found that Below's plan was imperfect; and besides, the tampon caused constant irritation and cough. To shun these inconveniences Trendelenberg invented a tampon that was similar to a small India-rubber balloon which surrounded the vertical stem of the canula; and when the latter was inserted, the balloon being uplifted, the trachea was completely occluded, so that nothing could descend below the canula.

The writer, in cases in which only temporary tamponing is needed, has accomplished this work in a somewhat different manner, as follows: an ordinary canula is inserted in the tracheal opening, and then the pharynx is closely plugged with a sponge; thus prepared, any cutting procedure can be done on the parts above, without risk of the blood entering either the œsophagus or the air-canal. As soon as the bleeding has been controlled, the sponge may be removed; and the canula can be left in the trachea for whatever time the case requires.

But if the case be one in which the healing will be tedious, and the excreted detritus may be considerable, to guard against the descent of the latter to the lungs, and the resultant ichorous pneumonia, then the canula with tampon should be used. Such canulated tampon may be continued in place for eight or ten days; and even if it be continued for a longer period, no ill results from it. An objection that can be urged against this procedure is that in some cases the tampon causes an irritating cough. And the same, however, might be urged against the simple canula; in his experience in its use, the writer has met with patients in whom the inserted canula caused an irritating cough; and it could only be borne by giving some medicine to lessen this irritability; and for this purpose, the camphorated tincture of opium may be given to a child, or morphia to an adult; and instead of these remedies, the bromide of potassium may be given in doses of three grains to the child, and a larger amount to an adult; and such remedy need only be continued until tolerance of the canula has been acquired.

Of the various emergencies or morbid conditions which demanded tracheotomy the one which stands proëminently in the foreground, is stenosis of the air-canal caused by croupal or diphtheritic neoplasm. Whether this occluding neoplasm is of single or dual origin is more a matter of controversy among pathologists than among practitioners of medicine who have frequent opportunities to observe the disease. American and

English physicians agree in the main that croup and diphtheria are different and distinguishable diseases; the French, here, as on another great pathological question, are divided into unicists and dualists; the Germans, as a rule, teach that croup and diphtheria are different forms of the same disease. The writer's observations confirm him in accepting the doctrine of duality, viz., that there are two diseases, in which the inflammatory process is followed by the appearance of a membranous structure on the mucous surface of the air-passages. This pseudo-membranous development is much more limited in croup than in diphtheria; in the former, the false membrane appears chiefly in the larynx and trachea; but the diphtheritic neoplasm, besides appearing in these parts, is present on the mucous membrane of the entire pharynx and nasal passages. The diphtheritic growth has been seen, as a rare occurrence, on the mucous lining of outlets of the genito-urinary organs, and the rectum.

When compared in respect to contagiousness, croup is not communicable, while diphtheria is eminently so. Croup is the disease of infants, and is only exceptionally seen in adults; diphtheria occurs in both infants and adults. Croupal disease is limited and superficial in site; diphtheria, besides its tendency to superficial invasion and generalization, penetrates inwards; and the septic principle existing in the affected surface is conveyed by the lymphatics to the neighboring glands, and awakens in the latter a rapid cell-growth. This glandular enlargement occurs first in the floor of the mouth, and at the angle of the lower jaw; thence it extends downwards on the side of the neck, in the chain of glands, which are adjacent to the large cervical vessels. This glandular enlargement is remarkable for its rapid development, and the great volume to which it can attain in a brief time. In croup, such glandular implication does not occur. The diphtheritic disease may affect the sinuses of the dura mater and cause coagulation of blood; and thus the encephalic circulation may be fatally interrupted, as was the case in a patient of which the writer witnessed the necropsy made by Bouchut. Such thrombus or embolism in the vessels of the cord, may account for the palsy that sometimes follows diphtheria.

The results of tracheotomy differ greatly in the two cases: an operation in the patient of diffused false membrane rarely saves life; but in the patient in whom the disease is confined to the larynx and trachea, life is often saved. From these clinical facts the inference is deducible that the distinction of these morbid

processes into two different classes is not only permissible, but it is necessary.

And finally, on the scene of this investigation, another witness appears: the bacteriologist finds a microphyte which is present in diphtheria, and is absent in croup; and to this microphyte is assigned the causal agency of the diphtheritic process. This microphyte may be the inceptive factor in causation; but the subsequent dissemination of the disease is partly due to the septic matter that arises from the death and putrefaction of the membranous pseudoplasm.

Returning from pathology to the domain of internal medicine, what chiefly concerns the tracheotomist in croup and diphtheria is the narrowing of the air-canal by a pseudomembrane, and which, unrelieved, progresses until the laryngotracheal canal is so small that fatal asphyxia ensues. In each disease the operation relieves temporarily or permanently the oppressed respiration, and furnishes air by which the circulating blood is unburdened of the carbonic acid which unfits it for the maintenance of life.

For a time, the anatomists led by Allan Burns taught that serious ill would result from the vertical section of the cervical fasciæ which overlie the trachea, and were supposed to relieve the tube of some of the pressure of the atmosphere; but the operation repeated innumerable times has long since demonstrated the groundlessness of these apprehensions; exposure of the canal in the otherwise healthy subject is not followed by collapse of its walls; and after recovery from such exposure or section, the trachea loses none of its functions.

The time when the operation is done in these diseases has great bearing on the successful or unsuccessful result; an unsuccessful result too often depends on delay in the work. When the tissues are once laden with non-aerated blood, the free admission of air into the lungs, though it mitigates the urgent symptoms, yet often comes too late to the rescue. Hence the watchword should be to meet the enemy early, before he has mastery of the citadel. The advance of the disease is insidious and by no means uniform; the neoplastic structure, in some cases, developing slowly: in others, rapidly. An enumeration here follows of the symptoms which denote that the subject of croup or diphtheria has reached the stage in which delay is perilous: The inspiratory act is made with effort, and it is accompanied by a hissing sound from the air being sucked through the narrowed canal; and,

at the same time, from the vibration of the vocal chords, a hoarse or croaking sound is produced. This sound may be simulated by the vocal sound which is made when air is drawn into the lungs: such phonation as the ventriloquist sometimes uses in his art. From an insufficient quantity of air reaching the lungs, the blood is imperfectly oxygenated; and, that venous blood is circulating in the arteries is apparent in the cyanosed or purplish hue of the lips and cheeks. And as a result of this, the patient is in a state of partial anæsthesia, so that an incision awakens but slight pain. This anæsthetic condition has been especially noticed by Bouchut. Though such insensibility to a wound exists, yet the patient is in a state of great restlessness, throwing his limbs hither and thither; and, in his disorderly movements, the patient seems seeking a position in which he can breathe more easily. In his efforts to get more air, he tries to catch or seize it with his mouth. And this labored breathing is revealed by unusual movement of the nostrils, mouth, neck, chest and præcordial region. The nostrils contract, the corners of the mouth are drawn laterally, and the lips, especially the lower one, are everted. The front part of the neck, and particularly the jugular fossa, are drawn inwards and downwards, under the border of the sternal manubrium, during the inspiratory act; and these parts, in expiration, recede again to their normal position. The action of the diaphragm is peculiar: it contracts in inspiration as usual, but as the lungs do not receive enough air, through stenosis of the afferent canal, to fill them, a vacuum would arise if the præcordial wall and the sides of the thorax did not sink inwards. In fact, the in-sinking of the jugular fossa and the lower part of the thorax and præcordia is due to the weight of the external air resisting the formation of a vacuum, which, otherwise, would arise within the thorax. Such change in the form of the chest occurs in a far less degree in the adult, whose costal structures, both osseous and cartilaginous, are less yielding.

As the disease advances, the dyspnœa, which, at first, was so prominent a symptom, may lessen and awaken the illusive hope that the disease is stayed in its progress, and that the patient is better: and thus the medical attendant may be lulled into inaction and allow the precious moment to escape when an operation might have saved life. As signs that the patient is not better are the rapid breathing, and the livid lip and cheek, showing that venous blood is replacing arterial; in such cyanosed patient the insidious truce is an additional monitor to prompt surgical

action; as Hippocrates puts it, medicine failing to cure, the knife may.

Among the advocates of tracheotomy there are differences of opinion in reference to the site to be chosen for the work, the manner in which it is to be done, the risks which attend the operation, the use or non-use of the canula, the form of the latter, and numerous other points of greater or minor importance; hence with, perhaps, some risk of repetition and of tediously elaborating this chapter, the writer will proceed to the citation of a number of authorities who have written on tracheotomy, and expressed their opinions on these points.

Petel, in 1841, offered a report of one hundred and twelve tracheotomies, among which were twenty-eight cures. He advises where the danger of suffocation is imminent, to make an immediate incision into the windpipe, regardless of hæmorrhage, since bleeding soon ceases after the opening has been made. In one hundred and nine cases operated on by Trousseau, in no one was he compelled to resort to ligature or torsion. After the opening was made, Petel used a piece of sponge, a feather, or injections of water to remove the excretions found in the trachea.

As after-treatment of the patients on whom he had operated, Trousseau, in 1842, recommended, as an application to the interior of the trachea, a solution of nitrate of silver, in the strength of one grain to the ounce of water; of this he dropped into the canal from fifteen to twenty drops, four times on the first day, three times the second day, and twice the third day. Where the cough is dry and the expectoration slight, Trousseau counsels to drop into the trachea, every hour or two, from ten to fifteen drops of water. A dry adhesive excretion resembling mucilage of gum Arabic, is an ill omen. Of one hundred and twelve operations, twenty-seven recovered.

Though Trousseau had no trouble from hæmorrhage in his operations, yet others have had; and this sometimes depends on vascular anomaly, especially that in which there is a fifth thyroid artery. Gruber having frequently met this artery, published, in 1844, a carefully written dissertation on the subject. He found that it occurs one time in ten cases. The vessel arises oftenest from the innominate artery; though sometimes, it arises from the arch of the aorta between the innominate and the left carotid; and exceptionally, it arises from the carotid or the inferior thyroid. When found, it is oftener on the right side. The middle lobe of the thyroid gland was found in one-half of the cases.

Gruber advises when the opening is made through the crico-thyroidean membrane to make the cut a transverse one, and through the upper third of the space; that is, close to the lower margin of the thyroid cartilage.

In 1850, Sestier wrote exhaustively on tracheotomy; and especially in its use as relief in œdema glottidis. As ill events, which may complicate the operation, are the entrance of air into the veins, and the entrance of blood into the air-passages; also, the trachea may be imperfectly opened, and it may afterwards be occluded through swelling of the submucous tissue. As more remote complications are suffocation from spasm of the bronchial muscles, closure of the bronchi with mucus, bronchitis, delirium, convulsions, ill results from the premature removal of the canula, the entrance of fluids into the wound from careless drinking; finally, a fistula may remain after the operation.

Impending suffocation from oedema is an indication for its performance. And if the patient is dying, or has ceased to breathe, Sestier would do it; and he would use for opening the windpipe, the first instrument at hand; even a pocket-knife would do, and crooked pins might do the service of retractors, and a quill act as a temporary canula; and in such emergency, he would operate high up, viz., through the crico-thyroidean space, the cricoid cartilage, or through the cricoid cartilage and the upper tracheal rings. When a choice of site is permitted, Sestier would select cricotomy or crico-tracheotomy, since these sites allow the best inspection of the air-passage: and should the cricoid cartilage be ossified, then the section should be made through the upper tracheal rings. The Pomum Adami serves as a guide for finding the cricoid.

For the admission of air, a double canula is a better means than the various dilators, which have been employed for the purpose. Remove the canula as early as the condition of the patient will permit: and as the tracheotomies described by Sestier were done for the relief of œdema of the glottis, it was generally possible to remove the canula, at an early period.

In 1841, Maslieurat-Lagémard wrote on the substitutes which may be used in place of the canula; being led to a study of the matter by an operation, in which having no canula at hand, he retained the opening patent by means of pins which were bent into the form of fish-hooks. These bent pins after being inserted into the lips of the wound, and through the subjacent cricoid cartilage, were held in place by threads attached to them and tied behind the neck. Instructed by the results

obtained by this plan, he afterwards had a dilator constructed, which, similar to eyelid retractors, held the lips of the wound asunder. The special advantage claimed for this plan was that the child, after the operation, could lie on its side and expectorate the matter from the windpipe, and thus dispense with the frequent cleansing which must be done when the canula is employed. This method is of special service when the tracheotomy is done for the removal of a body that has entered the air-passage, and which not being found, the wound must be maintained opened for the subsequent expulsion of the body.

Dés Chenais suggests as an improvement on Maslieurat-Lagémard's pins or wire spring, the use of hairpins, or iron wire bent into proper form, and retained in place by India rubber bands. Such a device as is here proposed was constructed and used by Dr. Asa Clark, of Stockton, California; having no canula in a case of emergency in which he opened the trachea, he so bent a hair-pin that when introduced, it retained the passage open. And on an occasion in which the author found himself in a similar strait, he inserted into the wound a pair of dressing-forceps, of which the handles were separated and kept apart by means of a cork, of which the opposite sides were so furrowed that the cork remained in place.

In 1852, Thompson announced a mode of tracheotomy similar to that done by the ancients; to wit, he made a transverse incision between the first and second tracheal rings. He operated with a species of bronchotome, of which the blades, after the opening was made, could be separated, and a canula introduced between them.

Near the same time, Chassaignac announced, as an aid in operating, a peculiar tenaculum that was grooved on the posterior side; when the point of this was fixed in the trachea, the scalpel was carried along this groove, and an opening made, at once, into the trachea; and as soon as this was done, a dilator was inserted and the wound so widened that a canula could be introduced. By this method Chassaignac claims that the opening can be made, and the canula introduced so quickly, that no blood enters the air-passage.

Guersant, in 1854, reported one hundred and seventy-one tracheotomies, with thirty-six recoveries; and, in the work, he says that the special dangers to be avoided are the vessels which lie on each side of the trachea, and, in the lower part of the field, the innominate artery; and, as a guard while incising, the finger

should be placed over the latter vessel. Instead of using a tenaculum, Guersant used his finger to fix the trachea, and directed the point of the bistoury with the nail. He extracted the false membranes with a long pair of forceps.

Pitha, writing in 1857, does not find the operation an easy one: the position of the trachea may be deep and difficult of approach; its calibre is sometimes small; it is in constant motion; and besides these obstacles, the anxiety and unrest of the patient, and the haste which the surgeon must make to outspeed death, are conditions of gravest moment which surround this operation.

Pitha's three sites for the opening are, first, between the thyroid and cricoid cartilages, second, above, and third below the thyroid isthmus. The first site is ill suited to cases in which the canula must lie long in the canal, since it can cause necrosis of the adjacent cartilages. To make this opening in the adult, measure one inch downwards from the hyoid bone, and from the inferior end, cut one inch downwards in the median line. Having found the crico-thyroidean membrane, cut transversely through the upper third of the space: thus incising, one shuns the crico-thyroid artery, which lies near the inferior edge of this space. Be sure that the cut has reached through the mucous membrane. The bleeding is not great; and in place of aspirating the blood which enters the trachea, insert the canula as soon as possible.

Should there be a largely developed middle lobe of the thyroid gland, Pitha operates below it, unless it be possible to uplift the part and operate behind it: and for such work, a cut should be made an inch and a half long, commencing at the lower edge of the cricoid cartilage. In the adult, an opening a half inch in diameter, can be made through the crico-thyroidean membrane.

Pitha praises the bronchotome of Bromfield, especially in the inferior operation; and here the tracheal rings should be well exposed to sight, before the instrument is used.

Pitha objects to the usual canula, finding it too short; also, that its ill curved form causes too much pressure on the posterior wall of the trachea; and, as an improvement, he devised one with a catheter-like beak, and which had two oval fenestræ. Other surgeons who used this canula were not pleased with it, finding that, by its length, it irritated the trachea; and also, that the lateral fenestræ easily became obstructed with mucus.

About this time, the observation was made that pneumonia often followed tracheotomy. Pitha claimed that the pneumonia had already commenced when the operation was done; but Schuh finds the causal agency in the operation. He contends that the normal air-passage is shortened and made irregular by the canula; and also, that the changing calibre and frequent movements of the canula, and the occasional closure of it in the work of removing the mucus which accumulates in the canula and trachea, have an ill effect on the tender tissue of the lungs.

The large calibre of the canula is sometimes found inconvenient by the adult patient; and he breathes more easily when the outer mouth is lessened by a slip of adhesive plaster.

In 1857, Fuller introduced a modification of the canula, which consisted of an outer portion that was composed of two blades, speculum-like, which could be introduced through a small fissure and dilated; and between the expanded blades the inner tube is then inserted.

In 1858, Neudörfer constructed a canula, which was double, and so arranged that the outer tube could be removed. The canula had a small mirror attached to the outer part, so that a view could be had of the vocal chords, and of the different portions of the trachea.

In 1858, Hardy wrote a history of tracheotomy from the time of Asclepiades (who is reputed to have done the first operation at Rome), to Bretonneau and Trousseau, who gave the operation a permanent place in surgical work. He reviews the two methods of opening the trachea, by one sudden cut, or by slow dissection; the latter plan, pursued by Trousseau, Hardy prefers, since bleeding is thus more easily avoided. An objection to incision suddenly done is that the cutaneous cut may not correspond to the deeper one. Hardy proposed to use the cricoid cartilage as the guiding landmark in the work of tracheotomy.

In the same year, Passavant advised to fix the trachea with a tenaculum, and, after the opening is made, to retain the tenaculum for a few minutes, transfixing the tracheal wall, as aid in inserting the canula.

In the hospital for children in Paris, from 1850 to 1857, Guersant performed three hundred and ninety tracheotomies; of these eighty-six recovered. In most cases, the operation was done when the child was near death. Guersant would not operate in diphtheria; the condition, according to him, for the operation is a gradually increasing asphyxia; and as long as this is only intermittent, he would delay.

In 1859, Pauli, of Landau, wrote a dissertation on tracheotomy, in which he formulated the following doctrines:—

Tracheotomy, though sometimes necessary in croup, can never become the principal means of curing that disease. When done by an experienced surgeon, the operation is nearly free from danger; when danger attends it, it is usually from the entrance of blood into the trachea. Tracheotomy should always be done before the disease has gained mastery over the patient: that is, before the patient has lost his strength, and the pulse has become small and weak; and prior to the appearance of delirium. The opening should be made just below the cricoid cartilage.

In 1858, Bouchut advised as a substitute for tracheotomy, the passage of a tube into the trachea through the mouth: a method that has recently been revived. This procedure was examined by Trousseau, who reported adversely to it. In experiments made on dogs, Trousseau found that the inserted tube caused ulceration of the glottis; and would probably end in destruction of these parts. A canula which has been inserted through a tracheal incision, can be tolerated for a much longer time.

In 1859, Fock reported twenty-four cases of tracheotomy, of which twelve were successful. The children varied in age from fifteen months to nine years. The period of recovery varied from nineteen to one hundred and twenty-seven days, and the canula was carried from ten to twelve days, in most cases; yet in one it remained in the trachea twenty-six days. Success was more often in those cases in which, from the commencement of the disease, there was constantly augmenting dyspnœa. The emaciated child with a long thin neck is a better subject for recovery than one which has a short, thick and adipose neck The existence of the obstructing membrane in both the larynx and the trachea does not make the case a worse one for recovery. The work is far from being completed when the operation is done; the child must have a skillful nurse, who can cleanse the canula, from time to time; and the surgeon should see the case twice a day.

The advice in regard to skilled attention receives full sanction from the writer of this work; more than once he has seen an excellent operation frustrated through the ignorance and incompetence of those to whom the subsequent care of the patient was intrusted.

In 1860, Barthez wrote upon croup, and the proper stage of the disease for the performance of tracheotomy. He makes three

stages of the disease; in the first there is no dyspnœa; in the second stage it appears intermediately; and in the third one the dyspnœa is constant, and suffocation seems impending; and finally death comes from asphyxia. He finds but little difference between croup and diphtheria; there is a toxic element, also one of asphyxia, in the disease, and these elements are difficult to distinguish. Barthez finds that in the first and second stages of croup, relief may be obtained from internal remedies, but in the third stage the only relief is from tracheotomy. When the disease is of the pronounced diphtheritic form, there is no relief from either medicine or an operation; of seventeen operations done in such patients, seventeen died. The appropriate time for the operation is in the second stage; done then, the patient often rallies. If the tracheotomy be deferred until the third stage, the child makes no effort to expel the false membrane, or the fluids which flow down into the bronchial tubes. But if the opening be made earlier, then the admission of increased quantities of air gives strength; the child coughs vigorously, and expels the false membranes.

In 1862 an elaborate report was made by Lissard of tracheotomies done by Roser, of Marburg. Roser does the work by slow dissection, and then he opens just below the cricoid cartilage, dividing three or four tracheal rings. To separate and retain asunder the lips of the wound, he employed hooked retractors; and this device is praised, as it enables the surgeon to operate almost without an assistant. An elastic catheter with large fenestræ was inserted into the opened trachea, and by means of it, the mucus and false membrane were aspirated. And if the patient be asphyxiated, this tube may be used for blowing air into the lungs.

Instead of the ordinary double canula, Roser used a triple one, of which each tube contained one that was smaller than the one containing it. The external plate was immovable, and the entering end was conical. After the fourth or fifth day, when the false membrane had been entirely discharged, then the triple tube was removed and replaced by one that avoided the erosion caused by the ordinary tube.

The position of the patient for the operation according to Roser, should be the recumbent one, with a support under the neck, so as to uplift the part to be operated on. Sponges large and small should be at hand; and it is better to clean these with a towel than with water. A cut is to be made reaching almost

from the larynx to the sternum; the structures are to be uplifted with toothed forceps; thus small portions of tissue can be uplifted and divided without severing the vessels. Anomalous vessels should be remembered and sought for with the finger. The work is most safely done by circumscribing the vessel with a ligature.

If the thyroid gland be large, it can be pulled aside, sometimes; in others, it can be circumscribed with ligature at two points, and divided between the ligatures.

To open below the gland is difficult in children having short, thick necks; for in such, emphysema often arises during the work; and a still greater peril is that from wounding the fascia; since from subsequent suppuration, pus may pass behind the sternum.

Before opening the trachea, the bottom of the wound should be well explored, and the tracheal rings brought fully into view; and when this is done, the trachea should be seized with toothed forceps, and being steadily held, an opening should be made leisurely into the canal. After the cut is made, before inserting the canula, Roser passes a ligature through the lips of the wound on each side, and ties these threads around the neck. With these ligatures the wound is under control, and can be kept patent during the introduction of the canula. After cleansing the wound insert the canula.

After the operation is completed, the child should be placed in a room of which the temperature is sixty-eight degrees Fahrenheit. In many of the cases operated on by Roser, this precaution was neglected; the child was transported to its home through inclement winter, and no ill resulted. After the operation, the child received medical treatment; it was given calomel and bicarbonate of soda.

During the after-treatment, the child sometimes has trouble in swallowing; a convulsive movement ensues that causes strangling. The canula must be carefully watched, and cleansed from time to time, with a feather.

An erosion or ulceration of the anterior wall of the trachea may arise, and death has arisen from this cause. If such event occurs, try a canula of different form. During the subsequent treatment for the removal of the excreta from the trachea, Roser sometimes used a catheter. Should the wound become covered with diphtheritic-membrane, touch the affected part with nitrate of silver, or with sugar of lead.

Of forty-two cases operated on by Roser, nineteen recovered: proof of the excellence of his method.

In consequence of the perils attending the ordinary method of tracheotomy, in 1861, Maisonneuve advised a new procedure, viz., incision from within outwards. The point selected for the operation was the crico-thyroidean membrane, and thence downwards towards the sternum. He invented a tracheotome for the work. The instrument is first forced through the membrane, and is then made to cut the cricoid cartilage, and the subjacent tracheal rings. The crico-thyroidean membrane is chosen as the initial point, since it is easily found. After the opening cut is made, the wound is enlarged by means of a dilating instrument. During the cutting, the parts adjacent to the instrument are to be pressed against the latter, so that no blood can enter the wound.

From observation of the ulcerative action which arises from the pressure of the canula, in 1862, Bouvier was led to make an exhaustive study of this instrument. He refers to Roger, who had noticed such trouble, and proposed changes in the form of the canula. In the history of the canula, Bouvier finds that Fabricius d'Aquapendente is accredited with having first used this instrument, of which there have been two forms: a lateral one, and a central or tubular one. For about two hundred years, the lateral one was the only kind used; and this was inserted into and occupied one side of the trachea, and it was only in contact with one side of the air-passage. It was straight or curved in form, and had the disadvantage of only having the diameter of the glottis.

In 1812, Maunoir constructed a canula of lead, which more nearly corresponded with the diameter of the trachea; and this was still further improved by Bretonneau, who constructed a canula of two tubes: one resting inside of the other; and this filled the trachea.

Bretonneau had a suggestion for his invention in an instrument devised by Gendrin, in 1835. This consisted of two plates attached to a cylinder, and so arranged that the blades could be made to approach or separate, according as change of adjustment was required. This instrument, though popular for a time, finally was superseded by a dilating, screw-like apparatus. Though the use of an internal tube, which can be withdrawn at pleasure, dates back to an earlier period, when such a device was used by Martyn, yet to Bretonneau is chiefly due the instrument in its present state of perfection.

The curved double canula has the disadvantage that it

presses against and produces erosion of the wall of the trachea; for the trachea is straight, while the canula is curved. This erosive action is increased when the canula moves up and down, or when the patient bends his neck. Mathieu advises to give the canula a curve equal to ninety degrees; yet Bouvier thinks this would be too great in the child. The external plate, which is fastened to the canula, should be fixed to the latter at an angle of thirty degrees, so as to lessen pressure. And to lessen or avoid pressure, Roger had an instrument so made that the plate is movable, and permits the attached canula to move in all directions; and such a canula follows or yields to the motions of the neck. Other modifications of the canula have been devised, with the design of avoiding pressure and erosion; these have been but partially successful; and hence the prevalent rule, to remove the canula as early as possible.

Burow, of Königsberg, in 1862, reported eleven tracheotomies, which were done as follows: a cut was first made through the skin, and then the dissection was continued with toothed forceps, with which the tissues were pulled asunder; thus vessels were shunned, and if encountered, where they could not be avoided, they were tied. When the muscles have thus been separated, the lips of the wound are pulled apart by means of eyelid retractors; and when the white trachea is found, open it with a falciform tenotome. In some cases Burow used a canula; in others he used a specially-contrived dilator.

In 1863, Lücke observed that the innominate artery often rises so high that it is imperiled in tracheotomy. This knowledge was verified to his dismay in one case in which finding the tracheal opening too small, he continued the incision through another tracheal ring, when a vessel was opened which flooded the parts with blood, and caused death. At the necropsy it was found that the cut had divided the second to the seventh tracheal rings, and had opened the innominate artery. He infers that the operation is more perilous when the incision is low in the neck.

About the same time Hueter examined the thyroid gland in young infants, and found that the isthmus is so adherent to the trachea, that if one pulls the gland downward, he cannot expose more than two tracheal rings; hence he counsels crico-tracheotomy.

Millet, of Brussels, finds the following risks in tracheotomy: bleeding from the wounded veins and arteries; blood entering the

air-passages from detachment of the false membrane (and such blood should be sucked out with a suction syringe); wounding of the thyroid gland and the œsophagus; and, as later complications, pneumonia, excessive secretion from the bronchi and entero-colitis.

In 1864 a modification of the tracheal incision was recommended by Porter, of Dublin; instead of the vertical cut, he practiced cutting out a circular portion of the wall. The advantages claimed for this plan were that the canula could be inserted more easily, and the false membranes, blood, and excreta could be more readily extracted. Also, the canula completely fills the round orifice, and there remain no angular openings above and below through which blood can enter the trachea, as is the case when the straight incision is made. Such oval opening can be used in cases in which the canula cannot be borne; also, when the tracheotomy is done for the removal of a foreign body from the air-passages. Porter does not fear that such loss of tissue will lead to narrowing of the trachea. He makes the incision by seizing the edge of the vertical cut with a tenaculum, when he cuts out a semi-circular section.

The writer would offer as comment on this plan of excision, that it has not been sufficiently verified by experience to justify its adoption; the slight power of cartilage to reproduce itself where there has been structural loss, is a serious objection to it. The contractile scar tissue would end in lessening the calibre of the trachea in the adolescent subject; and, hence, narrowing must finally appear, that would trammel the freedom of respiration, and lead to intermittent or permanent dyspnœa.

In 1866, Simon reported twelve cases of tracheotomy, with five recoveries. He made the operation by an incision through the cricoid cartilage, and one or two tracheal rings; by this high opening, the isthmus of the thyroid gland, which lies high in young children, was shunned; likewise, the thyroid veins and the innominate artery were avoided. An incision below the thyroid isthmus imperils these vessels. After the opening was made, Simon introduced a catheter, and sucked with his mouth the blood and mucus from the passage; and he counsels to do this with the mouth, rather than with a syringe.

The writer would pronounce this oral aspiration an unjustifiable personal risk to the surgeon; and which would hardly be consistent with the Homeric estimate of him, viz., that he is worth a thousand men. Diphtheria has been contracted by medical men in

this way, and in several cases it ended fatally. The warrior imperils or gives one life for the multitude; but the physician who would aspirate the toxic excreta does much more, since he risks his life for the possibility of saving that of an individual.

Dusch, in 1867, made a study of the emphysematous infiltration of air that sometimes occurs during the operation of tracheotomy; he attributes it to opening the deeper fascia near the sternum, and as a result, the air is sucked underneath this during inspiration, and thence diffused into the tissues. As soon as the trachea is opened so that air can freely enter, the infiltration ceases, and the air which is so diffused soon vanishes.

The writer's observations in regard to the appearance of air in the tissues have led him to an opinion differing somewhat from that of Dusch: instead of arising from the outside air during inspiration, he has seen the emphysema arise from air within the trachea, viz., that which was escaping from the lungs during expiration. During the operation, the trachea, besides being occluded with false membrane, has its calibre lessened by pressure or by displacement; and in this condition the author has observed that a prick made with the tenaculum or scalpel was instantly followed by an escape of air, which, being caught in the wounded tissue, at once appears as an emphysematous diffusion of air. He has also seen such infiltration in cases before the operation had commenced; and then the air had escaped between the tracheal rings; and this could only have happened during the expiratory effort. Hence, though the writer would not wholly deny that the air may enter the cervical structures in the manner claimed by Dusch, yet he is convinced that a frequent source of origin is from air within the trachea; and also that if care be used by the operator not to prematurely pierce the canal, such infiltration may be avoided.

In 1867, Gueterbock reported on the operations done in the Bethanien Hospital, at Berlin; recovery occurred in about one-third of the cases operated on. Of fourteen tracheotomies done in children over seven years of age, only two recovered.

In the same year, Boeckel published reports of tracheotomy done by several operators: the recoveries were about thirty-three per cent. During a period when the disease is epidemic, and assumes a malignant form, almost all the cases die; and during such season, Boeckel would not operate; or only exceptionally.

In 1867, Bourdillat, a French surgeon, advised to operate by making a single cut; he claims that this is an easier and a

speedier plan, and is attended by less bleeding than the usual plan of slow dissection.

The plan of opening by one cut, is liable to the grave objection that the cut may pass through the trachea and open the subjacent œsophagus: such mistake in a reported case, led to the death of the child.

Peter, a French authority, in 1867, called attention to the difficulty of operating on small children in whom the neck is fat and thick; the tracheal canal is small, not being more than two-fifths of an inch in diameter in a child aged seventeen months. In such children there is a risk of mistaking the thyroid cartilage for the cricoid, a mistake made by Peter, who divided the thyroid cartilage. There is also a danger that the trachea will slip, and the incision go astray. And in thus wandering from its aim, the knife may wound the closely contiguous carotid artery. A case was reported to the writer in which this occurred, and the victim of the error died from hæmorrhage, in a few moments. In children of such conformation, the surgeon runs the risk of slightly wandering from his intended course and incising the side of the trachea. In such a case, the inserted canula would be deflected to one side; and, situated thus during the respiratory movement, the ill-placed instrument would irritate the parts, as the writer's experience has verified.

In cases in which croup and pneumonia coëxist, Grisolle and Nélaton advise to perform tracheotomy as a means of relief. That tracheotomy cannot cause inflammation of the lung is shown by the fact that pneumonia does not arise from the operation which has been performed for the removal of foreign bodies from the windpipe.

In 1868, Barthez made a comparison of cases of croup in which tracheotomy was performed, with those in which no operation was done; of the unoperated cases, only one in eleven recovered; while of those operated on, two in seven cases were rescued: and the operation should be done early. He thinks that there is a fair future for tracheotomy; and that it will not share the fate of trephining, which is falling into discredit.

In the same year, Steiner published the report of fifty-two cases of tracheotomy, of whom eighteen recovered. One child died from bleeding caused by the operation. From a study of the fatal cases in which necropsy was made, Steiner refers death to one of the following causes: a chronic swelling of the laryngeal mucous membrane, which was a sequel of the antece-

dent croupal process; or from ulceration from the same cause; and a third cause of death was palsy of the glottis. Steiner operates as soon as emetics fail to give relief.

The risk to which the surgeon is exposed in the treatment of croupal diphtheria was illustrated in the experience of Kröll, of Baden, in 1868: in the treatment of a patient, the latter coughed out excreta which came in contact with the face, mouth, eyes, and nose of the physician. Kröll soon afterwards became the subject of a severe attack of the disease, which almost ended fatally. He concludes that the excreted matter of the diphtheritic patient can, through contact, cause the disease in a healthy person, and the time necessary for such development, as shown by his own case, is given by Kröll as about six days.

In 1868, Hasse wrote on tracheotomy: his observations were made in the operations done by Wilms, of Berlin. To avoid the risks which attend the removal of the canula, forceps were used by the aid of which the lips of the wound could be held asunder, and air admitted. Hasse thinks the form of the canula should be modified. Instead of having the form of a quadrant or fourth of a circle, he would give it a curve of about one-sixth of a circle: for the latter form permits of the matter being expelled more easily. His canula is straight in its lower third, and is one-sixth of a circle in its upper two-thirds.

As an aid in the introduction of the canula, Couper first passed in a small rod of flexible gutta percha, over which the canula was slipped and guided into the trachea.

Hüter, in 1869, from an extended experience in tracheotomy, advises the section through the cricoid cartilage. The advantage claimed for this point is its superficial position, and its easy fixation with the tenaculum. He attaches much importance to the aspiration of the matters collected in the trachea, after the opening has been made. And this should be repeated afterwards, whenever the material collects in the air-passage. The aspiration was done by the aid of a flexible tube, which being admitted through the wound could be carried down to any extent desired.

From a comparison of cases thus treated with those not aspirated, Hüter finds that more of the former recover; also, that in cases which ended fatally, life was prolonged in those in which aspiration was practiced.

In 1872, there was published a report of three hundred and thirty tracheotomies done by Wilms, in Berlin: of these, one hun-

dred and three recovered; that is, a little over one-third of the cases operated on. The canula was removed between the fifth and eighth days, as a rule. If some hours after the operation the pulse is much accelerated, it indicates a fatal ending; but a low rate of pulse and a diminution of temperature are signs of a favorable termination. If after the canula has been introduced, the respiration is not improved, but the patient continues to breathe rapidly, the portent is unfavorable.

In 1872, Bruns wrote on tracheotomy done by means of the galvano-cautery. He states that the operation was thus done by his father, in 1867, and in 1869. There are other claimants for priority in this method; and it is probable that several operated thus, near the same time.

Bruns says the operation with the cautery is not so free from the danger of bleeding as has been claimed; indeed, in one case he was thus operating on, the hæmorrhage was so excessive that he was compelled to finish the work with the knife; he also finds that the operation is by no means an easy one. From the statement of Bruns and others concerning galvano-caustic tracheotomy, and from the writer's personal observation of this method of incision, this plan seems really deserving of so little commendation, that were the author concerned in the matter of its priority, he would cheerfully resign his share of the quest to others. The writer was a witness to a number of operations done in Paris with the galvano-caustic knife, in 1876; among them was the excision of a cancerous breast, and the removal of a vesical calculus. In the removal of the breast the entire cutis was sacrificed, and the excision, commencing at the peripheral margin of the part, proceeded thence by concentric circles of detachment, until, after great perseverance, the task was accomplished; but so much time was consumed in the work, that, when it was completed, nearly every seat of the room was empty, which, at first, was filled with those whom the fame of the eminent surgeon had attracted to witness the new method; all learned that the excision done with the galvano-caustic blade, so far from being a blood-saving method, was a blood-wasting one, and the wound made was of such a form that many weeks would be required for its closure. The first cystotomy thus performed illustrated how much of barbaric rudeness and uncouthness can be introduced in and mar an operation which, by centuries of revision, has been brought to a marvelous stage of perfection when done by a cold-bladed knife in an adroit hand. And a further remonstrance

against the method was the near approach of the patient to death through subsequent inflammation of the wounded parts. And tracheotomy done by the thermal method, must leave similar ill concomitants and events, and prevent its further continuance. The galvano-cautery in tracheotomy, like some other procedures, has had its brief hour on the surgical stage, and will only be recalled to view by the pen of the historian of tracheotomy, and by him cited as an example of the irrepressible spirit of innovation that has attended the development of every operation done by the surgeon.

Körte, a German writer, in 1879, published an article concerning the granular growths, cicatricial narrowing, and ulceration, which may follow and seriously complicate tracheotomy: he saw this, especially where the operation was done low down in the trachea. As treatment of such cases, curetting and cauterization may be resorted to; also, a canula of a peculiar form has been employed.

Petel, of Paris, observed the granulative complication: after the wound had healed, the granulative tissue grew inside to such an extent that the trachea was nearly occluded, and partial asphyxia occurred.

Madelung, about the same period, pointed out (Archiv für Klinische Chirurgie) certain difficulties which may arise in tracheotomy from the presence of accessory or anomalous portions of the thyroid gland. He classifies these anomalies, according to their site, into superior, lateral, anterior and posterior accessory portions. And in the adult, the anomalous part may become goitrous. Such thyroid structure might be so situated as to embarrass the work of tracheotomy.

Ipsen, of Copenhagen, in 1881, reported the observations made by Bloch in the necropsies made in thirty cases of unsuccessful tracheotomy. Sloughing was found in sixteen cases, which had arisen from the pressure of the canula. The silver instrument becomes darkened in such cases, and the detaching slough may be followed by hæmorrhage, which, in some cases, may be so serious as to contribute to, or even cause death. The detached slough may be succeeded by a polypoid mass of granulative tissue. To guard against sloughing, Ipsen advises to use a canula composed of India rubber, rather than of silver.

Zimmerlin, in 1882, wrote on the hæmorrhage that may arise during the operation of tracheotomy: he describes two species, extra-tracheal and intra-tracheal; and it may be arterial, venous,

capillary, or parenchymatous. Arterial bleeding may originate from opening the innominate or the thyroid artery; and this may arise primarily, from a direct wound of the vessel; or it may occur later from sloughing, through pressure of the canula; and hæmorrhage is more apt to arise when the tracheal opening is made low down. Venous hæmorrhage is from the thyroid veins. The chief means of control advised by Zimmerlin is pressure, which is to be made around the canula. The author would add, that if the bleeding be from a vessel of considerable size, no other treatment offers certain security, except that of finding the bleeding vessel and ligating it. And hæmorrhage will generally be avoided if, at the time of the operation, care be used to tie vessels which are wounded, or which, being laid bare, may subsequently open through pressure of the canula, or through pseudo-membranous invasion and disintegration.

Chaym, of Berlin, in 1883, wrote on tracheotomy in children under two years of age; in such subjects great difficulties are encountered, especially in the first year, from the thick, fatty couch of the neck, the large volume of the thyroid gland, and from the smallness and mobility of the trachea. Of nine hundred and seventy-seven infants operated on under two years of age, eighty-five per cent died. To obtain better results Chaym counsels to do the operation before the appearance of asphyxia; and the opening should be made just below the cricoid cartilage, not including that part. By observing these precautions, he finds that twenty-nine children under one year, and fifty-eight under two years of age, were operated on successfully. Chaym finds recorded two hundred and twenty children under two years of age, who were saved by tracheotomy. Isambert, in 1868, advised tracheotomy in the infant.

Gresswell, in 1884, wrote on the trouble of breathing which may arise after the removal of the canula; he disagrees with those who refer this trouble to the sinking of the tracheal wall around the opening which has been made through it; his explanation is that the child has unlearned, or forgotten, to open the larynx when the respiratory muscles act. To avoid such subsequent trouble, Gresswell resorts to the novel artifice of creating some dyspnœa in the child, before the removal of the canula; for this purpose, he devised a canula which was provided with lateral openings, which could be closed or opened so as to diminish or augment the amount of admitted air; and thus the child was compelled to make some effort in breathing.

Besides the difficulty referred to, Köhl in 1887, mentions others which may follow the removal of the canula: these are relapsing diphtheria; inflammation of the vocal chords; granulative growths in the wound; curvature and other alterations of form which may arise in the air-passage as the result of the operation; relaxation of the anterior wall of the trachea; tracheal stenosis due to external pressure; primary or secondary palsy of the laryngeal muscles; paresis from non-use of the parts; spasm of the glottis; and too long retention of the canula in the trachea. From the author's experience, nearly all of these troubles will be avoided, if the canula can be removed at an early period.

In cases of croup in which the pseudo-membrane penetrates deeply into the air-canal, tracheotomy will furnish but slight relief, if means be not used to extract the false membrane. In such patients after the tracheal opening is made, Pienazck, in 1886, advised the use of forceps of which the blades are long and narrow; and he claims that with this instrument the surgeon can penetrate into, and extract the pseudoplasm from, the right and left bronchi. But in case the pseudo-membrane penetrates into the secondary trunks of the bronchi, then it cannot be reached with forceps; and in such patients, death is inevitable, according to Pienazck. The writer in cases in which the membrane has reached this low site, has found some relief in the inhalation of an atomized solution of chlorate of potassa, or of Aqua Calcis. The atomized vapor may be conducted into the mouth of the canula through a funnel, which has been inserted into it.

After this extensive review of the teachings of authorities who have written on tracheotomy as a means of relief of the patient, who is the subject of obstruction of the air-passage through croupal or diphtheritic pseudoplasm, the writer will proceed to an application of the principles deducible from these doctrines.

The first and cardinal point in regard to the operation is that it be done timely, opportunely and prudently; the moment for opening the air-passage should be so chosen that one may apply to it slightly paraphrased the classic expression of Tacitus: *felix opportunitate mortis vitandæ* (*fortunate in the opportunity of escaping death*); and the moment for operating should be so chosen that the surgeon can neither be accused of undue haste, nor of fatal delay. Dyspnœa which is continuous and constantly increasing, denotes that the pseudo-membrane is encroaching on

and lessening the calibre of the air-passage; this means that the amount of air being admitted is insufficient for the maintenance of life; and that cyanosis will soon be present, when unoxygenated blood occupying the arteries, the chances for a successful operation will be slight.

The site at which the air-passage should be opened has been the matter of varying opinion, as the reader has seen in the previous citations of authorities on that point. An enumeration of these sites in the order of their succession from above downwards is as follows: the section may be made between the thyroid and cricoid cartilage; through the cricoid cartilage; through the cricoid cartilage and one or two rings of the trachea; through three or four of the uppermost tracheal rings; through the tracheal rings which lie behind the isthmus of the thyroid gland; and lastly, through the portion of the trachea that lies just below the thyroid gland. As seen, the operator has amplitude of choice in the selection of site.

The first point mentioned, which lies between the thyroid and cricoid cartilages, is too small in the child for the operation; but in the older subjects this space occupied by the cricoid ligament is large enough; and this site is sometimes selected for what may be named inferior laryngotomy. The section of the cricoid cartilage in the child would not give an opening which would admit a canula of sufficient calibre for normal breathing; in the adult it might suffice; yet if an opening were desired at this location, it would be better to incise the crico-thyroidean (conoid) ligament, cutting transversely, close to the upper margin of the cricoid cartilage; thus incising, one shuns the crico-thyroid artery, which pierces the ligament above its middle, at a point where a lymphatic gland is often found.

Should an emergency arise in the adult from diphtheritic occlusion, or other cause, demanding section through the cricoid cartilage, the work should be done as follows: to locate the part, let the finger pass searchingly from the pomum adami downwards; the yielding interstice filled by the conoid ligament will be found, and then underneath this, the cricoid cartilage is situated; though less prominent than the thyroid cartilage, yet the cricoid is enough so to be distinguishable from it, and also from the subsequent tracheal ring. Since the crico-thyroid muscles, which are somewhat concerned in vocal function, lie on the sides of the cartilage, these structures must be avoided in the division of the cricoid. And no less important, though less

imperiled than the muscle, is the external branch of the superior laryngeal nerve, which passing under the sterno-thyroid muscle reaches and penetrates the cricoid-thyroid muscle. The operations of Hueter have repeatedly demonstrated that the cricoid cartilage can be divided without impairment of the voice; yet to do this the opening must be made in the anterior median line of the cartilage; and the dissection which is done to reach it should be neatly, and not laceratingly made: thus the nerve will be shunned and the muscle left intact. A vertical line dropped from the notch in the thyroid cartilage above, to the sternal incisura (or hollow space in the manubrium of the sternum) will indicate the site of the median section to be made; and should the division of the skin and the platysma myoid muscle have wandered from the surgeon's aim, correction can be made by continuing the incision through the line which separates the sterno-hyoid muscles. There is a considerable interval between these muscles above; but this becomes less below where the two muscles meet; and after contact in the median line, they diverge again as they pass to their respective points of insertion. With these guides, the scalpel need not lose its way; finally, the white cricoid structure being reached, the operator transfixes it with a tenaculum, and holds it steady while he divides it.

Isolated cricotomy is no longer resorted to as an operation for the relief of pseudo-membranous occlusion of the air-passages; but when this cartilage is divided, the section is generally made along with two or more of the tracheal rings.

An objection against cricotomy in the adult is, that the cricoid cartilage in the old subject is ossified; this does not obtain in the child, in whom the cricoid ring is as easily divided as the succeeding tracheal rings. The operation thus done is known as crico-tracheotomy; and this has been decided as the one which, anatomically, offers the most advantageous conditions when it becomes necessary to open the infant's air-passage. Among these conditions may be mentioned the thinness of the soft parts which must be divided, their usual freedom from vessels, the certainty with which the part may be found, and the facility which an opening made there offers for reaching the occluding membrane, whether the latter be seated in the larynx above, or in the trachea below.

In the median line of the neck, in descending from the hyoid bone, the air-passage becomes buried deeper as one approaches the sternum; so that the lower portion is quite impalpable in

the child of short, fat neck; but, fortunately, in the critical moment which demands prompt and speedy action on the part of the tracheotomist, there is for him a landmark which can always be easily felt, though it may not be visible: this is the prominent eminence of the thyroid cartilage: a cartilage which, in the work under consideration, is not to be touched by the scalpel; but in the infant, the finger passing directly downwards from this point a half inch, can fix the point where the scalpel being held vertically, is to be thrust downwards and backwards; and this incision is to be continued until it encounters the white cricoid ring, below which lies the trachea, of which one or more rings are to be divided.

Besides the thinness of the soft parts which rest on the cricoid cartilage and upper tracheal rings, these structures are less often traversed by vessels which would bleed freely, if cut, than are the structures lower down. A third advantageous condition which this site offers is that the air-canal can be found more readily here, than below; the finger can easily distinguish the cricoid ring by its unyielding firmness; and its separate mobility from the thyroid cartilage above will enable the operator to avoid the latter. And, finally, an opening made here enables the surgeon to remove the false membrane which may lie in the passage above and below the opening. The conditions enumerated speak strongly in favor of the crico-tracheal site, which Hueter and other authorities unite in selecting as the appropriate one for the performance of tracheotomy.

The next site, viz., through the upper tracheal rings, is usually so encroached on by the isthmus of the thyroid gland that it offers insufficient space for the opening; in fact, the isthmian bridge commonly spans the passage at a point corresponding to the second tracheal ring; and occasionally an anomalous lobe so encroaches on the limited space, that the latter is quite too narrow for operating here.

The post-isthmian site is rarely a suitable one for the operation; the vessels in the isthmus are often of such calibre, that the section would cause copious bleeding: an event which seriously embarrasses the operation; in fact, in many cases, such bleeding has caused death. In some cases, however, the isthmus is only a thin filamentous structure, in which only diminutive vessels exist; in such favorable conditions the tracheal section could be made at this point.

Below the isthmus of the thyroid gland there is a space of vary-

ing distance in which the trachea may be opened; in the child of long, thin neck, there is ample room for the work; but in a neck which is short and thick, this site is ill fitted for tracheotomy. An advantage which the opening here offers is this, that section made there will probably be below the diseased portion of the air-passage; the pseudo-membrane will be above the fenestra opened by the surgeon in the tracheal tube. Objections which sometimes far outweigh this advantage are the occasional anomalies of the vessels in this region, to which some reference has been made; the innominate artery may rise unusually high; it was once seen by Allan Burns so high that it reached the lower border of the thyroid gland; he saw also the right carotid cross in front of the trachea. Both carotids may originate from the innominate, and then the left one will cross the trachea. The inferior thyroid artery may arise anomalously as a single trunk from the sub-clavian; and then, as stated by Burns, the vessel is so situated as to be endangered in the operation. These anomalies are so frequent that the surgeon may expect to encounter one of them in eight cases: frequency sufficient to command cautious advance of the knife. Again, the gradually deepening position of the trachea, as one approaches the sternum, is a disadvantage that is present in all patients, and is especially serious in the short, adipose neck.

Despite these several impediments, this site was the favorite of one of the most celebrated surgeons, B. von Langenbeck, whose operations the author has repeatedly witnessed. The deliberate manner in which this eminent surgeon operated enabled him to shun the perilous vascular anomalies which occasionally occur there; and should the right or left carotid have encroached on the trachea, or the subclavian have reversed its course and destination, or any of the vascular surprises have presented themselves, which have been described and delineated by Henle and Tillaux, the self-contained bistoury of Langenbeck would have shifted its point to a portion of the trachea less beset with perils, and there have completed its work. One of less experience would do well to avoid such a region, and select one of less possible hazard; and a reflective study of the various sites in which tracheotomy has been performed leads the writer to select that of crico-tracheotomy; besides the commendation of this site by Hueter and other authorities, the writer's own experience, embracing a series of sixty tracheotomies, confirms this choice.

There is another obstacle which often confronts the surgeon

on the threshold of his purpose; this is the opposition of the parents or relatives of the patient to the operation: or if consent is given, it is often at so late a stage in the croupal disease, that the work is in vain. Much address is often needed to overcome this obstacle. An argument sometimes used by the writer, and which usually has a convincing effect, is the following: Your child will die within a few hours, unless the operation be done; if done, it will give it one chance in four of saving its life; should it die unoperated on, it will die by slow strangulation; the child's condition is the same as if a cord encircled its neck, which is being tightened every minute; the operation proposed will cut this cord and give the child easy breathing; and if this be done, though the child may not be saved, it will render its death an easy one. A statement of this purport will rarely fail to obtain permission for the operation, even from one ignorant, or prejudiced against surgical work. And should these arguments still fail of purpose, then, as occurred in a case which the author saw, the final appeal may be in the following form: I offer the child a reasonable chance for saving its life; if you deny it this privilege, who will be accountable for its death? Such an appeal, as in the writer's case, extorted a reluctant permission; and though the case ended fatally, yet the relief obtained by the operation was so marked, that the obstinate parent found no cause for regret that the operation had been done. The number of successful tracheotomies, which have been done in all parts of the world where intelligent surgery exists, has now nearly banished the prejudice against it, with which the old generation of surgeons was forced to contend, and, as Trousseau says, it "must henceforth be looked upon as one more conquest of the healing art."

To perform tracheotomy, the surgeon should have a properly lighted room, a table on which the patient will rest, assistants in his work, and a small number of instruments. It is true that in an emergency, it can be done anywhere, and in a room so poorly lighted that fingers rather than eyes will do the seeing. Under such embarrassment the writer has been forced to operate; and with perhaps an incompetent assistant, and with only the smallest instrumental equipment.

If there be time, as is usually the case, for deliberate preparation, and it is during sunlight, the patient should be so placed that the operator will not overshadow the field of his work: that is, his shadow should fall behind him. And the light from the southward quarter of the sky will be better than that from the

northward. Also during the night, the patient should be so placed that the surgeon and his aids will not darken the operative field. In case the room has a central, suspended light, the patient should not be placed directly under it, but slightly to one side. If light must be gotten from lamps, these should be placed on a small table, near the side of the patient, opposite to the surgeon. The light should not be held in the hand of an assistant: lest he, fainting, should drop his light, and leave the room in darkness, as occurred once in the author's practice.

An operating table may be extemporized by placing together two or three small stands or tables; or it can be made by unhinging a door and placing this on two stands, or small tables: and if tables be used, they should not be too wide. The table may have as covering, a quilt or blanket; and a small, hard pillow or cushion must be provided, which placed beneath the child's neck and shoulders will uplift the neck, curve the head backwards, and expose the surface to be operated on.

As aids, the surgeon should have one to administer the anæsthetic, one to sponge, one to manage the retractors, and one to arrest or control any irregular movements of the child. As such aids may not be present, the surgeon if he has had experience in emergencies, might anæsthetize the patient, and then do the work with one untrained assistant; or if he has learned to operate where the luxury of assistance was denied, then it would be possible to do the work alone, after placing the child in complete anæsthetic narcosis; yet in such an attempt, one would run many risks, which assistants would remove. In case the child is nearly moribund, which is too often the condition present when surgical aid is invoked, then anæsthesia may be omitted, since unoxygenated blood circulating in the arteries will render the tissues nearly insensible; and in such patient, only dark venous blood will ooze from the divided structures; and as the incision is being made, the slight movements of the patient will clearly show that the work is nearly or quite painless.

And finally, to operate with ample facility, the following instruments should be at hand:—

1. A sharp pointed, short-bladed scalpel, and a probe-pointed bistoury: and these two may be contained in a sheathing handle similar to that of a clasp-knife.

2. Two blunt retractors, the form of which is shown in Figure 102. These instruments have two points, blunt and separated a quarter of an inch from each other. This retractor has been of

eminent service to the author; it serves a twofold purpose: for, besides separating and holding the lips of the wound asunder, it can do hæmostatic duty: for, as soon as a vessel of small size is opened, the retractor can be so shifted that one of its tines rests on, and compresses the vessel. Such pressure made by lateral traction will control ordinary venous bleeding: but if an artery be opened, it would be safer to tie it. It often happens that beneath the skin, near the median line, the surgeon finds one or two anterior jugular veins, which, when encountered, can be

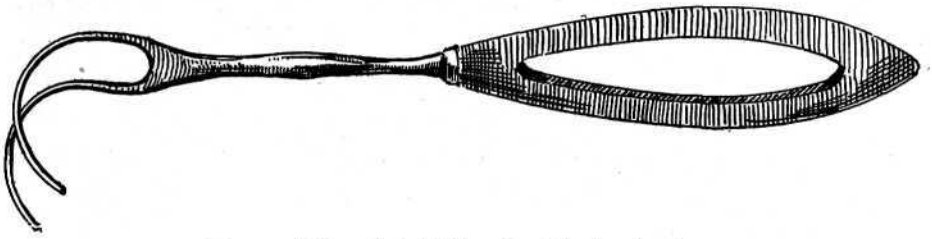

FIGURE 102. Exhibiting the blunt retractor.

caught by the retractor, and pulled aside from the point of the knife. Of all the instruments which the writer uses in the operation, he places the highest estimate on this retractor: it is an assistant in dilating the wound and controlling bleeding; and it may be added, that it is no small aid in the dissection: for with it the tissues can be caught, and by lateral traction separated from the subjacent structure.

3. The blunt dissector, shown in Figure 103: to this instrument the writer assigns a position in importance near that which he has given to the retractor. After the skin has been divided, with

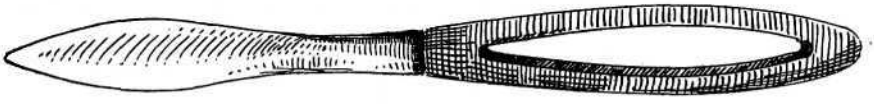

FIGURE 103. Showing the form of the blunt dissector.

this instrument the subjacent structures can be separated rapidly, and almost bloodlessly; and should vessels be met, they can be loosened with the blunt point, caught by the retractor, and pulled aside. This instrument can, in a great degree, replace the scalpel after the skin has been divided. It is of special use in the management of the thyroid gland, should this part encroach on the field of the operator: for the blunt point can be thrust under the margin of the gland, above, below, or at the side, and the gland then pushed away so that the trachea can be exposed.

The gland is sometimes very closely adherent to the trachea; and even in that case, with care the parts can be separated; and thus, as the writer has done, the supra-thyroid section can be extended downwards by the division of one or two tracheal rings, which are bridged over by the thyroid gland.

4. Two or more hæmostatic forceps should be at hand, with which bleeding vessels, which cannot otherwise be controlled, may be seized and the forceps left in place until the opening has been made, provided asphyxia seems imminent; if, however, the patient's condition will permit, let the vessel be tied, and the forceps removed.

5. Thread for ligating vessels should be provided; also a threaded needle for suturing a portion of the wound, after the canula has been inserted. And for removing blood, a fine sponge is needed; and in the absence of this, aseptic mops, or even a towel or soft cloth, will suffice.

6. Some instrument should be provided, with which the semi-liquid excreta can be aspirated from the opened trachea; this may be a soft catheter or rubber tube, to which a suction bulb, or the suction end of a syringe, has been attached. This suction, as before stated, has been done by the surgeon's mouth: and though the act was one of philanthropy, it also proved to be one of fatal rashness. Recently, in England, a father at the suggestion of his physician extracted with his lips the excreta from the wound in his own child, and became infected with diphtheria; the parent instituted legal proceedings against his physician, and blind Themis turned her scale against the latter, and the parent recovered heavy damages. It is fortunate that in the web of common humanity, such brutal thread has rarely been inwoven; though the tooth of the ingrate is sometimes felt, yet the tear of gratitude oftener flows.

7. The operator should have an assortment of double canulæ —at least three: one of small calibre, another of medium size, and a third still larger; and if the case be an adult, a canula of the greatest diameter will be needed. A form of canula which the writer has found very satisfactory is that represented in Figures 104 and 105. The canula may be of silver, hard rubber, or aluminum; that of aluminum shares with that of rubber the advantage that it is very light, and hence will be less apt to erode than one of silver. That of silver has done excellent service for the writer; and within his experience he has rarely seen ulceration arise from it. A more important thing in the canula is

that it should be solid in its construction; and especially, that the horizontal plate to which the outer tube is attached should be so firmly fastened that the two cannot separate: or if motion between the two has been provided for, as is the case with that made by Luer in Paris, then this connection should be secure against separation: for the history of tracheotomy contains records of several accidents, in which the canula descending into the trachea, the patient had the double calamity of having coupled

FIGURE 104. Showing the canula of usual form.

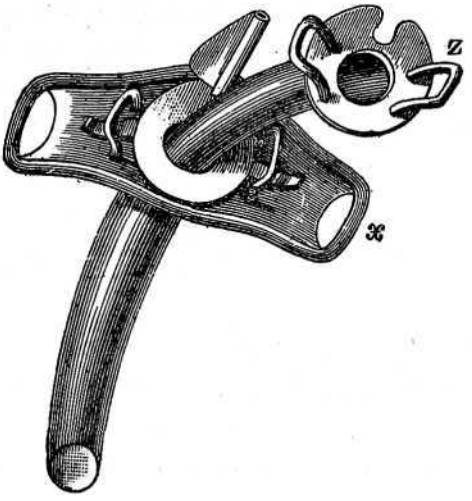

FIGURE 105. Showing the canula with the inner tube partly withdrawn.

with his croupal trouble, also a foreign body in his air-passage; and this has descended so deep as to be inextricable. In a case recently published, the operator was so fortunate as to extricate the tube by suspending the patient with head downwards, and then striking the thorax, when the tube descended and was extracted.

Morax, who measured the trachea of children between two and fifteen years of age, finds that they vary from three and one-half to seven and one-half lines in diameter; and, of assorted canulæ, he would have four, viz., one of three, one of four, one of five, and one of six lines in diameter.

The horizontal plate of the canula, on each side near its end, is provided with orifices, in which cords are to be tied, and passed around the neck, and tied so that the instrument cannot be dislodged.

The inner tube of the canula is fixed and held in the containing tube by a kind of key or latch which is fastened to the horizontal plate, and can be so turned as to fix or release the inner

tube. The inner tube should extend downwards somewhat beyond the outer one. The canula being thus constructed, when it becomes obstructed with detritus or excreta, the containing key is turned, and the inner tube is removed, cleansed and again replaced. The outer tube is provided with a fenestra, at the site of its greatest curvature, which is intended to let the air pass through the larynx, when the latter becomes permeable. By means of this ingenious contrivance, the advance of the patient towards recovery can be determined; to test this, let the inner tube be extracted, and then, when the external outlet is closed, if the larynx be free, the patient can breathe in normal manner; if, however, the obstructing agency is still present, breathing will be correspondingly impeded, and phonation absent.

8. Two tenacula should be present for seizing and fixing the trachea when this is found; the work can, however, be done with one; yet by the aid of two, when these are inserted somewhat laterally, the tracheal wound can be made between them, and its lips pulled apart.

9. A basin of aseptic water should be provided, to be used for cleansing sponges or gauze used in the work. Feathers from the wing of a fowl are needed for cleansing out the mucus that may lodge in and obstruct the canula: for the use of these will dispense with the frequent removal of the inner tube.

Many tracheotomists, particularly Trousseau, use an instrument specially intended for dilating the wound made in the trachea: and, in the absence of the tenaculum, such an instrument might be necessary; but with two tenacula, and the aid of the small, blunt retractors, the dilatation can readily be done; and the work being done in this manner, the surgeon can easily extract the morbid material from the opened trachea. The writer prefers the method in which the wound is retained open with retractors as aid in extracting the false membranes: for, in the plan advised by Trousseau, there is danger of thrusting the material further downwards.

Such is the equipment for the systematic performance of tracheotomy when the operation can be leisurely done; sometimes, the condition of the patient permits no formal preparation; only prompt action can baffle death. In such an emergency (*occasio præceps*) the writer once made an opening with a clasp pocket bistoury, with one stroke, and, as a temporary substitute for a canula, a silver catheter was used. In such urgent case the intuition of the surgeon will usually suggest

means and manner by which the work can be best and quickest done. A remarkable example of how difficulties may be surmounted in such a strait is that of an American physician who performed tracheotomy in the midst of a forest, while on a hunting expedition. In the absence of a canula, he constructed one which answered the purpose, from a leaden bullet, which he hammered into a thin sheet, and then he molded this into the shape of a canula.

Whether the patient should be anæsthetized, will depend on his condition; if he be cyanosed or near complete asphyxia, an anæsthetic is unnecessary; in fact, if anæsthetized he would run a risk of dying during the operation; but previous to the cyanotic stage, the mixed anæsthetic or ether should be given; as thus, the patient will be spared pain; and what is more, the slumber of anæsthesia will relieve him of terror. But in the partly asphyxiated child, both mentality and sensibility are so depressed, that, as the writer has witnessed, scarcely a struggle will be made while the knife is dividing the cervical structures.

The patient, surgeon, assistants, and instruments next take their respective positions: the patient on the table with nucha and upper part of the shoulders so uplifted as to bring the front of the neck into prominent relief; the surgeon, with his instruments near his right hand, must stand on the right side of the patient, so that in using the knife, the incision will proceed downwards. An assistant will stand behind the head and maintain this fixed, with the chin turned backwards so that the latter will not be in the surgeon's way; but in this, the skin of the neck must not be displaced from its normal site, lest the median line be shifted to one side.

Another assistant should stand so that he can hold the lower extremities; and if the child be small, this aid can easily hold both arms and legs; in doing which he stands on the side opposite to the surgeon, and resting his left arm across the child's knees, he grasps the latter's right hand, and pulls it downward, while with his right hand he draws the patient's left arm downwards, alongside of the trunk: and thus held, the patient's arms will not disturb the surgeon's work. Another assistant must aid in holding the retractors. This aid should, if possible, be one who has had some training in such service; if such a person is not at hand, the surgeon must choose, from those present, some one who may appear to have the best requisites for such duty.

After the instruments have been rendered pure, and the sur-

face to be incised has been sponged well with, first an alkaline, and then an alcoholic solution, the operation begins by an incision made exactly in the median line, the cut beginning just above the cricoid cartilage and extending well towards the sternal manubrium. And that the median line shall not be deviated from, it is well first to trace it with an aniline pencil; for if this precaution is not taken, though the scalpel may start right it may stray from the intended route and end on one side; and this deviation is oftenest towards the surgeon.

There are advocates of rapid work, in which the opening is made with one continuous stroke; prominent among these is St. Germain, who has operated thus many times, and successfully. His method is to seize the trachea between the thumb and fingers of the left hand, and then, with one or two strokes, to enter the air-passage, and, immediately after this, insert the canula. A practical hand, like that of the Parisian professor, might safely do this, but ere the operator could acquire such deft precision, it is probable that more than once the point of his instrument would pass the forbidden mete beneath, and enter the œsophagus: an error which would insure a fatal result. Hence the writer does not commend this method; and it should only be resorted to where imminence of death forbids deliberate work. Trousseau, whose pen and scalpel have given tracheotomy a place in surgery, directs that the work be done as follows: "I cannot insist too much on the necessity of incising the tissues, layer by layer, and of separating the vessels and muscles with blunt hooks; and thus proceeding, to fully lay the trachea bare before opening into it; I insist on the absolute necessity of working slowly; and if, during the work, the child becomes suffocated, then cease for a moment, and let it struggle, and sit up until it regains its breath; and though a minute may thus be lost, this is not to be feared. I have never seen slowness cause an accident; but I have often witnessed difficulties and peril from doing the work too rapidly, even though the work were done by an adroit operator."

The difficulties sometimes encountered will be slight in the child whose neck is long, and in whom the structures lying in the trachea are thin; in such a case, as soon as the skin is divided, one is near the trachea; and if the wound is then dilated by the retractors held by the assistant, the surgeon, using the blunt dissector, can easily pierce and separate the thin structures which lie on the trachea; and the retractors can aid in this dissection. And when the trachea is reached, it will be recognized

by the white color of the rings; and these are distinguishable from each other by the tissue of pinkish hue which connects the rings together. And when the trachea has been sufficiently displayed, the surgeon transfixes it longitudinally, somewhat aside from the median line, with the tenaculum, and commits this instrument to the hand of the aid who held the retractors: and the surgeon next transfixes the trachea on his side with a tenaculum, and holds this in his left hand. While the tenacula are thus held, the surgeon pierces the wall vertically, and then continues the incision downwards until three rings are divided. Or if the cricoid cartilage be divided, then it will suffice to sever two tracheal rings. And this longitudinal opening should be made with blunt scissors or with a probe-pointed bistoury, as extension of the first aperture made, and it must lie in the median line; if not, the inserted canula will be deflected to one side.

The writer commonly uses but one transfixing tenaculum; yet in cases of urgency, he has found that greater expedition can be made with two tenacula, since by their aid, as soon as the trachea is opened, the lips of the incision can be drawn laterally, and air thus quickly admitted.

As soon as the incision is made into the trachea, air gushes forth, carrying with it blood, mucus, and perhaps false membrane; and this material often bespatters the surgeon's face and dress. And as the disease has thus been communicated, the prudent operator, at the moment when he makes the opening, may direct his assistant to hold a cloth which may receive the expelled matter: or the operator's open hand may be so held as to receive it. The first expiratory effort forces out the most of the semi-liquid material; but if there be bleeding, as often happens from the wounded mucous membrane, then this blood, flowing into the tube, causes coughing, and, at short intervals, the blood is expelled through the tracheal incision. The opening being completed, the free supply of air, like magic, relieves the agony of the patient; and the relief is such that the unanæsthetized child ceases to struggle, and is content with what has been done. The lips of the wound are now to be held asunder, while the interior of the trachea is examined and freed of any obstructing material, visible or accessible; and for this purpose, both forceps and an aspirating tube are to be used. When the passage has been made clear, the canula is to be introduced. In the subject of thin neck, in which the work is here supposed to be done, this

insertion is easily accomplished through the dilated wound. The canula should be of a calibre which will quite fill the trachea: neither too large, lest it erode; nor too small, lest it be too movable, and be inadequate for the transmission of the due amount of air for normal breathing. The moment the canula enters, it generally causes a momentary irritation, and a spasm of coughing ensues; if, however, the patient has been anæsthetized, or is in a cyanosed state, this spasm of coughing may not appear. The introduction of the canula is always an easy matter, if a free opening has been made, and the lips of the wound be held well asunder; and when it is inserted, the pieces of tape, which are fastened to the fenestræ of the horizontal plate, must be carried around the neck and tied; and this knot should be on one side, so that it will be easily accessible. This tying should be so done that it will surely hold; also, the tapes should be neither loose nor tight; for if tight, the constriction will interfere with the circulation of the head; and if loose, the canula may slip from its place in the trachea.

When the canula has been inserted and fixed securely in its place, the wound must be closed by suturing, either above or below; and then to prevent friction of the parts by the horizontal plate, there should be placed a strip of rubber adhesive plaster underneath. The work being completed, the patient is next removed to his bed, and the head laid low. The head should lie on a very low pillow; for if the usual thicker one be used, there is a risk that the patient's chin will encroach on and obstruct the canula.

The tracheotomy on the patient just described, in which the anatomical conditions rendered the operation a very simple one, is so absolutely free from difficulties that the young operator, to whom such a case has fallen, may conclude that the difficulties and obstacles enumerated by writers as confronting the surgeon are exaggerated; this opinion, however, will receive severe correction, should his next patient be a child of short, thick neck. In a child of such conformation the shortness of the neck renders but a small portion of the trachea accessible; in fact, the larynx will occupy the middle third of the neck, and being buried there beneath a thick adipose stratum, it runs much peril of being inadvertently injured. In such a patient, the voice would be irretrievably lost, were the scalpel to divide the vocal chords by a rash thrust; but if the work be done leisurely, such accident may be avoided. In a patient of the conformation

referred to, the nucha should be well uplifted, and the head turned so backwards as to lift the air-passage upwards to the greatest possible extent. The child thus placed, an incision should be made in the median line of the neck, embracing the second and third fourths of the front of the neck. The knife, held vertically, is passed through the skin; then being inclined, it is carried downwards. The skin being divided, close to the median line, the anterior jugular veins are sometimes found; and these swell to such a volume as to present a formidable appearance to the untrained operator. These veins may be tied: a precaution that is seldom necessary; but instead, one may catch them both with the retractor, and draw them to one side; or the veins may be separated, and one pulled to one side, and one to the other. The incision and dissection now proceed with cautious steps towards the trachea; and, first of all, the operator must now determine accurately, what is before him. For example, he may find that a portion of the thyroid cartilage lies in the way which he had intended to traverse with his knife; then the field of work must be shifted downwards. The palpating index can now feel what it could not do through the intact skin. Every care must be used to continue the backward incision in the sagittal or median plane; and this is not difficult if the initial cut was correct; and even if this was wrongly made through displacement of the skin, it is not too late to correct it; for then the knife can be shifted to the right or left, as may be required.

In the course of the deepening incision, veins are often encountered, which traverse the adipose structure; these can usually be displaced with the blunt dissector, and held aside with the point of the retractor; or this failing, the vessels may be tied. The thick couch of adeps, including the superficial and middle cervical fasciæ, being severed, the trachea is sometimes reached without any further impediment: such good fortune, however, is rare; normal, or anomalous thyroidean structure often interposes a perilous barrier to further progress of the knife; and what further intensifies the gravity of the occasion is, that the dyspnœa is rapidly becoming more oppressive: a condition that urges expedition; and audibly admonishes the operator "It were well it were done quickly." In such contingency, if the child is ceasing to breathe, the knife should be urged amain, and borne quickly athwart visible and invisible obstacles, until an opening is made through which the canula can be inserted.

And if, in this deep cutting, vessels be opened which bleed freely, the patient should be quickly turned on his side, so that the blood can escape from, and not flow into, the tracheal opening. In thus doing, though for an instant death may appear to have won the victory, yet, as the writer has witnessed, breathing may recommence; and this has the effect to lessen or arrest the hæmorrhage. Should bleeding from an artery continue, this must be caught and tied.

But should the patient's condition be less pressing and admit of deliberate action, and if the thyroidean structure be found in the way, whether isthmus or anomalous lobe, this should be loosened from the trachea with the blunt dissector, and drawn away from the rings which must be divided. Should this displacement not be possible, then let the structure be grasped by two pairs of clasp-forceps, and divided between; and should bleeding follow the removal of the forceps, then each portion must be tied.

In the deeper part of the incision, besides the thyroidean structure mentioned, anomalous vessels, if they exist, will be encountered: and the most common one is the middle thyroid artery, which is so frequent that the surgeon may reasonably expect to soon meet it in his operations. Should this be found, it must be doubly tied and divided. More formidable vessels, as the carotid, the subclavian or the innominate, may confront and call the knife to a sudden halt. The discovery of such an anomaly would compel the surgeon to shift the site of his work to a higher point, viz., the crico-thyroidean space, the cricoid cartilage, and the uppermost tracheal ring. And should this route be deemed impracticable, then one could resort to the bloodless method of intubation.

In regard to the manner of opening the trachea when this is reached, something more should be said than what has already been stated: for authorities here differ. Some operators discard all instruments of fixation, and do this by seizing the exposed trachea between the thumb and index. The objection to this plan is that there is not sufficient room for the insertion of the fingers; and, hence, the trachea would be compressed, and robbed of some of its space, so precious to the suffocating patient. Trousseau pressed his finger nail against the upper surface of the trachea, and used this as a guide in making the first incision into the trachea. Archambault, the favorite pupil of Trousseau, having reached and verified the trachea with the index finger, rests this on a tracheal ring, and then carries the knife down on the

volar side, and thus makes the first puncture. He counsels to touch lightly; for the less the pressure is, the less apt is the knife to stray from the proper track. He totally discards, in a flippant line, the use of a fixing tenaculum. It is true that the opening can thus be made: and the writer has so done it; but, by so doing, one loses the control of the trachea at a moment when such control is so needful. During this most eventful moment in the work of tracheotomy, the forcible respiratory movements carry the trachea upwards and downwards; and these movements are increased in the unanæsthetized child by the terror awakened by the whistling sound of the air entering or escaping from the first puncture. In such an anxious moment, when neither delay is allowed, nor error permitted, and the arbitrament of a life depends on faultless action, nothing can so exempt the young operator from disorderly confusion, nor so maintain the unperturbed coolness acquired by the tuition of experience, as to be able to hold and accurately fix the trachea, when the opening through its wall is being made. And in no way known to the writer can this be more surely and well done, than with a tenaculum of well-curved point, which has been inserted into the trachea longitudinally, alongside of the point where the opening is to be made. And still greater advantage will be given by the use of two such instruments; the second one being inserted parallel with the first, on the other side: for with these the trachea is easily steadied and fixed; and when the incision is made, the tenacula can be used as lateral retractors, by means of which the tracheal wound can be laterally opened so that an ample current of air can enter the air-passage.

Instead of tenacula, Trousseau, Archambault and many eminent tracheotomists use a dilator, which is inserted into, and made to widen the tracheal fenestra as soon as this is made. Archambault and his great master expatiate on the utility of this instrument: yet it has the unavoidable disadvantage that it may catch and carry with it the pseudo-membrane, which, when present, it is so desirable to remove. But with the tenacula, besides dilating the new-made window for the free admission of air, the operator can also retain this patent until the obstructing material has been removed; it would be impossible to extract this successfully, if the passage were obstructed with a dilating instrument. An objection urged against the tenaculum is that it wounds the tracheal wall; in reply, the writer would state, that from repeated employment of

the instrument in tracheotomy, he has seen no bad effects follow its use.

When the opening has been made, and the trachea freed from visible or accessible obstruction, then comes the important act of introducing the canula. Different methods of doing this have been adopted. Archambault used his index finger as a guide, which being inserted into the wound, the canula is carried down on the palmar side, and, as this is done, the finger is withdrawn and the canula slipped into its place. The objection to this plan is, that in so doing the trachea is wholly closed, and breathing arrested for a moment or two: a serious fault. Guersant, to insure against failure which has occurred in the introduction, inserted a flexible male catheter into the tracheal wound, and over this the canula was passed. Others have devised and used a guiding instrument of smaller dimensions than a catheter. If the wound be opened by tenacula, no such guide is needed: for the lower end of the canula is passed into the well-opened wound and carried straight backwards; and as soon as it reaches the posterior wall, the outer end is uplifted and carried backwards through the arc of a circle, while the inferior end descends. The contact with the mucous membrane often causes a fit of coughing, which will soon subside if the instrument be held in place. As soon as the canula is in place, the tapes attached to it are to be passed around the neck and tied; and this done, the tenacula may be removed. If the tenacula be removed too early, there is danger that the canula may be expelled in a fit of coughing, and the operator be much embarrassed to reinsert it. Such accident cannot occur if the tenacula remain in place until the canula has been secured by tying. Should the canula be accidentally dislodged, then the inspiratory effort will close the outer wound, and the child will get but little air until the wound is reopened, which may be done with the retractors used in making the incision. Also, from the struggles of the child, the wound may again bleed; yet the incision, thus hidden from view, may be opened with the retractors, when, if possible, one side of the tracheal cut should be caught with a tenaculum or forceps, and so pulled aside that the canula may be replaced. But if this plan fails, then a finger should be introduced through the wound into the air-passage, and the canula carried quickly along the volar side into the trachea.

When the primary opening has been made in a subject in which the structures are thick, if a fixing tenaculum has not been used, the difficulties just recounted may be met: and in the

attempt to insert the canula, the entering end of the canula may catch on the front wall, and, instead of passing into the trachea, it may be forced down in front of it. And this mistake has been an occasional cause of death during the operation: an accident that would have been avoided, had the operator first secured control of the trachea with the tenaculum before opening it.

Another occasional complication of serious nature is hæmorrhage, just as the final opening is being made: and this may be caused by the opening of a large vein, or by division of thyroidean structure. Or an artery may be opened, and in this case, the bleeding will be in jets. No vessel of size should be severed before it is ligated; to do otherwise could only be justified by extreme asphyxia and imminent death. And even then, before incising vascular structure, or dividing a vessel, the precaution should be taken to catch with clasp forceps on each side, and then sever between them.

Most authorities teach that, when asphyxia impends, the operator should hasten to conclude the opening, and, though minor vessels or vascular structure be in the way, he should open, at once, through these into the trachea. It is claimed that, by so doing, the bleeding will cease as soon as the canula is inserted and respiration is freely restored. This doctrine is fallacious, as has more than once been verified by the author's experience; for if an artery is opened, it will surely continue to bleed until tied, twisted, or its mouth is stopped with a clot. And a mesh of thyroid veins being severed, the little sheet of blood thence flowing will continue for a brief time, despite the tracheal opening; and, also, large thyroid veins being cut will continue to bleed. Free breathing accelerates the circulation; it does not slacken it; the inspiratory effort attracts the venous blood towards the heart: facts well known to the practical surgeon. Hence, before dividing vascular structure, it is safer to include it in a circumscribing ligature, or catch it in clasp forceps and subject it to compression or torsion, until the vessels are closed.

In case of parenchymatous bleeding, control of this is sometimes obtained by the pressure of the canula; and to get this action, the canula should be in close contact with the contiguous wound. In such a case it is advised to remove the canula and replace it by one somewhat larger, which will completely fill the wound in the trachea. The wound usually bleeds most from the upper angle, owing to the greater pressure of the canula on the lower

portion; hence some aid can be derived from passing a suture through the sides of the wound above the canula, so as to lessen the wound; thus doing, the writer has more than once controlled bleeding. The use of the solution of the chloride or sulphate of iron, as a styptic to arrest bleeding in tracheotomy, is opposed by all authorities; for the agent, in its work of coagulation, forms a soft compound that can readily enter the trachea, to the ulterior detriment of the patient. And it may be said of the use of such agent, employed here or elsewhere, that though the bleeding is thus arrested, the evil hour is only postponed: for, when the coagulum is detached, bleeding sometimes ensues; and the parts are in an ill state for healing, since the salt of iron acts as an escharotic.

When blood from the wound has entered the lungs, in even moderate amount, it interferes with bleeding; and, in a subject that is partly asphyxiated, this added trouble can quickly end life; hence, such blood should be removed. As the writer has verified, the titillation of the mucous membrane of the trachea below the wound sometimes causes an expulsive effort, which brings the blood up, and frees the lungs, so that breathing is easy. The aspiration of such blood by the mouth of the operator brings peril to the surgeon rather than relief to the patient, since the aspiration could only be done imperfectly by oral suction. As already indicated, an elastic tube with suction balloon would do the work better. Or in the absence of this, a soft catheter attached to the suction point of a syringe might be employed.

In the haste sometimes demanded in the operation, the surgeon finds that his incision is ill placed in the trachea: instead of being in the median line, it is in the side of the canal: or commencing in the median line of the trachea it may have diverged somewhat towards the right or left side. In the second case, the error of place will not interfere much with the use of the canula, since the outer end of the latter will be near its proper site. But if the tracheal incision be wholly on the side, its ill position will so interfere with the use of the canula that authorities counsel to make a new opening, parallel with the preceding one. In making this new opening, the error has been committed of carrying the new cut into the first one and forming a movable spur in the front wall of the trachea. If this be done, it would interfere with the subsequent form of the trachea, when the wound has healed. And, again, should no spur be made, there is still the risk that the narrow bridge-like slip of cartilage between the two incisions may die, and thus leave a

breach in the wall of the trachea, whence stenosis of the canal would remain after healing. Hence, the writer advises to use the lateral slit when this has inadvertently been made, rather than to attempt to form a new one; thus doing, though the canula deviates to one side, a satisfactory result has been obtained by the writer.

A more serious error is that of perforating the posterior wall of the trachea, and probably entering the œsophagus. A mere perforation of the wall might cause no trouble; but should the œsophagus be opened, the condition would be a very serious one, since in the swallowing of food, especially that which is liquid, a portion of the same would enter the trachea and pass to the lungs. Such a complication would almost certainly cause death. As a means of rescuing the patient, one might resort to alimentation through an œsophageal tube; thus treated, the patient would have a chance for recovery, which otherwise, would be denied him.

The emphysematous infiltration of the air into the surrounding tissues is an occasional occurrence; it has been observed a few times by the writer in his operations. It disappeared without treatment. The case might be otherwise, were the emphysema to arise from the mouth of the canula becoming so buried in the wound that the expired air could not escape, but would enter the structures which rest on the outlet of the canula. This condition may arise from swelling of the wound: and then to prevent infiltration of air, a longer tube must be used. And as a further aid, the surface of the wound may be covered with a coating of collodion. Any attempt to remove air which has once entered the tissues of the neck will prove futile. Left to itself, it will spontaneously vanish.

Should a case occur in which there is an intolerance of the canula, then some other method of maintaining the tracheal wound open must be resorted to. In such a patient, the writer made two incisions in each side of the tracheal cut, which so converged that a thread could be tied to each side, and the sides pulled laterally, so as to hold the wound open. In this way the wound was easily maintained patulous for almost a week.

The operation having been completed, the patient is placed in bed, with the head low, so that the chin will not obstruct the canula: and the mouth of this may be left uncovered; or there may be placed over it a few layers of thin gauze. The covering of the outlet of the canula with gauze is highly recommended by

Trousseau. He claims that this muffling screen, becoming warm and moist, prepares the air for admission to the lungs, in the same manner as if it were breathed through the mouth or nose.

Special attention should be given to maintaining the air of the chamber at a uniform temperature; and for this purpose a thermometer should be placed near the bed of the patient, and the air maintained at seventy degrees, Fahrenheit. The error is often committed of keeping the room too warm; and, when the thermometer denotes more than seventy degrees, cool air must be admitted until the heat is reduced.

The patient must be properly cared for, and this duty should be committed to a nurse, if possible, who has had experience in such work; but if such aid cannot be had, then some person of self-possession and intelligence must be instructed by the surgeon in the duties required. The most important task, for a time, is to prevent the child from reaching to and disturbing the canula. Through lack of care in this respect the writer has seen the canula nearly plucked out from the trachea. Hence, for an hour or two, the child's hand should be held, or prevented from doing mischief. Another task quite as important as the preceding is to watch the canula, and see that it does not become obstructed with excreta from the air-passage. Such material, in a liquid or semi-liquid state, in coughing is continually lodging in the canula; and, in time, it becomes inspissated and adherent to the inner wall of the canula. To prevent such accumulation, the assistant should, occasionally, pass a plumed feather into the tube, twirl it around, and thus catch and extract the matter. For this purpose, the smaller wing feathers of the domestic fowl will do the work well. This is pliant enough to easily traverse the canula, and, being turned about, it will dislodge the adherent matter. In using this, the plumed end which is inserted should be carried somewhat beyond the lower end of the canula, so as to entirely detach the obstructing matter. In the beginning, this will irritate the mucous membrane and provoke coughing; later, this does not occur.

Soon after the work is completed, and breathing through the canula is freely established, the patient falls asleep; and in this, the breathing is so noiseless that the inexperienced watcher fears that something is wrong. Besides being noiseless, the respiration may be slower than usual: which arises from the canula admitting more than the normal quantity of air.

Visitors and useless attendants are to be excluded from the

patient's room; for the presence of such will render the air impure, to the patient's injury; and the curious and inquisitive gaze of visitors will disturb, if not alarm, the child. The presence of the parents in the room, unless they lose their self-possession, may be allowed

To arrest the pseudo-membranous formation, and to aid in the solution of that which may be present, a valuable auxiliary is to atomize some agent near the patient which has such solvent action. For this purpose, some alkaline agent may be used; as examples of such are lime water, or a solution of bicarbonate of potash, or soda. The writer's preference is for lime water, of which the officinal preparation may be used in a simple atomizing apparatus. The vapor thus generated may occasionally be thrown into a funnel which is inserted into the mouth of the canula. Or the current of vapor may be made to simply play over the patient's neck; and to protect the dress and the bedding from moisture, these should be covered with India rubber cloth during the use of the atomizer. Another agent used in atomized state that has enjoyed some celebrity, is chlorate of potash: this may be used in saturated solution, viz., fifteen grains to the ounce of water. The peroxide of hydrogen may also be used in atomized form.

In spite of all the care used in cleansing the canula, some material, in hardened form, will collect on the inside of the canula, and attenuate its calibre; hence the inner tube must be removed, every hour or two, and cleansed. This cleansing will be much facilitated if a solution of bicarbonate of potash be employed for the purpose. In the act of removing the inner tube and replacing it, the nurse, if untrained, must have special instruction. The key, which attached to the horizontal plate fastens the inner tube, sometimes works ill. If the retaining key does not work well when the inner tube is shifted, the child will be disturbed and probably thrown into a spasm of coughing: all of which will be avoided by the selection of the canula without such defect.

Trousseau and other authorities recommend to drop occasionally, a few drops of warm water into the canula; they claim that doing this one compensates for the absence of moisture which arises from the admission of air through the canula; instead of through the nose or mouth. The use of an atomizer, in the manner before referred to, renders it unnecessary to do this, since the vapor thus generated would be ample to moisten the air-passages.

The internal medication which usually has been plied assiduously, and often to excess, may be reduced to a minimum, or discontinued, when tracheotomy has been done: but the nutrition of the patient must be well maintained.

There usually occurs at once a great amendment in the condition of the patient; and both parent and surgeon indulge in exaggerated hope; but the experienced medical man tempers such hope with prudent reserve; for he has long ago learned that apparently assured victory may end in defeat. The improvement is too often merely temporary; the slow breathing, within a few hours, may become hastened; the pulse, likewise, accelerated; and the tranquil composure of the patient may be exchanged for one of restless anxiety. The child tosses its arms about and makes the same appeals for help which it did before the operation. But should the peaceful composure which instantly followed the tracheotomy, continue into the second day, there is a fair prospect of recovery.

A change to the worse is announced by hastened breathing, quickened pulse, and increase of temperature. The accelerated breathing may be caused by obstruction of the trachea below the opening into it; or it may arise from pneumonic œdema or actual inflammation. The conditions of the lungs supervening, a fatal ending may be apprehended; for within some hours, or a day or two, at most, the pulmonary breathing space becomes reduced to such small limits, that life cannot be continued. Along with hastened respiration, the air-passage becomes dry; but little material collects in the canula, and this is remarkably thick and adherent. The breathing is accompanied by a creaking or whistling sound. In this unfortunate condition the writer has seen relief from the frequent use of the atomized lime water; but as a rule, such patients die in the latter part of the second day, and all that is done but prolongs the scene of struggling agony.

The case is otherwise where the unfavorable condition arises from obstruction of the trachea through an accumulation of inspissated mucus in the canal, or from the formation of croupal membrane there; in such patients the surgeon can often give relief by extracting the impeding material. In some cases, though the false membrane be thoroughly removed at the time of the operation, yet some hours afterwards it reforms, and the patient breathes with difficulty, similar to that which necessitated the operation. In such condition, the canula must be removed

and, the lips of the tracheal wound being securely grasped and held, a pair of slender forceps is to be introduced into the trachea, and the material caught and removed. If the matter be thin, instead of forceps, a small probang may be passed down the trachea, twirled around, and the passage thus freed of the obstructing matter. If the obstruction arises from a membranous formation that has reappeared, it is well, after the removal, to apply some solution which will prevent the re-formation. For this purpose, a solution of corrosive sublimate, in the strength of one part in a thousand, may be used. The agent which the writer has found most effectual is nitrate of silver applied in solution, of which the strength is eight grains to an ounce of distilled water. This may be applied with a small probang, which, being passed through the tracheal opening, is caused to ascend and descend rapidly, in contact with the tracheal wall. The surgeon should do this himself, and not commit the work to even an expert nurse.

The first few days which follow the operation are hours crowded with weighty duty for the surgeon; at short intervals, he, or his representative should revisit the patient; and of equal importance, one or more assistants disciplined in such work should unremittingly watch the case. For upon the faithful discharge of those minor duties, as well remarks Archambault, depend the chances of success, rather than upon perfection in the operation.

At the end of forty-eight hours, if all has proceeded favorably, a strong hope of recovery may be entertained; and the conditions justifying such expectation are the following: the pulse is under a hundred, the temperature does not exceed one hundred and a half, or one hundred and one degrees; the cough is absent or slight, and the air-passages are moist. But, as before mentioned, the ominous symptoms are constantly accelerating respiration and disappearance of moisture from the air-passages; the supervention of these conditions upon the previous favorable ones almost certainly portend death of the patient within twenty-four or thirty-six hours.

The child which has been operated on is sometimes disturbed by finding that it cannot talk as hitherto; though its tongue and mouth shape words, yet not even a whispering sound is uttered: and this silence renders the patient anxious, sad and dispirited: so that to the attendant falls the further task of amusing the patient, and causing him to forget his condition. If the case is

going favorably, the child may soon be permitted to sit up in bed; or he may be lifted from bed and held in the arms of the nurse. The tractable or intractable character of the child will determine how this management must be pursued.

The precautions given in regard to maintaining the room at a uniform temperature are of much importance; and besides this, should albumen be found in the urine, the child must be well clothed both during the time that the canula is used, and also after the removal.

In feeding the patient, care must be used that no foreign matter enter the canula: and though the nutrient material be liquid, its entrance into the air-passage would prove extremely detrimental. Such accident occurs oftenest when the child takes too large a draught, and a portion escaping from the mouth overflows on the neck and enters the wound. More care in giving food will avoid this accident.

After the lapse of a few days of anxious solicitude and weighty suspense, the fortunate patient is rescued from most of the perils which menaced him: yet one more eventful period must be passed; and this is that in which the canula must be removed. The child, which, at first, was alarmed by the new mouth-piece to the air-passage, soon learns to tolerate it, and finally fears to part with it; and a similar fear often harasses the surgeon: his uncertainty voices itself in the famous words, "If it were done when 'tis done;" and if he has had little experience in such cases, he is embarrassed by hesitation in the selection of the proper hour for this work.

The canula can only be removed when the calibre of the superjacent air-passage is fully restored: and in case the instrument be taken out before this restoration, the expectation that the wound will freely admit air is seldom realized. It often occurs that, the canula being withdrawn, the altered condition alarms the child, and causes it to struggle and breathe violently, the result of which is that the lips of the tracheal wound close and allow but little air to enter; and in such condition, the writer has seen the patient almost lost by asphyxia. The violent struggling movements of the child render it extremely difficult to reinsert the canula; and this can only be done by the aid of a couple of assistants. In such emergency, dispensing with tenaculum or retractor, the writer has used a pair of dressing forceps, of which the closed blades being introduced, the instrument is then opened and the wound dilated so that air can enter, and the canula be replaced.

The modern canula is so constructed that the surgeon can determine before its abstraction whether its absence can be borne: this consists in an opening in the outer tube at a point where the expired air can pass upwards through the natural route, when the outer mouth of the tube is closed. To test the permeability and patency of the larynx, let the inner tube be withdrawn; and when the patient's attention is withdrawn, place the finger over the mouth of the outer tube and thus test the degree of permeability of the larynx: and if the breathing be free, then a more prolonged test of this can be made by closing the canula with a cork. If such closure be tolerated for some time, then the canula may be withdrawn; and if all has proceeded favorably from the time of the operation, then removal can sometimes be done as early as the fifth day: but usually, this cannot be done before the ninth or tenth day.

After the canula is removed, some authorities permit the wound to remain with little or no dressing: others, on the contrary, approximate the lips of the opening with adhesive plaster. For this purpose, the author uses isinglass plaster, of which strips six inches long and a half inch wide may be so stretched across the opening as to approximate the sides. For some hours after such closure, the air in inspiration and expiration will pass through the interstices of the plaster: and this may continue for some days, before the wound is so closed as to prevent the passage of air. Ordinarily, the wound heals without delay: exceptionally, this does not occur; especially in the subjects of severe diphtheritic disease.

The most frequent embarrassment, which the operator encounters after the removal of the canula, is an excessive granulative growth which develops in the wound; and such growth often so encroaches on the tracheal canal that respiration is interfered with. This occurred in two cases of tracheotomy done by the writer, and amounted to a formidable obstacle to recovery. In the first patient, the canula was removed on the tenth day, and for two or three days the case proceeded favorably, and an early recovery seemed probable: but as the wound was near the point of final closure, the breathing became difficult, and in a few hours the dyspnœa reached such a gravity that it became necessary to reopen the trachea and introduce the canula again. In this work it was found that the granulative tissue had reached inwards, and, in polypoid form, nearly occluded the tracheal canal. This neoplasm was excised, and the deeper portion of the

wound cauterized with nitrate of silver. After a few days, the canula was again removed, when similar difficulty in respiration recurred. It was treated similarly, with the same result as occurred the first time. The procedure next attempted was to trim off all the raw surface, and convert the old wound into a new one, in which the walls were fresh wounds: then the incision was carried downwards, and the canula having been inserted in this lower point, the upper portion of the wound was closed by deep suture. Thus the old wound quickly healed, after which the canula was removed from the new one, which, also, healed. In this way perseveringly pursued, through difficulties which have been but half recounted, the patient was finally cured: and but a tithe of the service paid for, since the parent held the operation responsible for the later difficulties which were encountered: as logical as are many of the ingrates for whom Medicine saves life. In the patient here mentioned, after recovery, respiration was untrammeled.

In another patient, still greater trouble was encountered in dispensing with the canula: after the removal of the latter the trachea soon became obstructed by granulative tissue, and it was necessary to reopen the wound, and replace the canula; yet before doing so, the new tissue was thoroughly excised. After the second removal of the canula, the granulative growth soon reappeared: and this time, instead of removal by excision, it was done by cauterization with the small blade of the thermal cautery. This cauterization was done a second, and even a third time, before the exuberant growth was so repressed as to admit of closure of the tracheal wound. This child recovered, yet the tracheal canal was left in an imperfect condition. When the boy was at rest, and breathing was not accelerated, there was no embarrassment; yet when active exercise induced a greater demand for air, then the respiration was labored; and it was evident that there was stenosis of the trachea at the point where it had been opened. This lad has now reached manhood, and though his respiratory difficulty has lessened, yet enough of it remains to seriously disturb him when he engages in active exercise.

In a third patient there was encountered similar difficulty, yet there was less trouble in repressing the granulative growth and dispensing with the use of the canula: the work was here done with the thermal cautery.

From the writer's observation he concludes that the prolific

granulative growth arises from retaining the canula too long in place: for it did not appear in patients in whom the instrument had been removed early; and it only occurred in those in whom the canula had been used for ten days, or longer. Hence, in practice may be formulated the rule to remove the canula as soon as the air-passage above is sufficiently permeable to permit free breathing; and this can often be done as early as the fifth day after the operation.

A singular difficulty sometimes met is that the child having breathed for a few days through the canula forgets the habit of breathing through the nose or mouth; or does so with distrust; and such a patient, after the extraction of the canula, from slight causes may have a panic of dyspnœa, in which it quite loses its breath, and life is so imperiled that it becomes necessary to replace the canula. Such trouble was experienced in a case operated on by the writer. This child was cajoled into natural breathing by removing the inner canula, and then when the child fell asleep, the remaining canula was closed by a cork, and allowed to remain so after the child awoke; breathing then occurred normally through the fenestra of the remaining tube. By this management the child was finally trained to breathe without the aid of the canula.

Instead of excessive growth from the wounded tissues, there may be a defect in their reparative action; and sometimes there is an ulcerative action, by which the wound is increased in dimensions. In such a case there is encountered no dyspnœic difficulty, since there is ample ingress of air through the wound, as well as through the laryngeal canal: but there is trouble in effecting closure of the wound. Such ulcerative action, or indolence in the work of repair, may arise from mal-nutrition of the subject, which previously existed, or may be caused by the diphtheritic disease which led to the operation. Such patient should be fed as generously as the digestive powers will permit, and to awaken appetite, there may be given three times daily a wine-glassful of decoction of bark or gentian, which has recently been made, and acidulated with hydrochloric acid. As a local stimulant, the surface of the wound may daily be touched with a solution of nitrate of silver, viz., one grain to the ounce of distilled water; or with a ten per cent solution of alcohol. Exercise in the open air and sunshine will act favorably: yet a portion of the time, the patient should be in a recumbent position, in which the afflux of blood to the part will be promoted. And to retard

and hold the blood in the tissues about the wound, the neck may be encircled with two strips of adhesive plaster placed horizontally, and so situated as to include the wound between them. Instead of adhesive plaster collodion may be used.

In some unfortunate cases, owing to some constitutional cachexy, or to depression of the vital forces through the virulence of the diphtheritic poison, the wound becomes the site of progressive gangrene: instead of healing, the parts die; and in such cases the death of the patient, as a rule, soon afterwards follows. To uplift the enfeebled vital forces, the chief reliance should be placed in concentrated nutrition and a free use of stimulants; and as local treatment, a cataplasm composed of powdered charcoal and pulverized Peruvian bark moistened with red wine may be used. And to combat the probable microphytic causal agency, the surface of the wound may be penciled daily with Oleum Terebinthinæ. Such a course of treatment should be diligently carried out: more in the line of duty than with the expectation of saving the patient.

A grave intercurrence which sometimes appears in the subject of tracheotomy, is palsy of the muscles of the pharynx and throat, which are concerned in the function of deglutition. This ill event is referable to alterations in the nerves which furnish motor and sensory influence to these structures: such nerves are the glosso-pharyngeal, and branches of the pneumogastric distributed to the pharynx and larynx. It is probable that the cell-growth which accompanies the diphtheritic process penetrates and trammels the office of these nerves: that such infiltration does occur the pathologist has verified: it was inferable from the macroscopic appearances of the structures in necropsies made by Virchow and Bouchut, which were witnessed by the writer. That the disease traveled centrally from the throat along the nerve sheaths to the medulla oblongata, and there exercised its paralyzing action, is problematical, though Bouchut endeavored to show this in his demonstration made at the Hospital des Enfants, Paris. The morbid action is exerted, probably, chiefly or wholly, on the terminal ramuscules of the nerves supplying the palsied parts.

As results of such loss of innervation are the loss of voice, and difficulty of swallowing. The voice is first reduced to a whisper, and this soon disappears: and then the effort to talk is reduced to mimic movements of the tongue and lips, similar to those made by the patient when aphonia arises from the trachea being

occupied by the canula: the muscular movements are made which should coin the voice into articulated sounds, yet the voice for coinage is absent. The graver trouble is the inability to swallow: at first, the component acts of deglutition are wrongly coördinated; and strangling occurs; and finally, a portion of the liquid food, instead of taking the normal route, enters the larynx and descends to the lungs; so that the child has a violent fit of coughing every time it attempts to swallow liquid nutriment. The result of this is that the patient is but partly nourished, and the lungs receiving foreign matter, soon become affected with ichorous pneumonia. The harassing cough which is aroused by swallowing finally causes the child to refuse food.

As treatment which has proved most beneficial in such case is electricity and strychnia. Potain has reported a case in which electricity speedily overcame the palsy. Also, Dr. Cohn, of San Francisco, has had excellent results from the administration of strychnia: even where the palsy was general and not limited to the throat. The writer has found that it is better to give food in solid, rather than in liquid form: bread can be swallowed, when milk would cause strangling. And as an important adjuvant, rectal nutrition should be resorted to; and for this, no article of aliment is equal to milk; and the absorption of this will be aided by the addition of the extract from the salivary glands and the pancreas of the ox, hog and sheep.

A complication sometimes arising from tracheotomy is suppuration in the wound, from which pus gravitates downwards, and may enter the anterior mediastinal space of the thorax. This results from unskilled work in operating, in which the structures are needlessly lacerated and separated from each other, so that blood and excreta from the wound, instead of escaping, enter and gravitate downwards. Also, from awkward insertion of the canula, the structures may be forcibly dissected from the trachea, and thus a route is opened into which the materials mentioned may enter and descend. This pus lodged behind the sternum is concealed from sight, and is only revealed by a necropsy; and as such examination is often not made, the existence of the pus is not suspected, though it was a material factor in causing death. If, however, it be detected, an attempt to remove it should be made by partially inverting the patient, as often as every six hours, and washing out the cavity with alcoholized water: thus diligently working, the purulent cavity might finally be closed. And should pus originating from any other

cause during the course of tracheotomy, for example, from erysipelas or phlegmonous inflammation, enter the thorax, then a similar treatment might be pursued. Such work falls rather within the line of hopeless action, *ut aliquid fecisse videamur.*

A complication sometimes disturbing the course of a tracheotomy is ulceration of the trachea. This may arise from pressure of the canula, and may occur in the margins of the tracheal incision, or where the convexity of the tube rests against the posterior wall of the trachea; or it may be lower down, where the end of the canula rests on the tracheal wall. It has been seen oftenest in the lower part of the tracheal cut. This ulcerative action may be very superficial, or it may reach quite through the thickness of the wall. And cases have been recorded in which the perforation reached and opened the wall of a vessel, and serious or fatal bleeding occurred.

Such ulceration is partly due to the pressure of the canula; it is likewise promoted by the erosive action of the instrument, which is kept in constant motion by the respiratory movements: and such agency, whether pressure or erosive friction, will have greater effect when reinforced by infectious diphtheritic disease. And if such disease be of a virulent character, then there may occur extensive gangrenous destruction of the walls of the trachea.

The pain from such ulcerative or gangrenous action, though present, is hardly distinguishable from that caused by the contiguous wound: and hence it is of little diagnostic value; the diagnosis is to be made rather by the dark discoloration of the canula, provided this be of silver. The silver tube becomes blackened through the formation of the sulphuret of silver, which is due to the contact of the tube with the disintegrated cartilage, which contains sulphur. And the location of this black stain will indicate the point where the tube caused pressure: namely, if it be at the lower end of the canula, it can be inferred that pressure there is causing ulcerative chondritis; or if the posterior convex curve be blackened, this denotes disintegration at that part of the trachea; or should the entire canula be blackened, then the inner surface of the trachea, wherever it touches the canula, is breaking down from mechanical cause, or from diphtheritic infection. But should the upper end of the canula and the horizontal plate be darkened, this may proceed from the pus of the wound, and, meantime, the trachea be intact.

In case the canula be of material which can form no colored compound with sulphur, then the diagnostic aid of discoloration would be wanting.

As means of treatment, the following may be resorted to: if the ulceration wholly arises from erosive action of the canula, this may be remedied by the use of an instrument of a different size, or model. To lessen or avoid erosive attrition, a canula has been constructed by Luër, under the direction of Roger, of which the tubular section is movable within the horizontal portion. By this device the horizontal plate is not disturbed by the movement of the head and neck; and the unfixed or movable canula can cause but little attrition during the respiratory movements.

But in the event that the ulceration or gangrene is produced by diphtheritic infection, it must be combated by some topical remedy; and for this purpose pure alcohol or the spirit of turpentine may be applied to the affected part.

The writer will here briefly refer to his own experience in tracheotomy. He has operated sixty times, and has saved twelve cases; that is, twenty per cent. The cases were children suffering with croup or diphtheria, and at ages varying from two and a half to seven years of age. In many of the patients the operation was only permitted when the child was in a hopeless condition: and so near death were a few of the children that they died during the operation: in these, and in others, had the operation been done earlier, the writer is convinced that one-third of the patients would have been rescued. The section was always the high one in which the cricoid cartilage was sometimes included. Other facts concerning these operations have already been referred to.

In the foregoing collection of facts, it has been the purpose of the author to furnish the reader with a full store of materials which may serve for guidance in the critical work of tracheotomy. As before stated, the operation may be one of the simplest character: a few strokes of the scalpel then suffice to open the tracheal fenestra. But exceptionally, this narrow field may be the lurking place of uncounted difficulties; so that though the operator may have in his mind an ample store of shifts and expedients, still chance may summon up, anon, some contingency which he did not expect; but with which it is believed the preceding exposition of facts will enable him to satisfactorily cope.

No moment in the surgeon's life can be happier than the one in which he saves a life. And if life be valued by its number of years, upon no one's work can a higher estimate be placed than on that of the tracheotomist: for he rescues from death the young. And should the operator fail to save his patient, as he often does,

yet he has the satisfaction of knowing that he has not shortened life; and, further, that, though death won the victim, yet the former was robbed of its terror: for tracheotomy assures a painless death,—enthanasia, or happy death, as the Greek beautifully expresses it.

As concluding advice to the tracheotomist, the latter must bear in mind that his task to end well must be one of tireless care and constant attention to minute details: for here, as elsewhere, the crown of success awaits him who best toils and best watches.

CHAPTER XXXII.

LARYNGOTOMY.

A SUBJECT cognate to tracheotomy is laryngotomy, which will next be considered. As tracheotomy is yielding a portion of its work to the intubationist, so that of laryngotomy is being somewhat supplanted by the procedures of the laryngoscopist: and, as usual, the old method has not willingly borne the encroachment of the new; so that the laryngotomist and the laryngoscopist at the present hour are vigorously wielding the foils of heated controversy; and in listening to the dialectics of the respective claimants the observant reader is both diverted and instructed, and is convinced that each, with some selective care, may be followed.

In laryngotomy, the entire larynx may be opened; yet it is rare that such an extensive operation is demanded: usually the opening is made through the cricoid cartilage, the cricothyroidean ligament, the thyroid cartilage, or through the thyrohyoidean ligament. When a vertical section is made through all the component parts of the larynx, the work is named total laryngotomy; and it may be remarked that the indications for such an extensive operation will seldom present themselves; usually, the purpose for which the operation is performed can be accomplished by an opening through one of the component parts of the larynx: and when it is desired to do this, the incision may be made through the ligament above or below the thyroid cartilage. The operation generally designated by laryngotomy is that in which the thyroid cartilage is partly or wholly divided: yet the term thyreotomy, by which this operation is often designated, is the more appropriate name. An operation cognate to the one just named is that in which a passage is made through the lateral or anterior face of the larynx, by exsecting a portion of the thyroid cartilage.

The operation of laryngotomy is an old one; it is mentioned by writers of the seventeenth century; and in the eighteenth

century it is mentioned by Detharding, of Rostock; also by Vic d'Azyr and Sabatier in France. The operation referred to by these writers was that in which an opening was made into the larynx through the crico-thyroidean space. The authority who merits special credit for the advocacy of laryngotomy in the eighteenth century was Desault, whose intelligent hand also advanced other sections of surgery. One finds in the first half of the present century the records of a number of cases of laryngotomy: the operators were German, French and English; and the work was chiefly done for the removal of foreign bodies which had entered and lodged in the larynx, usually, in the ventricle of Morgagni. Thus needles and the seeds of cherries and plums, were extracted.

The first operation of thyreotomy recorded was performed by Brauers, who opened the cartilage for the removal of an intra-laryngeal growth; the patient recovered and lived twenty years afterwards.

Laryngotomy was done by Larrey in his experience as military surgeon, for relief in gunshot wounds of the larynx: he operated but a few times, and on the whole with doubtful result. The operation was done twice by G. Buck, of New York.

Laryngotomy has been done for the following purposes: for the removal of foreign bodies which have lodged in the larynx, as aid in certain injuries of the part, for relief of laryngeal stricture, and to prepare a way for the removal of intra-laryngeal growths.

As before mentioned, whether the relief for the exigencies enumerated may best be done by a route incised through the laryngeal wall; or whether the way proposed by nature is the better one, is an unended contest between the surgeon with his scalpel, and the laryngoscopist; with his mirror and forceps, the latter justly occupies the greater part of the field, yet the general surgeon holds a portion of it, and will continue to do so: and when the controversy is ended, the two should occupy this ground in common, and remain mutual allies of each other.

The most ordinary object for which laryngotomy, for a long time, was performed, was the removal of some body lodged in the larynx. As a preliminary aid in this case, to get immediate relief for the pressing demand for breath, tracheotomy should be done; and even though the dyspnœic symptoms are not great, it is well to first open the trachea, and introduce a canula; for thus doing, the surgeon forestalls the possible emergency in which

the shifting of the foreign body may induce a fit of strangling, or fatal suffocation.

Also, through the tracheal opening it is sometimes possible to pass an instrument upwards into the larynx and dislodge the body; and for this a convenient instrument is a soft, flexible sound: the urethral sound of India rubber or gutta percha may be employed. In this manner the writer removed by the aid of tracheotomy a large metallic body that had lodged in the larynx, by forcing it upwards. As soon as the object was expelled, the breathing was easy, and there being no need of a canula, it was dispensed with, and the wound closed by sutures.

Should the attempt prove fruitless to thus force the body upwards, or to extract it through the tracheal opening, then let the tracheal wound be maintained patent by means of a pair of dressing forceps, passed inwards and downwards, and then opened; then having lowered the patient's head, introduce the nozzle of a syringe and throw a stream of water through the larynx. If the head be well dependent, such a stream of water will flow towards the pharynx and escape through the mouth or the nostrils: the same as blood does in operations done in the Rose position; that is, with the trunk raised and the head lowered. In this way it is probable that a body which is lodged in the larynx would be carried by the water into the oral cavity. If the object be sharp-pointed, as a needle or a fish-bone, and have become fixed by insinuating its point into the mucous membrane, even then such a stream of water might dislodge and carry away the object. And as this hydraulic washing would be harmless, it should be tried before the more formidable procedure of laryngotomy is resorted to. Another method akin to irrigation would be to attach a piece of sponge to a thread and carry the thread by means of a flexible tube through the wound upwards through the larynx into the mouth; then by traction on the cord, the sponge could be drawn through the larynx; and in its passage, it would probably sweep out any object lodged in the canal. And finally, should these non-operative plans fail, then a resort to thyreotomy would be permissible.

Thyreotomy, done for the removal of foreign bodies, has generally proved a successful operation. Durham has collected a list of twelve cases, done for this purpose, which terminated successfully; and in most of the patients the work done did not injure the voice.

In case of wounds of the larynx from gunshot or other causes,

laryngotomy may become necessary: but here, to insure a free route for breathing, tracheotomy should first be done, and a canula inserted. After this, the surgeon may leisurely proceed to treat the laryngeal wound, in which one of the main objects is to replace dislocated fragments. Sometimes, the restitution to form can be done through the wound: and this may be enlarged if the opening be too small for the introduction of probe, forceps, or other instrument needed in the rectification of the fragments. Where the wound cannot be thus utilized, then, as Eichenmann has done, an incision may be made through the crico-thyroid ligament and the lower part of the thyroid cartilage; and thus reposition of fragments can be effected. For retention of the fragments in proper site, a T-shaped canula may be used: and this is to be constructed of two rectangular sections of which each can be introduced separately, and when united, a canula is formed of them, of which one portion lies vertical, reaching above and below the laryngeal wound, while the horizontal part traverses and reaches beyond the laryngeal wall. One part of this ingeniously contrived instrument can be removed, while the other remains in site. This instrument must be maintained in its place for a number of weeks, until the injured larynx has healed: for if it be removed prior to healing, then cicatricial contraction can occur and interfere with voice and respiration.

Injury of the interior of the larynx from the entrance of caustic liquids, as acids, or alkalies, as well as from boiling water, according to Durham, becomes an indication for thyreotomy. The laryngoscopist would claim that these cases lie within his domain: and always in the adult the non-operative course should first be tried; and should this fail, the more radical way remains open to the surgeon. But in case of children, who are the usual subjects of such laryngeal injury, the laryngoscopist would find it hard to carry out his treatment. In such patients, tracheotomy should first be done; and then through the tracheal fenestra, the conservation of the calibre of the laryngeal passage might be accomplished by the passage from below upwards of an elastic sound: and if a stricture has already formed, then the writer suggests that through the tracheal opening dilating sounds might be passed, and the calibre finally enlarged to satisfactory dimension. If an opening into the air-passage be made by crico-tracheotomy, then through this sub-laryngeal route, the treatment referred to could easily and successfully be carried out; and when the laryngeal canal is restored, then the tracheal

wound could be closed. But in case the stricture has already formed, then the narrowed calibre can often be restored by gradual dilatation, by means of instruments introduced through the mouth and throat: and this work, to be effective, must be done with infinite gentleness and patience; for the laryngologist and the urethral surgeon have both learned that a narrowed canal cannot be hastily restored to normal calibre, and that the compressive action of the instrument, gently manipulated and long used, finally causes absorptive action in the encroaching wall. Should this plan be impracticable, or, for some cause, not be feasible, then tracheotomy must be done, and a canula worn until healing has taken place: and when this has taken place, it will be necessary afterwards to practice endo-laryngeal dilatation.

And finally, as indication for laryngotomy is the presence of a neoplasm within the larynx. Until recently, it was not thought possible to remove such growth in any way, except to open a route to it with the knife: but the increased adroitness of the laryngoscopist, in discovering and attacking such neoplasm by the bloodless endo-laryngeal way, has rendered a resort to the surgical method a rarer procedure than formerly. Bruns, a partisan of the former method, has collected, within a period of twenty-five years, one thousand cases of laryngeal tumor, removed by the endo-laryngeal method: and during the same time, there were but one hundred operations in which the removal was done by opening the larynx. These statistics show that the laryngoscopic plan is greatly in the ascendant: nevertheless, the better method to be pursued in the removal of these growths will be indicated by their location in the larynx, and by their nature: for in certain locations, the neoplasm is nearly or quite inaccessible by the natural way; and, if it be of malignant character, its extirpation could be less radically done by this method, than by laryngotomy.

Bruns studied the location of the endo-laryngeal growth in eleven hundred cases, and he finds that in eight hundred and thirty-six, or about seventy-six per cent of the cases, the neoplasm was on the vocal cord, or the anterior commissure of the glottis: and this location is favorable for the removal by the laryngoscopist. But if the growth be seated below the vocal chords, or if seated within the ventricle of the larynx, then the work should be done by laryngotomy. Such cases, however, are rare. Again, if the growth be of malignant character, then its

laryngotomy may become necessary: but here, to insure a free route for breathing, tracheotomy should first be done, and a canula inserted. After this, the surgeon may leisurely proceed to treat the laryngeal wound, in which one of the main objects is to replace dislocated fragments. Sometimes, the restitution to form can be done through the wound: and this may be enlarged if the opening be too small for the introduction of probe, forceps, or other instrument needed in the rectification of the fragments. Where the wound cannot be thus utilized, then, as Eichenmann has done, an incision may be made through the crico-thyroid ligament and the lower part of the thyroid cartilage; and thus reposition of fragments can be effected. For retention of the fragments in proper site, a T-shaped canula may be used: and this is to be constructed of two rectangular sections of which each can be introduced separately, and when united, a canula is formed of them, of which one portion lies vertical, reaching above and below the laryngeal wound, while the horizontal part traverses and reaches beyond the laryngeal wall. One part of this ingeniously contrived instrument can be removed, while the other remains in site. This instrument must be maintained in its place for a number of weeks, until the injured larynx has healed: for if it be removed prior to healing, then cicatricial contraction can occur and interfere with voice and respiration.

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wound could be closed. But in case the stricture has already formed, then the narrowed calibre can often be restored by gradual dilatation, by means of instruments introduced through the mouth and throat: and this work, to be effective, must be done with infinite gentleness and patience; for the laryngologist and the urethral surgeon have both learned that a narrowed canal cannot be hastily restored to normal calibre, and that the compressive action of the instrument, gently manipulated and long used, finally causes absorptive action in the encroaching wall. Should this plan be impracticable, or, for some cause, not be feasible, then tracheotomy must be done, and a canula worn until healing has taken place: and when this has taken place, it will be necessary afterwards to practice endo-laryngeal dilatation.

And finally, as indication for laryngotomy is the presence of a neoplasm within the larynx. Until recently, it was not thought possible to remove such growth in any way, except to open a route to it with the knife: but the increased adroitness of the laryngoscopist, in discovering and attacking such neoplasm by the bloodless endo-laryngeal way, has rendered a resort to the surgical method a rarer procedure than formerly. Bruns, a partisan of the former method, has collected, within a period of twenty-five years, one thousand cases of laryngeal tumor, removed by the endo-laryngeal method: and during the same time, there were but one hundred operations in which the removal was done by opening the larynx. These statistics show that the laryngoscopic plan is greatly in the ascendant: nevertheless, the better method to be pursued in the removal of these growths will be indicated by their location in the larynx, and by their nature: for in certain locations, the neoplasm is nearly or quite inaccessible by the natural way; and, if it be of malignant character, its extirpation could be less radically done by this method, than by laryngotomy.

Bruns studied the location of the endo-laryngeal growth in eleven hundred cases, and he finds that in eight hundred and thirty-six, or about seventy-six per cent of the cases, the neoplasm was on the vocal cord, or the anterior commissure of the glottis: and this location is favorable for the removal by the laryngoscopist. But if the growth be seated below the vocal chords, or if seated within the ventricle of the larynx, then the work should be done by laryngotomy. Such cases, however, are rare. Again, if the growth be of malignant character, then its

removal can be far more effectually done by thyreotomy, in which the neoplasm being exposed to view, its removal can be more accurately and safely done.

The determination of the nature of the growth is not an easy matter: the microscope is not a faultless mentor: that its statement is frequently erroneous is a fact which has fallen within the writer's observation, a number of times: and no more striking example can be cited than the case of the late Crown Prince of Germany, in whom the microscope gave a report that proved to be erroneous, though it was in the hands of the ablest microscopist and pathologist of the century. The truth is, that infinite training and experience cannot always warrant infallibility in this work; the eye may wrongly see what is within the visual field. And, further, connective tissue and epithelial cell and intercellular elements do not always conform to the schematic framework which the pathologist has constructed for them. Nature delights in variation, and rigorously eschews the thraldom of uniformity; no two hands are alike; no two vascular systems agree in disposition: slight difference or abrupt anomaly occurs; and so no two specimens of epithelioma or sarcoma are identical; the bounding line inclosing one group of cells in one specimen would not geometrically fit those of another specimen of identical nature. The indefinite bounds between fibroma and sarcoma, and between the latter and carcinoma, will often cause hesitation, and interfere with accurate diagnosis. Should the evidence in favor of malignancy predominate, then the only hope of cure depends on thorough removal of the growth; and for this purpose laryngotomy offers many advantages over the other method. The removal should be complete; suspicious tissue should not be spared; and if partial removal does not promise a cure, then extirpation of the entire larynx should be done: it is only by proceeding in this way, that the surgeon can offer his patient a hope of immunity from recurrence.

The sessile or pedunculated form of the growth determines the difficulty or facility in the removal of the laryngeal neoplasm: thus, the growth with footstalk can easily be plucked from its nutrient ground; and such a case is well suited for endo-laryngeal extraction; but when it is sessile, and especially if the growth be of multiple form, the laryngoscopist must travel the tiresome way countless times, before he brings away the final fragments of the growth.

If one compares the endo-laryngeal with the extra-laryngeal

method, in respect to the chance of impairment of the voice, a preference may be claimed for the latter: for the operator has, when the larynx is opened, directly under his eye, the parts which are to be removed, and hence he can do it without peril to the vocal chords. The surgeon sometimes finds an irregularly formed thyroid cartilage: one side may project further beyond the median line than the other, and thus there is danger of injuring the vocal chords at their anterior insertion, whether the section be done from the inside or the outside. Again, it sometimes occurs that in healing the two halves do not unite symmetrically; or the closure may take place by loose ligamentous tissue, and then the vocal chords lacking firm insertion in front, their function may thus be impaired. Hence, as seen, phonic impairment may follow the work of thyreotomy. The perils which menace the voice are less when the operation is limited to partial laryngotomy; that is, when the growth is reached by an opening above or below the thyroid cartilage.

Thyreotomy has an advantage over the endo-laryngeal method in this, that the treatment is concluded in a shorter time in the former. Of forty-four cases of laryngotomy, healing occurred in nearly half of them within one week; and in nearly all of the remaining cases, the patients were well within two weeks. In a few cases, by the endo-laryngeal procedure, the work may be concluded instantaneously, yet when the tumor is less favorably situated for removal, weeks and even months may be required to effect complete extirpation.

Operation of Laryngotomy.—In many cases it is prudent to precede laryngotomy by tracheotomy; and, as additional aid, the air-passage may be tamponed above the canula. If the vertical division of the larynx be carried below the thyroid cartilage, then the canula may rest in the lower part of the cut, that is, in the crico-thyroidean space. But, as a rule, it is better to make a separate opening in the trachea for the canula: and then above this, a tampon may be introduced, and allowed to remain for two or three days.

In the operation of laryngotomy, to reach the larynx but a thin stratum of soft parts requires to be divided; the prominence of the larynx lies just underneath the skin. If thyreotomy be done, no vessel is imperiled unless the knife carelessly stray beyond the proper field of work. Only in case it be necessary to extend the cut into the crico-thyroid, or the thyro-hyoidean space, would the vessels there be endangered. And then such vessel

should be tied. Another element of embarrassment is an abnormal development of the thyroid gland: this gland may have a middle lobe reaching upward on the thyroid cartilage. Should this be present, and it not be possible to deflect it aside with the blunt dissector, then the glandular structure should be circumscribed by ligature at two points, and division done between the ligatures.

The patient to be operated on should rest on a bed or table where he is accessible on each side; and a cushion must be placed under the shoulders, so as to render prominent the field of operation.

The instruments required in the work are the following: scalpel, two retractors similar to those used in tracheotomy, a fine saw, scissor-shaped forceps, needles, silken thread, sponges and a canula.

The work commences with simple tracheotomy: and if thought necessary, through this tracheal wound a sponge may be introduced, and the trachea plugged well, just above where the canula is to lie. This preliminary being concluded, the thyroid cartilage is next to be reached and exposed by an incision in the median line. The cartilage being in view, the manner in which it may be opened will be determined by the age of the patient. For example, in the youthful subject, the cartilage can readily be divided with a strong knife, and this can be done, in the median line, from before backwards. If the cartilage has become partly or wholly ossified, as is the condition in the old subject, then the division is not so easily done. The instrument for the work may then be a fine, narrow-bladed saw, such as is used in resection of bone; or a strong knife, if wielded by a strong hand, will answer the purpose. And such ossified cartilage is divided from the outside inwards, by some operators: others divide from within outwards; and in this case, a probe-pointed knife is used. To use the blunt knife, let an opening be made at the upper or lower border of the thyroid cartilage, in the median line; and through the opening insert the knife and then make the division from behind forwards. This is the method devised by Schüller and Hueter. If the small saw is used, its track should first be prepared by a division of the mucous membrane with the knife. Instead of knife or saw, the section may be made with narrow-bladed bone forceps, or with strong narrow-bladed scissors.

After this division of the thyroid cartilage, should the space

exposed be found insufficient to do the work intended, then the section of the parts may be continued upwards, or downwards; and in the latter direction, the cricoid cartilage may be severed. And after this complete laryngotomy, or after the division of the thyroid cartilage, should the space be inadequate for the removal of the laryngeal growth, or too small for any other purpose for which the opening is done, then a portion of one or both sides of the thyroid cartilage may be exsected. Such exsection was done by Heine; and his plan is as follows: after the median cutaneous incision has been made, and the cartilage having been reached has been divided vertically, then let the cartilage be freed from its lining, both internally and externally, and next, with strong scissors or resection forceps, remove the required portion of cartilage.

The excision of a portion of the thyroid cartilage may enable the operator to enter the larynx and do his work without further division of the parts: that is, a window may be made at a point, which the laryngoscopic examination indicates will render the growth most readily accessible to the surgeon; and as this may be at the lower or upper margin, so a corresponding cut is to be made, the larynx uncovered of its soft parts, and then a portion of the wall is excised. The location of such opened fenestra should be such as not to interfere with the vocal chords.

According to the purpose for which the laryngotomy has been done, so will the operator proceed when the cavity has been opened: whether the case be one of neoplasm, of stricture, or of dead cartilage, the surgeon should bear in mind that his work should be well and thoroughly done: so completely done that there will be no occasion for another operation. Still a laryngotomy has been done a second and even a third time, on the same patient: but it were better, for both patient and surgeon, that the work should be so fully done as to exclude such future contingency.

How the wound is to be closed has been a matter of disagreement among surgeons: some favor and others oppose closure by suture. Against the use of the suture its opponents urge that it may cause emphysematous infiltration of air in the wounded tissues; also, that the suture may be the cause of necrosis in the cartilage. Krishaber reports such emphysema in a case in which suture was used. That the ill which may arise from suture has been magnified, is apparent from the results obtained in thirty-five cases so treated: in twenty-nine of these, the wounded carti-

lage united by first intention; and only in five of the cases was the healing prolonged by suppuration.

Where suture is used for closure, silk or wire may be employed: the author would use silver wire, in case it is intended to penetrate the entire thickness of the cartilage. But in case merely the lining membrane of the cartilage is traversed, then it is immaterial whether silken or metallic suture be employed. In case steady fixation of the parts can be made by simply including the perichondrium, it should be done in this manner: and experience has shown that this superficial suture suffices. After the laryngeal wound has been closed, the wound in the skin and soft parts must be closed by more superficial sutures.

Closure of the wound can often be satisfactorily done without the use of sutures, namely, by adhesive strips placed transversely across the part; and these may be aided by compresses laid on each side, and the whole retained in place by means of a bandage around the neck.

The canula inserted in the preliminary tracheotomy should remain in place in children for a time varying from a few days to some weeks: thus doing, one guards against respiratory obstruction through intra-laryngeal swelling. In the adult, it is sometimes necessary to let the instrument remain in place many weeks: and in some cases it has been found necessary to let the canula remain in position for months, and sometimes for years. The prolonged use of the canula is required in the adult in whom the endo-laryngeal growth may soon recur, and suddenly obstruct the air-passage.

In concluding this chapter upon laryngotomy, the writer will formulate as a rule of guidance, that in all cases in which the operation is contemplated, a consultation should be held between the laryngoscopist and surgeon, and if in the opinion of the former, the case can surely, or even probably, be successfully treated by the endo-laryngeal method, then the latter should be pursued: but in case this method be deemed impracticable, or have failed in its purpose, then the case should be committed to the surgeon, and one of the methods heretofore described, be pursued.

INTUBATION.

About 1858, Bouchut advised as a substitute for tracheotomy, the introduction of a tube or canula into the larynx. In 1859, Trousseau who had gained great éclat by his successful

operations in tracheotomy, and was the leading champion of this operation, violently opposed the new procedure of Bouchut. Trousseau founded his opposition on the observations of dogs, in which such tube was introduced into the larynx, and worn for some days, with the result that the tube caused ulceration of the glottis, and if it were to remain long in place Trousseau claimed that it would cause necrosis of the larynx. The high authority of Trousseau, and the general antagonism of the medical profession in Paris to Bouchut, prevented the adoption of intubation as a method of relief in croup and diphtheria. Bouchut, though deprived of his well-merited honor, lived to see the method revived and adopted in the New World.

In 1870, Weinlechner, of Vienna, resorted to intubation in the treatment of croup and diphtheria. He first tried the plan of passing a solid sound into the air-passage, and with this, he attempted to remove the impediment existing there: and this failing to relieve, he next passed a tube that was closed by an obturator, and when introduced, the latter was removed, and the tube allowed to remain. So much benefit was derived from this procedure that Weinlechner recommends that it be tried before tracheotomy is resorted to. Besides in croup and diphtheria, he recommends tubage in œdema of the glottis, laryngo-spasmus, asphyxia, stricture of the larynx or trachea, and foreign bodies in the air-passages.

Despite the attempts to substitute tubage or intubation, as it is now generally named, for tracheotomy, the procedure fell into disfavor and was soon abandoned. In 1884 it was again called to life by Dr. Joseph O'Dwyer, to whom more credit is due than to an originator, since in his work he has reclaimed a procedure that had twice or thrice been tried and rejected. O'Dwyer's early attempts were not crowned by remarkable success; yet it was enough to direct the attention of the profession to the method, and to enlist a few followers. Among those who adopted and did much to popularize the procedure may be mentioned Dr. Waxham, of Chicago, and Dr. Dillon Brown, of New York. Early in 1885, Dr. Waxham, an ardent advocate of intubation, read a paper on the subject, before the Chicago Medical Society; and later in the year, he read another paper, in which were detailed the results obtained in a few cases. Some improvements had been made in the instruments first employed. Dr. Byford also praised the method, for its simplicity, safety and the immediate relief obtained; and another strong point in its favor is that the opera-

tion is less objectionable to parents than that of tracheotomy. About the same time, O'Dwyer reported two successful cases, in which the tube had been worn ten days. No œdema of the larynx was caused by the tube. In very young children he counsels to occasionally remove the tube and cleanse it.

In 1886, Dr. Dillon Brown, of New York, having collected eight hundred and six cases of intubation, read a paper on the subject before the New York Academy of Medicine. The number of medical men who had employed the procedure were sixty-five; the recoveries obtained were two hundred and twenty-one, that is, about twenty-seven and five-tenths per cent. The average age of those who died was three years and two months; and of those who recovered, a little over four years. The average duration of the laryngeal trouble, before the introduction of the tube, in those who died was one day and nineteen hours; and in those who recovered it was two days and nine hours. The usual cause of death was the passage downwards of the diphtheritic disease. The advantages claimed by Brown for intubation are that the operation is bloodless, the air in breathing is admitted through the natural route, there is no shock, and the procedure incurs no opposition from the parents or friends of the child.

Northrop has made post-mortem examination in one hundred and seven cases in which intubation had resulted unsuccessfully. In a few cases, the lower end of the tube had caused ulceration of the trachea.

Huber found that after the introduction of the tube, it might be coughed up; and even coughed up and swallowed. The tube may also become closed with false membrane. In swallowing food, particles of matter may enter the tube, and, passing down to the lungs, become the cause of pneumonia. Huber saw ulceration and bleeding caused by the tube. Swallowing is difficult; and sometimes the breathing is suddenly arrested. And the most improved forms of the tube have not guarded against the troubles mentioned.

The instruments used by O'Dwyer for intubation, shown in the accompanying figure, are the following: assorted tubes (A), varying from small to large; an applicator (D) or instrument which is attached to an obturating stem, and by the aid of which the tube is inserted into the larynx; a gag (C) for holding the jaws asunder, and the mouth open; an extractor (E), by the aid of which the tube (A) is seized and withdrawn; and a gauge (B) for admeasurement.

Of the tubes there should be five of differing calibre, and lengths varying from one and three-fourths to two and a half inches. The tube has attached to it a silken thread by which it is held and withdrawn, if in the work of insertion it is not properly placed: but when the insertion is properly done, the loop of the thread is cut, and the latter removed.

In the work of introducing the tube, the hand of the opera-

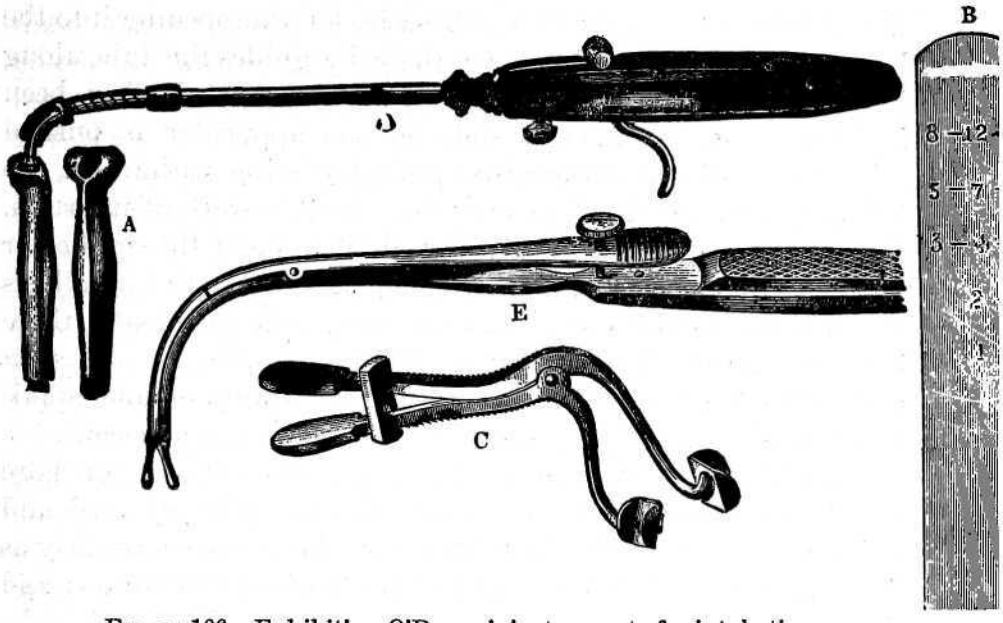

FIGURE 106. Exhibiting O'Dwyer's instruments for intubation.

tor should have previous training on the cadaver; for to attempt the introduction without some preliminary training, will be attended with much bungling effort, and may end in failure. The index must be taught to recognize the hard cartilaginous entrance into the larynx, and to distinguish this opening from that of the gullet: for the mistake oftenest occurring in the introduction is to place the tube in the œsophagus, instead of in the larynx: yet by means of the tethering thread, the tube can be drawn back and replaced again.

The fear was entertained for a time that the tube might slip downwards through the glottis into the air-passages; to avoid this the tube is now provided with a larger shoulder around its mouth. And, as Ingalls remarks, even should the tube pass down into the air-passages, its length is such as to prevent it escaping so far that it could not be reclaimed through the natural route; or, this failing, it might be removed by tracheotomy. The length of the tube is such that it reaches to within one inch of the bifurcation of the trachea.

The applicator and the obturating appendage are to be attached, and then the tube being placed on the former, the instrument is ready for insertion.

To introduce the tube, let the child be held in the nurse's lap wrapped about with a cloth that securely incloses the arms. An assistant firmly holds the head turned backwards, while the gag is introduced, well back on the left side of the mouth. The surgeon sitting in front passes his left index finger into the throat behind the epiglottis and seeks for the opening into the larynx; and holding the finger there he guides the tube along its palmar surface, into the glottis. When the tube has been inserted to its shoulder, a slide on the applicator is pushed against the latter, and then the applicator being withdrawn, the tube is left in the destined position. In this work of insertion, O'Dwyer advises to commence with the handle of the applicator near the child's breast, and then gradually to lift the handle as the introduction advances; thus elevating well the handle, there is less danger of slipping the tube into the œsophagus. As soon as the tube has been introduced, after the obturator and applicator have been extracted, the child will soon breathe easier.

Should the tube become obstructed with mucus or false membrane, it must be removed with the extractor, cleaned and re-inserted. As a rule, the tube should be removed as early as the fifth day, and a test made of the patient's condition; and should breathing remain free, the tube may be dispensed with; but should dyspnœa reappear, then the tube must be inserted again.

A critical contingency sometimes occurs during the wearing of the tube, viz., that the latter is expelled by coughing: and at the time of such accident, if the surgeon is not present to replace the instrument, the patient may be lost: and hence, here, as in case of tracheotomy, there must be ever at hand an assistant or nurse, who is capable of meeting the emergency; and such an aid, if not a medical man, should be someone who has had medical training, and especially in the work of inserting the tube.

Ingalls, an early reporter on intubation, selects the following cases as proper for its use:—

1. In diphtheritic and croupous stenosis of the larynx in children under three and one-half years of age. 2. In cases of these affections in which the surgeon, from any cause, desires to defer tracheotomy. 3. In those cases in which consent to tracheotomy cannot be obtained. 4. Those cases in which proper

nursing cannot be obtained. 5. Severe cases of spasmodic croup in children less than ten years of age. 6. Simple stenosis of the larynx, not diphtheritic, in children. 7. With tubes of proper size it might be of value in the treatment of various forms of laryngeal stenosis in adults. He intimates that a formidable risk in intubation is the coughing out of the tube, in the absence of any one who could re-insert it. Ingalls thinks intubation is especially suited for small children, since in these tracheotomy is usually unsuccessful. As large a tube as possible should be used, since one of less than one-fourth of an inch in diameter does not permit enough air to pass to maintain life.

Casselberry thinks a part of the success of O'Dwyer's procedure depends on the use of a long tube: the short tube employed by Bouchut rendered it difficult to be used, and caused the method to be abandoned. Casselberry fears that trouble will arise in feeding children who are the subjects of intubation; and that when the food is liquid, some of it will enter the air-passage. On this point, Parkes thinks there will not be much difficulty if a tube be so selected that it will fit well, and permit the epiglottis to close well over it in swallowing.

According to Northrop, the beginner in the practice of intubation is apt to use too small tubes, with the result that such are coughed up. He says there is no risk of the instrument slipping down into the trachea, since the head of the tube cannot pass beyond the cricoid cartilage, where the narrowest portion of the passage is situated. He cautions against premature removal of the tube. After the removal of the tube, whether it will be necessary to re-introduce it, will depend on whether the air canal remains free from obstructing membrane, or the lungs continue unaffected. The re-appearance of pseudo membrane demands re-insertion of the tube; and if ausculation shows that the lungs are becoming impeded in their work, then the tube must be used again. The pulse gives some information; its rapidity corresponding with pulmonary implication is an indication for intubation. The objection is urged sometimes that in the insertion of the tube, false membrane may be pushed before it and occlude the tube; the same, according to Northrop, applies also to tracheotomy. Intubation has the advantage over tracheotomy, that it can be done without an anæsthetic. Another advantage which it has is, that the air enters the mouth and is warmed and moistened before it enters the lungs.

Near the close of the year 1893, Waxham reported the results of intubation in four hundred and sixty-six cases: in the first one hundred there were twenty-seven recoveries; in the second one hundred, thirty-four recoveries; in the third one hundred, forty recoveries; in the fourth one hundred, thirty-eight recoveries; and of the last sixty-six cases, twenty-two recovered. The assertion that intubation is done early, and hence is more successful than tracheotomy, Waxham denies: for in many of the cases which he reported, it was done late, when the child was moribund and unconscious: and in many patients to which he was summoned, the children were dying, and expired before anything could be done. The cases reported were not selected ones, but were of ages varying from early infancy to much older children, and had been treated by physicians who had tried unsuccessfully to relieve the patients by other means. And many of them were among the poor and destitute and were badly nursed; even under such conditions, the results obtained were very satisfactory.

The instruments employed were an improvement on those originally introduced: the introducer could be used more readily; the obturator was not jointed, as it was in the original form. The instruments were purely metallic; and also the case which contained them, so that all could be washed in hot water, and rendered aseptically free from the bacterial virus with which they must come in contact in the treatment of croupal or diphtheritic disease.

At the sixty-fifth meeting of the Association of German Naturalists and Physicians, Ranke, in the section of diseases of infants, made an exhaustive report on intubation; and drew a comparison between intubation and tracheotomy. The figures presented by those who engaged in the discussion varied much in regard to success: and this is explained as dependent on the benign or malignant type of the diphtheritic disease, for which the tubage was done. In the cases reported, the procedure was only resorted to when the larynx had become so occluded with false membrane that tracheotomy would have been necessary to prolong life, if intubation had not been done. All cases, without reference to age, were operated on, and the whole number reported amounted to twenty-five hundred.

The cases operated on were classified as those of primary and those of secondary diphtheria; in the former, the recoveries from intubation were thirty-nine per cent; while from the latter there were twenty-two and three-tenths per cent of recoveries. Of one

thousand three hundred and twenty-four cases of primary diphtheria in which intubation was done, it was afterwards necessary to perform tracheotomy in two hundred and forty-two patients; and of these over eight per cent were saved; and that a greater number was not saved arose from the disease having descended into the bronchi.

Ranke thinks that intubation is especially suited for the country practitioner whose surgical skill is insufficient to perform tracheotomy. He thinks that in the country there might be saved twenty-five per cent of diphtheritic patients, which ordinarily die.

In instituting a comparison between intubation and tracheotomy, the number of recoveries obtained by the two methods is about equal. In children under two years of age, there are more recoveries by intubation than by tracheotomy; hence, intubation should be done in the very young.

In cases of diphtheria in which the membranous formation is very extensive, and the pharynx is much swollen, Widerhofer advises tracheotomy; also, to avoid ulceration from the tube, in cases in which this must be carried for more than five days, he advises that intubation should be followed by tracheotomy. When the membranous formation extends downwards towards the lungs, only in very strong children should tracheotomy be resorted to as subsidiary aid. In the course of intubation, should asphyxia suddenly appear, tracheotomy should be done: for through the tracheal incision, the surgeon can often extract the false membrane; or the laryngeal tube being removed, the patient is able to cough out the membrane.

The general opinion expressed by the German physicians was that intubation is a valuable procedure, and that, by it, the prediction of Malgaigne will be fulfilled, viz., tubage will one day bring as great a revolution in the treatment of croup as lithotrity has brought in the treatment of vesical calculus.

CHAPTER XXXIII.

EXTIRPATION OF THE LARYNX OR OPERATION OF LARYNGECTOMY.

THE removal of the larynx by the knife, was suggested some time before it was done; and the final realization of this bold procedure was rendered possible by experiments on the dog. In 1870, it was proved from operations on the dog by Czerny, that the larynx could be removed, and the animal continue to live: and his results justified him in believing that the operation could also be safely done on man. Long prior to Czerny's work, Albers in Bonn did similar work on the dog, with the object of determining whether the animal could live without the larynx. And, finally, when the operation had been done on man, other surgeons, and among them Von Langenbeck, announced that they had previously conceived its possibility, and had even planned to remove the human larynx.

The first operation was done by Billroth in 1873, who did it for relief in a case of carcinoma of the larynx. In this patient, laryngotomy had been performed to remove the endo-laryngeal neoplasm; but four weeks afterwards, the growth reappeared, when Billroth proceeded to dissect the larynx from the contiguous parts, and having removed it, the patient was provided with an artificial larynx by means of which he was able to talk. This patient lived in fair health for some months, yet the carcinoma returned, and death occurred about a year after the operation. This operation, in which the larynx was removed and replaced by an artificial appliance for phonation, attracted the eyes of the surgical world: and it was believed that if the work were timely done, the subject of laryngeal cancer might be rescued from a malady, which had hitherto been regarded incurable: and animated with this hope, or inspired with the desire to be among the first in this new field of daring, a number of surgeons hastened to repeat the new operation. Heine in Prague, Maas in Breslau, and Bottini in Italy, reported each an extirpation. In the case of Bottini, the disease was sarcoma; and after the

removal, the patient was attacked with erysipelas, which delayed the recovery. The man finally became well and resumed his former occupation as letter-carrier. The attack of erysipelas, now regarded as antidotal to malignant disease, may have stamped out all traces of the disease which had escaped the knife.

Since these pioneer operations, the extirpation of the larynx has been announced in all parts of the globe, in which surgery exists as a cultivated science and art. The published results, though not flattering, have been sufficiently encouraging to give this procedure an enduring place in surgical art.

Before having recourse to so radical a procedure, the surgeon does wisely who first opens the larynx by a vertical incision in the median line, and endeavors to remove the affected parts through such an opening: in fact, in the history of laryngeal extirpation, one finds that in many cases it has been preceded by thyreotomy, by which the neoplasm being removed and having recurred at an early period, the more radical procedure of total extirpation has been done. And a proper rule for observance in cases which have applied for relief early in the disease, is to first perform thyreotomy; and should the disease afterwards recur, the surgeon is justified in resorting to a more extensive operation: which may be removal of one side, or the whole of the larynx. If it be possible to limit the ablation to one side, or one-half of the part, the patient will be left in a much more favorable state for the introduction of an artificial vocal apparatus, than if the whole larynx be extirpated. Hence, from what has been said, the extent to which the knife will proceed in laryngeal extirpation is to be learned and decided on, as the surgeon proceeds with his work: one-fourth, one-half, two-thirds, or the whole, as the conditions denote and demand.

As stated, the operation is done for the removal of malignant disease, viz., carcinoma or sarcoma; and it is important to note that the results of operations in the two are different: the prospects of a removal securing future immunity, are much more promising in sarcoma than in carcinoma; the latter has almost always returned, while permanent cures have followed the extirpation of sarcoma.

As an adjuvant and prophylactic preliminary to extirpation of the larynx, tracheotomy has been done by most operators: thus certain provision for respiration during the work is secured. Some operators have done this a few days prior to the extirpation; and this plan seems to be a good one, since, thereby, famil-

iarity with this unusual route of breathing is early acquired; and it is likewise claimed that there results from this wounding of the cervical structures an adherence of the trachea to the surrounding structures, so that it will not sink downwards, to much extent, after the removal of the larynx. The site of the tracheotomy must be as low as possible; for thus done, it will be removed from the operative field; and this low site offers another important advantage, that it permits tamponing the passage above the canula, so that no blood or subsequent excreta can enter the air-passage, and generate pneumonic trouble. The occlusive tampon of Trendelenberg was used in extirpation of the larynx by Czerny, Heine, Wegner and others, and is advised by them; others have operated on the patient placed in the Rose position, and thereby diverted the passage of blood from the air-passages.

In the absence of a specially devised tampon, the closure of the upper end of the trachea can be done by means of sponge which has been purified by immersion in alcohol diluted with four parts of water: one or more pieces of sponge with cord attached may be forced into, and made to fill the upper end of, the trachea. Foulis, of Glasgow, successfully performed laryngectomy; and as tampon he used a large leaden tube, which completely filled the trachea above the opening made in the provisional tracheotomy, and was closed by India rubber in the shape of a plate. This occlusion is done after the patient has been well anæsthetized. The operation of laryngeal extirpation commences with an incision in the median line which should begin at the hyoid bone, and be continued downwards to the upper portion of the trachea. Through this longitudinal cut, the larynx may be exposed by dissection, and the entire work of removal done; other operators however have enlarged the operative field by intersecting the vertical cut by a transverse one. Or to the longitudinal cut, two transverse ones may be made, so that a lateral flap is formed on each side. The median longitudinal cut has been found sufficient by many operators; yet should it be found inadequate as the work proceeds, then such subsidiary incisions may be made, as the conditions found may necessitate.

If the surgeon confines himself to the single longitudinal cut, this must penetrate to the cartilaginous structures, when, by means of the blunt dissector, the cutaneo-muscular tissues are to be reflected laterally. In this dissection there will be encountered

above, the laryngeal arteries, penetrating the hyo-thyroidean membrane; and below, the crico-thyroidean arteries which perforate the crico-thyroidean membrane. In each case, the vessel is to be doubly ligated, and divided between the ligatures. By following the surface of the thyroid cartilage, the middle cervical fascia and the included muscles can be uplifted. The sterno-hyoid muscles may remain unsevered; but the sterno-thyroid and the thyro-hyoid muscles must be severed from their connection with the thyroid cartilage. In these soft structures are contained lateral lobules of the thyroid gland; and with care the nutrient arteries of these parts need not be disturbed.

When the larynx has thus been separated from the soft parts and exposed fully to view, then the removal may be done from above downwards, or from below upwards; and each mode has its advocates.

After exposing to view the larynx and upper part of the trachea, the removal from below upwards commences by a transverse cut between the cricoid and thyroid cartilages; and if then the cricoid cartilage be found sound, it may be left, and the thyroid and attached arytenoid cartilage may be pulled outwards, uplifted and separated from the œsophagus, and tissues to which they are adherent behind; and when the hyoid bone is reached, the structures may be divided just below. In this separation, the superior and inferior laryngeal nerve will be severed; an unimportant sacrifice, since the parts which these nerves innervate are removed. Should any vessels be met in the detachment, these should be carefully ligated. In regard to the epiglottis, authority is divided respecting its removal, or retention: those who would preserve it, claim that it would prevent the entrance of foreign materials into the artificial larynx; on the contrary, Czerny and Maas found that if it was retained, it fell into the artificial larynx, and interfered with its proper action. Wegner, who removed the larynx, preserved the epiglottis, and from his experience he prefers this mode; hence, with eminent authority for and against the procedure, it is probable that it is a matter of little import which method is selected. When its ablation, complete or total, is decided on, the part may be seized with forceps and drawn into the upper part of the cut, and then as much may be excised as is desired. Should it be suspected that the epiglottis is affected with malignant disease, it should be wholly extirpated, and even the excision may encroach on the base of the tongue.

In whatever way the work be done, whether from below

upwards, or from above downwards, it will be well to open the larynx by a longitudinal cut in front, through which an inspection can be made of the inner surface; thus a more correct notion can be obtained of the isolation or diffusion of the disease. By this means, both the upper and lower ends can be examined, and thus the excision may extend as far as may be required. If it be found that the cricoid cartilage is sound, it may be left in its entirety: or, perhaps, a portion of it may be spared, and thus the support for the vocal prothesis will be improved.

A troublesome complication may exist in the extension of the disease to, and implication of, the œsophagus; and in such condition it becomes necessary to extend the sphere of the operation, and to include the affected portion of the œsophagus. Such removal must be thorough, since to leave a fragment of disease, however small this might be, would not improve the patient's condition. And such removal, interfering as it must with normal deglutition, will cast an additional shadow on the patient's future. If but a limited portion of the canal be implicated, then it might be possible to excise a section, and then approximate and effect an anastomosis between the remaining ends. If the disease were so extensive as to prevent restoration of continuity, then the affected part must be removed, and alimentation maintained by means of a tube introduced into the distal portion of the remaining œsophagus.

In not a small number of cases observed, the œsophagus has been the part in which the malignant neoplasm commenced; and thence extended to the larynx. If such a case be early recognized, it might be possible to remove the disease by an exsection of the œsophagus, with the removal of a limited portion of the larynx; and in this case, if the excision of the œsophagus be extensive, then it would probably become necessary to nourish the patient through a tube retained permanently in the cervical opening.

Cases also occur in which the disease, commencing in, and extending from the larynx, spares the œsophagus, but attacks the parts situated laterally. When the disease is thus situated, besides laryngeal ablation, the muscles and other structures which are found implicated must be liberally sacrificed.

As appears from what has been stated, there is but little uniformity in the local development of laryngeal cancer; and the more favorite sites of the disease are indicated in the following statistics of Ziemssen and others. In eighty-two cases, the

disease began in the epiglottis in thirteen; in thirty-six, it was unilateral, occurring seventeen times on the right side, and nineteen times on the left side. Of thirty-seven cases seen by Fauvel, it was unilateral in all the cases except one; and in nearly all the patients, the affection was seated on the left side.

The limitation of the disease to a small part of the interior surface of the larynx has led to thyreotomy, in which the cartilage being opened, the diseased part was removed. This conservative plan has usually been followed by recurrence; and hence, to insure against a return of the disease, there should be a thorough extirpation of the affected and suspected structures.

When the affection is unilateral in site, the work may be limited to the removal of one side of the larynx. This partial ablation has been done successfully by Billroth; the remaining vocal chord sufficed for the function of voice; and thus the necessity of an artificial larynx is dispensed with. The caution here is proper, that there should not be too much economy in the work of the knife, lest the uneradicated disease may reappear. Every surgeon in the review of his operative work in the treatment of malignant disease, has cause to regret such economy. This statement is painfully supported by the personal experience of the author.

After thorough excision of the diseased tissues the remaining surface should be carefully inspected to determine whether all traces of the disease have been removed; and if this has been accomplished, the wounded surface should be sponged with a six per cent solution of chloride of zinc.

The remaining treatment of the wound is a subject of discussion among operators; as closure or non-closure of the cut-throat has been a matter of contention among surgeons, so a similar question has been mooted between the operators of laryngectomy. Schüller advocates the open or partially open treatment of the wound, claiming that, thus proceeding, the surgeon is better able to observe the progress of the healing, and to obviate or relieve any intercurrent disturbance. If the wound be thus treated, the opposite walls of the opening will advance towards each other so that soon there remains a hollow canal, incompletely closed in front; and this closure often proceeds so rapidly, that it becomes necessary to reopen, and retard the rapid approach of the opposite walls towards each other. In case, however, lateral flaps are made, then partial closure should be made by means of one or two sutures, which pass through the angles of the flaps, so as to

fix and hold them in place. By this incomplete closure, there will remain an intermediate opening sufficient for the purpose just mentioned. It should be stated that in a case of successful laryngectomy done by Bottini, he pursued the opposite plan: he closed the wound completely by sutures.

If only a small opening be made in the pharyngeal or œsophageal wall, this should be closed.

If the trachea when severed were not fixed in some way, it would descend and become buried and closed by the dermal structures; to prevent this descent, the lower end should be securely sutured in the wound so that it will remain in its site, and not become closed; and to insure patency of the trachea, a canula should be introduced at once, and allowed to remain permanently in position.

Another important part of the operation is to make provision for the alimentation of the patient; and this is done by introducing a tube through the wound which has opened the œsophagus, and letting this reach to the stomach and remain permanently in the canal: and around the tube, the wound can be packed with aseptic lint or gauze.

The tracheal canula, through the aid of a tamponing accompaniment, or other occlusive means, should so fill the trachea that no excreta can enter it; and to insure against such descent of matter, the wound should be redressed daily. In this dressing, the surface of the wound should be cleansed with alcoholized water; and also the mouth should, at short intervals, be rinsed with camphor water, or mint water.

Through the œsophageal tube, limited amounts of liquid nutrient material must be introduced to the stomach; such nutriment may consist of soups, milk, wine-whey, milk with brandy, and other articles of food of which the liquid character will permit of introduction through the tube. Nutrition by the rectum may also be resorted to; and for this purpose, pancreatinized milk may be employed.

If the lesion of the pharynx or œsophagus be a small one, so that it may close soon, then the tube for transmission of nutriment may be passed through the mouth, and the patient thus fed; thus proceeding, the healing may advance more rapidly. After these operations, patients soon learn to swallow: difficulties which were great at first, are gradually overcome. The base of the tongue is drawn towards the posterior wall of the pharynx, so that the food is carried through the faucial isthmus to its

proper channel below. Long ago, the physiologist Longet determined by vivisective trial, that the dog deprived of the epiglottis, soon learns to swallow food; and this fact has been corroborated in the human subject, in whom, from ulcerative disease, the epiglottis has been lost: the subject soon learned to swallow, without strangling.

In the case operated on by Billroth, the patient was able to swallow liquids after one week; and after three weeks he could swallow solids. The patient of Foulis swallowed fluids after five days; and that of Bottini, after a short time. From the cases observed, it is clear that the troubles apprehended from dysphagia after laryngectomy have fortunately not been verified.

Total extirpation of the larynx in the removal of the vocal chords necessarily deprives the patient both of voice and articulated speech: he becomes dumb; and thereby, is shut off from an important part of the enjoyment of life. In the treatment of criminals, condemnation to silence is one of the severest punishments. Thanks, however, to surgical ingenuity, the operator who takes from the patient his natural organ of voice, is able to give him, instead, an artificial one: the deft hand of Vincent Czerny, who gave surgical art this novel operation, gave, also, the yet more novel device of the artificial larynx. In his operations on the dog, Czerny introduced into the trachea a canula, in which there was placed a vibrating metallic tongue; and from this germinal device, of which the action was first verified in the dog, sprang a more complex appliance, designed by Gussenbauer and made by a mechanician in Vienna, for use in a man from whom Billroth had extirpated the larynx; and this was successful in enabling the man to talk in articulate speech. In language, the single function of the larynx is the development of sound; this sound is converted into articulated words composed of single or multiple elementary sounds, by means of movements made by the pharynx, soft palate, nostrils, inner walls of the cheeks, lips and tongue: the last instrument, though it has given its name to language, performs but a minor part in lingual function, since it really shapes but three elementary sounds. For the restoration of articulate speech after the removal of the larynx, it is only necessary to restore the function of the latter by introducing in its place a cord, thread or metallic tongue so fixed as to vibrate in the current of expired air: and, what is remarkable and difficult of explanation, the coinage of words, though somewhat uncouth, can be made by a current of inspired air. The artificial

larynx has for its office the generation of sound: its possessor being given a sound, coins the latter into the infinitude of forms which compose speech. A number of such devices have been contrived; that of Gussenbauer was the first that was used in man.

The artificial larynx of Gussenbauer, shown in Figure 107, is composed of the following parts: a tracheal portion, a laryngeal portion, and the apparatus for phonation. The first and second parts are made of hard rubber, while the vocal portion is made of German silver. The tracheal portion is a long curved part, in shape similar to the canula used in tracheotomy; and this is first

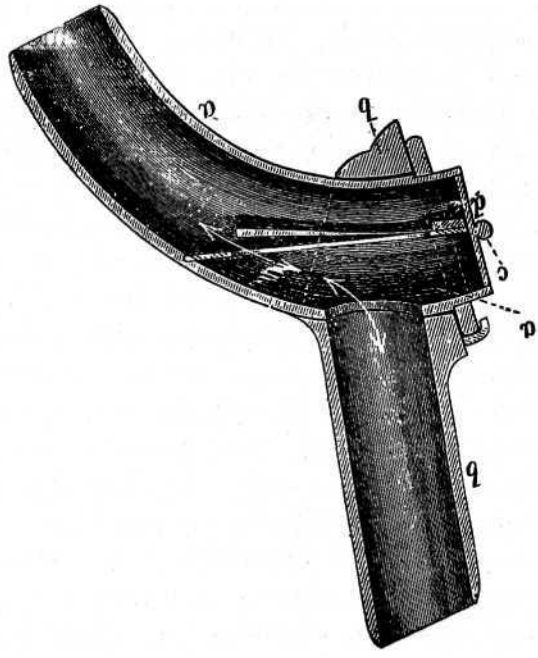

FIGURE 107. Showing the interior of Gussenbauer's artificial larynx. (From Schüller.)

put in place, when the laryngeal part is next introduced into the wound, corresponding to the site of the larynx; and then through an opening in the latter, the part for phonation is placed, and is similar to a drawer which can be moved inwards or outwards; and this contains a metallic tongue which vibrates in the current of passing air. This phonic section communicates above and below with the laryngeal and tracheal portions; it also opens externally; and hence when the instrument is in use, this latter outlet must be closed. To the laryngeal portion there is attached above and in front a movable valve, which is designed to act the part of an epiglottis. This portion was afterwards found unnec-

essary, and left off: since in swallowing, the base of the tongue moving backwards can dispense with an epiglottis.

Hueter adapted an artificial larynx to a man who in attempting self-destruction, excised a portion of the larynx; this consisted of a single canula, which was so bent as to be in bayonet form. The tracheal portion was larger and narrower than the upper or laryngeal portion; and in the latter there was a simple vibrating tongue. At the junction of the two portions, the canula had an opening through which passed the inspired and expired air: and, when the subject desired to talk, this opening was shut so that the expired air passed upwards and caused a vocal tone, which could be shaped into articulate speech.

In the patient from which Foulis, of Glasgow, extirpated the larynx, he simplified the matter by using only a tracheal canula, in which he inserted a vibrating tongue; this tongue, drawer-like, could be drawn in and out. In this device, the vibrating tongue was so placed that the expired air came chiefly in contact with the free end of the tongue. Foulis tried different materials, in the construction of the tongue, such as vulcanite, iron, horn, reed and metals. The tongue compounded of copper and silver he found to be the one which yielded the loudest sound; yet those from non-metallic material, though weaker, gave a sound most nearly like that of the human voice.

The construction of the artificial larynx in the different forms in which it has been made, has afforded ample opportunity for the exercise of mechanical ingenuity; still, some difficulties have been encountered in the work, which can scarcely be said to have been wholly overcome; the one is the length of the laryngeal portion, which, when it reaches too high upwards, interferes with the backward movement of the tongue in deglutition: and the other is that mucus and foreign matter tend to lodge on the sounding tongue, and to interfere with its proper action. According to the writer's judgment, in the simple device of Hueter, and the somewhat more complex one of Foulis, these difficulties have been most successfully met: yet after the best that has been done, when compared with Nature's simple model, the effort of Art has but slight cause for exultation.

CHAPTER XXXIV.

VESSELS OF THE NECK.

WHEN the neck is viewed in respect to its vascularity, it is found that all the vessels of importance lie in the anterior region; those lying behind are of minor calibre.

The vessels in front may be divided into two classes; those of intercommunication between the trunk and the head, and those connecting the upper extremity and the trunk; the former is the carotid artery, and on its outer side, lies its great satellite, the internal jugular vein.

The term carotid, according to Rufus of Ephesus, is of Greek origin, and refers to the fact known to the ancients that when the carotids are compressed, such pressure induces coma.

When the primitive carotids are compared with each other, the left is somewhat longer than the right, and it lies deeper, and, as a rule, it is smaller in diameter. In their lower portion, these vessels lie about three-fourths of an inch behind the clavicle, the left carotid being somewhat deeper. While the left carotid lies wholly on the left side of the trachea, the right one encroaches on the right side of the trachea, for a short distance.

Cutaneous landmarks, which serve as guides for finding the arteries, are the following: on the right side, a line, drawn from the space or sulcus between the ramus of the lower jaw and the mastoid process to the inner end of the clavicle, lies over the right carotid. But for the left carotid, let the line, starting from the similar space on the left side, reach down to the interspace between the sterno-mastoid and cleido-mastoid muscles, at their insertion: that is, the left vessel lies further from the median line of the body than does the right vessel. Allan Burns remarks that, as a rare anomaly, the carotid artery may bifurcate as low in the neck as the sixth cervical vertebra; in such a case, the surgeon, instead of finding one, would find two trunks. The usual site of bifurcation is on a level with the upper border of the thyroid cartilage. At the point of division

the primitive carotid presents a fusiform enlargement: an enlargement which has been mistaken for an incipient aneurism. The author was once consulted by a surgeon who was laboring under such apprehension. In this case, as in similar ones observed, there was tenderness, amounting almost to constant pain; yet no further enlargement occurred: nor did the inconvenience thus arising ever exceed the limits mentioned.

At their commencement the carotids are covered by the sterno-hyoid, sterno-thyroid and the sterno-cleido mastoid muscles: also by the subclavian veins; but above, near the bifurcation, the artery is covered only by the skin and inner margin of the sterno-cleido-mastoid muscle. The left carotid lies near the œsophagus, while the right one is more remote from this passage; and both vessels lie on the inner border of the internal jugular vein, which swells during expiration, and overlaps the carotid, especially in the lower part of its course. The carotids lie near the anterior tubercles of the transverse processes of the cervical vertebræ; and the tubercle of the sixth vertebra is so prominent and distinguishable that it serves as a guide to find the vessel, and thence it has been named by Chassaignac the carotid tubercle. The inferior thyroid artery in its ascent lies behind the carotid artery.

The artery has an important relation with the omo-hyoid muscle, which crosses it in its descent downwards and outwards; thus the vessel is mapped off into a supra-omo-hyoid and an infra-omo-hyoid portion. From the observation of a great number of ligations of the vessel, it appears that when the work is done above the muscle, there are more recoveries than deaths; but when done on the infra-omo-hyoid portion, the case is reversed, the deaths exceed the recoveries.

Besides the cutaneous landmark before given for incising to the vessel, another guide is the inner margin of the sterno-cleido-mastoid. It must be remembered that these guides are not infallible when the head is inclined far backwards: for then the vessels lying on the convex surface of the vertebral column slide and shift their positions laterally. And this accounts for the frequent failure of the suicide's knife to reach the vessels: for with the head turned far backwards, as the writer has known, a frightful yet unimportant cut may be made in which the air-passage is but slightly opened. In his wild and determined attempt to fatally cut his throat, the suicide may not only be prevented by the retreating vessels, but the frightful sound of the

air escaping from the opened windpipe makes him believe that he has accomplished his work, when in reality he has only but slightly wounded himself.

In many emergencies in which hæmorrhage occurs about the face, or in the mouth or throat, an arrest of the bleeding is accomplished by compression of the corresponding primitive carotid. By such compression the loss of blood can be temporarily controlled, until the bleeding vessel can be tied. The site advised for compression is over the carotid tubercle, in the lower part of the neck; yet from the writer's experience, he has found that such compression can be made much more effectively if done higher up; that is, alongside of the larynx: for here the vessel can easily be felt; and if the acting fingers be directed from without inwards, the carotid in the ordinary subject can be easily fixed, and held alongside of the air-passage. By such compression the writer has controlled bleeding from some part above, until some means of permanently controlling it could be resorted to. In case of violent epistaxis, the bleeding has thus been retarded, so that a clot could form at the bleeding point, and the hæmorrhage thus be controlled; or if the site of bleeding be an accessible one within the mouth, or externally, on the face, then such compression can so lessen the escape of blood that the point can be seen and secured by ligature, or other hæmostatic means.

Affections of the Carotid Artery.—The carotid artery is the subject of disease or injury; and this agency may be indirect or direct in its action.

As an example of disease originating indirectly, may be cited that arising from an abscess in proximity to the carotid, which through its closeness or contact with the vessel, may attack and disintegrate its walls. The starting point of such abscess may be a diseased gland, which, enlarging, presses on the vessel, and, finally, the latter may be involved in the suppurative disintegration of the gland. The true nature of such a case may not be suspected, and grave error arise from too hasty action in the treatment. This occurred in the practice of a famous English surgeon, who, on making a visit to his hospital one morning, was shown a patient with a swelling on the neck, which he mistook for an ordinary abscess, which, according to rule, the case should have been; but this case, unfortunately, proved to be an exception, as was painfully verified by the surgeon, who, with more precipitation than reflection, plunged his lance into the tumor, and his wound was followed by a hæmorrhage which ended fatally.

In the plan often pursued of curetting the suppurating gland, there is peril of inadvertently injuring the cervical vessels. The curette, however, endangers the wall of the vein more than that of the artery, since from the more quiescent condition of the vein, adherence to it is facilitated; and, besides, the wall of the vein being thinner and weaker, it can more readily be opened.

Besides peril from suppurative action, the walls of the carotid may become implicated in erosive or ulcerative disintegration seated in structures adjacent, and the vessel thus opened. As such erosion would be open to view, the watchful surgeon might intervene with his ligature, before the wall was perforated.

The anterior cervical structures are sometimes the seat of general phlegmonous inflammation in which there is a rapid breaking down of the tissues, and acrid pus appears in profusion, in which the vessels lie, and their walls are exposed to its corrosive action; and the final result may be a perforation of the vascular wall, with profuse subcutaneous hæmorrhage. The writer has known the coats of the internal jugular vein to be thus opened; but the thicker wall of the carotid, and the early incision by the surgeon of the sloughing parts, would guard against arterial hæmorrhage.

The more common injury of the carotid is that of traumatic nature, which may be a contusion, or the wound may be caused by a cutting blade, a gunshot missile, a pointed instrument, as a needle, arrow, lance, or other penetrating agency that cuts or tears a way into the tissues.

A severe contusion of the anterior cervical structures may involve and so injure the carotid artery that the vessel may rupture; and such rupture might be confined to a miniature cleft, through which blood could merely escape; or a large opening might occur through which fatal hæmorrhage could quickly ensue.

The incised wound of the carotid may vary from a minute prick to a complete division of the vessel; and the gravity of the case will be proportionate to the wound.

A wound in which the wall is simply pricked, as by a needle, or a small blade of a knife, may bleed rapidly for a short time, and then cease through the formation of clot, either in the opened wall, or in the canal-like wound made by the injuring agent in reaching the vessel. The peril in such a case is that the bleeding is perhaps only temporarily arrested, and may soon recur; or if this does not ensue, a false aneurism may originate,

at the site of the wound. If it be evident that the wound is only a slight one, the appropriate treatment would be to put the patient immediately at rest, and then place an adhesive compress on the wound, and retain this in place by means of a circular bandage, or adhesive straps, around the neck. A slight wound might thus be successfully treated. If the wound were a larger one, the hæmorrhage would be profuse, and would soon end life, unless the wound had some peculiarities of form which would aid in the formation of a clot, that might give the victim a temporary respite; for example, if the track of the wound were sinuous, or its walls uneven through retraction of severed muscular structure, then clotting blood might occlude the wound. The direction of the wound might coöperate in this coagulation; for instance, were the direction of the canal the opposite of that of the blood-current, this would retard the exit of blood, and favor occlusion by a thrombus. In such a patient, it would be imprudent to expect that the bleeding would thus be permanently arrested, and that closure of the wounded wall would ensue without operative aid; in such a case, ligation should be resorted to as the proper safeguard against an early return of the hæmorrhage.

If the wound traverses the tissues for some distance before it reaches the carotid, though it make a large wound in the wall, or wholly sever the vessel, yet, if compression were properly made, it would be possible to save the patient by immediate ligation, as the following famous case demonstrated: a girl was stabbed with a knife, in the upper part of the neck; with a large stream of blood gushing from the wound, she reached the establishment of a druggist near by, who with fortunate presence of mind, thrust his finger into the wound and arrested the external bleeding until the surgeon Michon, who was summoned, arrived. Michon found the patient bloodless and almost dead; the soft parts around the wound were greatly swollen by the passage of blood into them from the wound, that was only closed externally. The surgeon introduced his finger through the wound, and finding the artery entirely severed, he inserted the finger into the cardiac end; with the other hand he cut down and exposed the distal end, which being tied, he proceeded to ligate the proximal one. By this prompt work, the life of the girl was saved.

In such extensive wound, both ends of the carotid artery must be tied: for if the cardiac end alone were tied, then through the intercommunicating circle at the base of the brain and through

the numerous anastomoses between the right and left external carotids, blood can soon reach, and escape freely from the distal end. Though cases have been reported, in which ligation alone of the proximal end has controlled the hæmorrhage, yet bleeding has so often arisen from single ligation, that in case of a large wound, or the total division of the carotid, the prudent surgeon will tie both ends.

Ligation of the Primitive Carotid.—The carotid may be tied as a preliminary to operative work on structures in which the trunk or some of its branches will be wounded. Thus, in the removal of growths within the throat, or the infra-maxillary region of the neck, ligation of the primitive or external carotid is sometimes called for. Again, when the tumor lies lower down, and by pressure has weakened the arterial walls, ligation is indicated. Also, in those cases in which the growth has reached, infiltrated, and incorporated the arterial wall in itself: in such condition, the vessel should be ligated in its sound portion, and the diseased part, along with the growth, being removed, the distal end should be tied where it is intact.

The malignant tumor is sometimes so situated that in its radical extirpation, a portion of the carotid artery is left bare, and cannot be covered by any plastic shift, in the effort to close the wound. For example, there fell under the writer's observation an operation in a Parisian hospital, in which a large benign tumor was removed from the anterior cervical region, in which the destruction of parts was so extensive that the carotid artery was left exposed for some distance. The operator was in doubt whether he should ligate, but decided not to do so. A few days afterwards, the exposed part of the carotid opened, and a fatal bleeding took place: and in a clinical lecture on the case, the operator candidly acknowledged his error, with keen regret that he had not tied the vessel at the time of the operation.

In the event of the internal carotid being opened in an operation in the pharyngeal region, the corresponding primitive carotid should be tied; and should bleeding still continue from the distal open end, through refluent blood which has reached the wound through the circle of Willis, then if death be impending through loss of blood, the surgeon would be justified in tying the opposite primitive carotid, as the writer did in a case which hereafter shall receive mention.

The primitive carotid is the occasional site of aneurism. This is an infrequent occurrence, as appears from the figures of Crisp,

who has collected a list of five hundred and fifty-one aneurisms, of which only twenty-five were situated in the primitive carotid; that is, it occurred one time in thirty cases. Of these twenty-five cases, thirteen occurred in women, in whom such aneurism appears oftener than in men; while in other regions, aneurism occurs oftener in men.

The most usual cause of aneurism, here as elsewhere, is atheromatous change in the arterial walls; it has arisen exceptionally, from some violent expiratory effort, as vomiting. It has been seen in the infant, though, as a rule, it only occurs in mature adult life. As to the part of the carotid which is oftenest the site, authorities disagree; Burns and others place the more common site near the bifurcation, while Robert says the inferior portion of the vessel is the more usual site. The upper portion is probably the most common seat of aneurism; and this is dependent on anatomical conditions, viz., the bifurcation there, and the attenuated stratum of overlying structures. Almost the entirety of the primitive carotid is pressed on by the sterno-cleido-mastoid muscle; but the upper fifth is nearly free from muscular pressure; and on this account, the artery can expand more freely. And this takes place especially in expiratory efforts, as in coughing, when the expansion of both the artery and vein is visible to the eye; and under such circumstances, it is rather to be wondered at, that dilatation or rupture of the vessel is not a more common event.

The aneurismal tumor is, at first, a small tumor, passing, for a time, unobserved by the patient; finally its enlarged volume is not only visible, but, by its pressure, it causes inconvenience, and even severe pain. This trouble arises from compression of nerves which lie adjacent to the growth: also, from disturbance of the circulation in the head. When the tumor is low on the neck, by peripheral extension it may disturb the function of the pneumogastric, the inferior laryngeal nerve, the phrenic and the sympathetic nerves; and, thence, parts remote from the tumor, as the lungs, diaphragm, heart and laryngeal muscles, may act irregularly. Also, through the sympathetic, the pupil may be caused to dilate or contract. On the left side, the tumor may encroach on the thoracic duct, and thus prevent the evacuation of the lymph and chyle into the venous system, which occurs near the seventh cervical vertebra. The tumor can also compress and deform the œsophagus and tracheal canal. The patient is often disturbed by the movement of the tumor and the blowing sound, which usually is present in it.

Should the aneurism be situated higher up, then the functional disturbances enumerated will be present; that from the pulsation and blowing sound will be yet greater, and the power to utter vocal sounds may be quite lost. There is often congestion of the face on the side of the aneurism due to the tumor interrupting the return of the blood from the head. Vertigo, dizziness and ringing of the ears are sometimes present.

When seated high up, the tumor may encroach on the superficial cervical plexus, and cause pain that radiates along the nerves which arise from this plexus; thus pain in the pinna occipital region, and, also, in the acromial and clavicular regions may arise. Not unfrequently, a troublesome cough is present from irritation of the superior laryngeal nerve.

A very troublesome result of carotid aneurism often seen is difficulty of breathing, arising from pressure on the windpipe, by which the latter's calibre is narrowed; and this narrowing is augmented, or mainly produced, through œdematous swelling of the mucous lining of the air-canal. This stenosis increasing may finally fatally suffocate the patient.

Carotid aneurism may be slow in its development; or having grown, for a time, slowly, it may suddenly begin to increase in volume, and soon attain large proportions.

The diagnosis of the carotid aneurism has sometimes been a matter of much embarrassment. For example, if it be in the commencement of the vessel, it is difficult to decide whether the tumor may be of aortic, innominate, subclavian or carotid origin; and sometimes the true nature of such cases has only been determined through necropsy, in which the exact site of the tumor was discovered.

The greatest difficulty in diagnosis has arisen in case of abscess, lipoma, lymphoma, encephaloid growth and other neoplasm situated on, or adjacent to, the carotid. The proximity of such tumor to the vessel has permitted the pulsatile motions of the latter to be imparted to the tumor; and besides these movements, the pressure of the tumor on the vessel may alter the form of the latter and thereby cause a sound very similar to that arising in the aneurismal tumor. A condition in which sounds and movements resembling those of the aneurism are present, exists in the vascular encephaloid growth; yet this tumor, from the writer's observation and experience, rarely develops on the neck; its usual site is on the extremities. The differentiating means by which the ordinary tumor can be distinguished from

the aneurism are inapplicable to the vascular encephaloid. Perhaps the best distinctive characteristic by which this encephaloid growth differs from the aneurism is in its form: it usually is elongated in the direction of the longitudinal axis of the part on which it is situated; it has connections with the skin which do not exist in the aneurism; and its volume is less reducible by compression than that of the aneurism.

In case of the solid tumor which rests on the artery and receives the pulsatile movements of the latter, this movement may be made to disappear through lateral displacement of the growth; such displacement is commonly easily made, and thus the true character of the tumor is decided. Occasionally, however, the intimate anatomical connection is such that the two cannot be separated; and in this condition the tumor must move synchronously with the diastolic movement of the artery; and it continues to do so, even though the growth be considerably moved from its normal site. This oftenest occurs when the growth is of glandular origin, since the gland, whence an adenoma arises, often rests on the sheath of the vessel and, in developing, forms attachments to the sheath. And if the tumor be malignant in character, it often penetrates the arterial wall; and in this case it participates in the movements of the vessel. In all such cases, the tumor would be but slightly compressible; and it would be harder than an aneurism. And should the evidence from these sources not clear up the diagnostic obscurity, as last resort, the hypodermic syringe may be forced deeply into the tumor, and thus its neoplastic or aneurismal character will be determined. The hollow needle used for this work should be one of the smallest.

The tumor having been determined to be aneurismal, the question to be decided is what treatment will most safely and speedily relieve the patient. The curative procedures are numerous, the most trustworthy may be comprised under the following heads: compression, induction of coagulation by means of constitutional remedies which slacken the circulation, means which act directly on the content of the sack, and cause coagulation, and finally, ligation. These methods for the cure of aneurism have already been generally considered; a more detailed account of them will here appear.

The manner in which the cure is accomplished is through coagulation of the blood in the aneurismal sack; and this occurs when the blood is caused to move slowly; it may take place when

the movement is wholly suspended; yet under the latter conditions, the clot that is formed is soft and ill constituted for permanence, and may disintegrate, and induce gangrene in the walls of the sack. And even when the occluding coagulum has formed slowly, yet if the mass of it is so great that it receives less blood than is needed to maintain it alive, then the clot may die, and the superjacent wall sloughing and opening, violent hæmorrhage ensues, which usually ends the patient's life. The conditions, then, under which the treatment may successfully accomplish its purpose, are to retard the movement of the blood in the aneurismal cavity; and, in this manner, the coagulating blood will deposit itself in layers which will assume the properties of living tissue of a low grade of organization. And whichever of the curative procedures here mentioned is selected, the surgeon should bear in mind that the problem of cure must be solved in accordance with the principles just mentioned, which have been established by the painstaking study and researches of Broca.

Compression may be done digitally or mechanically: that is, with the fingers, or with some appliance by which pressure is made upon the vessel. A strong and trustworthy nurse can do the work by placing two fingers of one hand longitudinally over the vessel, and reënforcing these by two or more fingers of the other hand, placed transversely across the first. As fingers tire, two men should be selected for the work, who will alternately relieve each other in the task. Too much pressure which will wholly arrest the current of blood is faulty; and so is slight compression which will permit free movement of blood within the aneurism. Hence those doing the work must be instructed, supervised and controlled; the rule should be not to wholly interrupt the blood-current, some pulsatile movement should be perceptible in the vessel beyond. The time requisite to continue the compression varies much in different cases, and is dependent on certain anatomical conditions of the walls of the sack. The form and size of the opening in the wall, have an influence in this matter; also, whether the sack so lies that it facilitates or retards the return of the blood. If the inner wall of the sack presents an irregular surface, this favors the coagulation of the blood. For such reasons an aneurism may be cured by compression at periods varying from a few hours to several days. As criterion that the compression has accomplished its purpose is the cessation of the blowing sound and the pulsating movement in the tumor: it must be added, that sometimes when occlusion

appears to have been accomplished, the pulsatile movement of the tumor may reappear for a time, and then vanish permanently.

Compression has been done at different points, viz., on the proximal side of the tumor, on the distal side, and also, directly on the tumor: it is usually made on the cardiac or proximal side; and the work then can be done near to, or remote from, the tumor; compression on the distal side is only done in cases in which it is not practicable to make it on the cardiac side. And still more exceptionally, the compression has been made on the tumor itself. As is known, nearly every aneurismal tumor has a tendency to spontaneous occlusion through the gradual precipitation of coagulated blood on its walls; and should this work have advanced near to the stage of completion, then direct digital pressure might soon occlude the remaining cavity. An indication that the tumor is one suited for direct compression would be, that it is but slightly compressible on account of thickness of its walls. In such a case in the popliteal region, the author witnessed the curative action of direct compression accomplished by means of a compressor constructed by the patient himself.

As trustworthy hands cannot always be obtained, and even if they could be, yet fingers tire, and cannot act with the steadiness and unwavering continuity of a mechanical appliance, hence digital compression, once so much resorted to, has nearly been superseded by the mechanical, in which a device is used, known as the arterial compressor. The compressor is analogous to the tourniquet, and like that instrument it may be circular or semi-circular; and in each form it is so constructed that the action can be made on the artery while the adjacent structures are free from pressure, and the circulation in them is not arrested. The horseshoe or semi-circular compressor accomplishes its work in this manner; outside of the vessel compressed, the circulation through compensating trunks is unimpeded.

The rules given in regard to digital compression, apply to mechanical: the work must not be overdone, nor defectively done: the passage of blood through the vessel must not be entirely interrupted. To do the work so that there will be no danger of sloughing from excessive compression of the surface acted on, there should be two compressors, which will act alternately on different points. For the treatment of aneurism of the carotid artery a compressing appliance has been devised, which

is similar to a cravat which can be strapped around the neck, and pressure made on the artery, where desired. In the use of such a compressor, some trouble has been found in so fixing the compressing pad that it will not shift its site. Besides, patients are sometimes intolerant of such pressure; in one case, the patient, after having made trial of this means, declared that nothing could induce him to submit further to the compression.

A plan of treatment occasionally resorted to for the cure of aneurism is the administration of remedies which will promote the coagulation of blood in the sack. A few medicines have the repute of acting thus: their mode of action is difficult to explain. Agents thus administered by the mouth are ergot and iodide of potassium; the two may be given in combination, viz., a drachm of the fluid extract of ergot, with ten grains of the iodide of potassium, three times daily. This constitutional medication is resorted to chiefly in cases in which the aneurism is inaccessible to other methods of treatment. Such curative means rarely find use in the treatment of aneurism of the carotid artery.

A third method of treatment is the employment of means which act directly on the blood in the sack and cause its coagulation; such means are electricity and styptic agents, which, being introduced, cause coagulation.

Ciniselli has made extensive trial of electricity for this purpose; he used the static current, which may be generated by a series of small zinc and copper plates, connected by a saline medium, and having poles terminating in needles, which can be inserted into the aneurism. In the electrolytic action thus induced, different materials are drawn towards the positive and negative poles, viz., to the positive one acid elements are attracted, while alkaline elements are drawn towards the negative pole: as mnemonic aid to retain these facts in memory is the dissyllable *panalk:* positive, acid, negative, alkaline. The acid materials which collect as a coagulum about the positive pole are firmer in consistence than the alkaline matter at the other pole; hence it is desirable to make the positive pole do the work of coagulation: and to accomplish this, the positive point alone should enter the tumor, while the negative one may be placed on the cutaneous surface outside of the aneurism. The skin around the penetrating needle is cauterized by the electricity; and hence the action must not be prolonged too far, lest a large section of the skin be caused to slough, and the purpose of the work be defeated: and also the needle at each application must be introduced at a different point.

The aneurismal sack has been occluded by inducing coagulation by means of a styptic fluid, which is injected into the cavity. The agents most employed for this purpose are the salts of iron; for example, a solution of the chloride or the persulphate of iron. Such a solution may be injected by means of a hypodermic syringe; and this must be done carefully, drop by drop. As there is a risk that the coagulated blood may not remain in site, but may float out of the sack into the general current of blood, and work embolic mischief elsewhere, this plan of treatment has, at present, few or no advocates. And coagulating injection, if resorted to at all, is reserved for the cure of the aneurismal varix, in which, with the exercise of some care, there is but slight risk of dislodging the coagulated blood.

The most usual method resorted to for the cure of aneurism is the ligation of the vessel. Where the vessel is easy of approach, however, an endeavor should be made to cure by compression: since this method in no way imperils the patient, and does not preclude a resort to the ligature, should compression be unsuccessful.

The ligation of the artery for the cure of aneurism, is one of the signal triumphs of surgery, dating from the early part of the nineteenth century. The first successful operation was that of Sir Astley Cooper, done in 1805. That the carotid could be safely tied had been proven by other surgeons. Fleming, in a case of attempted suicide, tied the carotid, in 1803, with recovery. And, prior to this, the ligation had been successfully done by Hebenstreit. The first ligation of Abernethy, as well as that of Cooper, resulted in failure; later Cooper tied the primitive carotid for aneurism, and the man soon recovered, and resumed his occupation as a laborer. At this early period, it required a bold hand to essay such a task, when, as Allan Burns says, surgeons were "balanced between hope and fear" as to the results which might occur. Secondary hæmorrhage was feared as the inevitable sequent of such a venture. Daring hands soon put the matter to the crucial question of trial, and the answer was satisfactory.

As remarks Burns, "In no operation is a current knowledge of the locality of the parts concerned more indispensable than in the case under consideration." And these difficulties increase as one proceeds from the distal to the proximal portion of the vessel. Frequently the location of the aneurism is such that one is compelled to operate low in the neck. When done low

down, besides dividing the skin, platysma myoides and the cervical fasciæ, the sternal head of the sterno-cleido-mastoid must be drawn aside. The sheath containing the artery, vein and vagus nerve, is next found, and when opened, the next difficult step is to separate the internal jugular vein from the artery. He who is only familiar with the parts in the anatomical room, will be surprised at the ever-changing volume of this vein: in inspiration sinking to a small cord, but in expiration greatly swelling, so as to overlap the artery: "and the transitions from emptiness to fullness are so rapid that sufficient time is not given to detach it from the carotid. In the work of separating the vein from the artery, the former has sometimes been injured, and no ill resulted; and the writer would remark that in his experience in detaching the femoral vein from the adjacent artery, a prick of the former has caused no serious trouble.

In the low ligation on the left side, Burns thinks there is a risk of wounding the thoracic duct, which he finds behind the carotid, in some subjects, mounting pretty high up in the neck, before it curves downwards and outwards to join the subclavian vein. A nerve severed may reunite, but the duct wounded, Burns thinks, would not heal, and there is no substitute for it. The duct here is diminutive, and especially so when unfilled by chyle; yet after a full meal, it is so swollen that the containing chyle is visible through the thin walls of the duct.

The possibility of arterial anomaly must be borne in mind, in the inferior ligation of the carotid; instead of one trunk, there may be two arteries side by side, viz., the carotid and the vertebral arteries, which on the left side may spring from the arch of the aorta, and ascend close to each other; and also on the right side, the two have been found close together, though the vertebral arose from its normal point. In such a dilemma, pressure made on each vessel would clear up all uncertainty, and indicate the one to be chosen for ligation.

The bifurcation of the carotid sometimes occurs low on the neck, and in that case the surgeon might be embarrassed to know what the conditions were, and what vessels he had before him; as aid in such a case would be branches arising from one trunk, which would denote the external carotid.

If ligation be done for the cure of aneurism, it may be done on the proximal side, close to, or remote from, the tumor. The operation done near the aneurism on the cardiac side is known as that of Anel, an Italian surgeon who had the good fortune to

be the pioneer in this operation, and thus to secure a permanent place in surgical literature, especially among French writers. If the ligature approach more toward the heart, the name of Hunter is affixed to the operation by English authors. The operation of Hunter is the preferable one where this is practicable; but should space not permit this, then the less desirable site of Anel must, perforce, be adopted. And, again, if the aneurism occupy the first portion of the artery, where proximal ligation would not be possible, then distal ligation must be done; and this procedure having been first proposed or done by a French surgeon, Brasdor, his name has been given to the operation.

Of the three sites mentioned, the Hunterian offers more chances for a successful issue to the patient than can be obtained by that of Anel or Brasdor: the closeness of the ligation to the aneurism in the operation of Anel disposes to secondary hæmorrhage; and to the operation of Brasdor there are serious anatomical and physical objections.

The method of performing ligation has been the subject of much modification: as done by Sir Astley Cooper, the work first consisted in finding the artery, and tying it at two points near each other, and then severing the vessel between the ligatures. One end of each cord was allowel to remain long, while the other was cut short; and the wound was then closed by sutures, with the two threads projecting from it. Thus the operation for the cure of an aneurism was first done by Sir Astley Cooper; and, as he records, "the first ligature came away on the twenty-second day, and the second one, on the twenty-third day after the ligation. The wound was a long time in healing: first from a sinus in the course of the ligatures, and afterward, from a fungus where the sinus had formed. The man was discharged well in about twelve weeks after the ligation was done."

The purpose intended by doubly tying and dividing the vessel was to put at rest the distal portion, and thus favor the coagulation in the tumor.

The way so beset with apprehended perils having been safely traversed, the surgical world elsewhere was not tardy in following in the footsteps of the great English surgeon. The plan of doubly ligating was soon superseded by that of the single ligature; and then the continuity of the vessel was interrupted and severed by the including ligature sloughing out, after a few weeks. These early methods, reflecting honor on those who introduced them, have been succeeded by those which are simpler and

safer in their action. The small silken cord which has been rendered aseptic is used for the ligature; and the artery being tied, both ends of the thread are cut short, and the wound is closed, and the work so done that healing is obtained by primary union. Instead of silk, catgut cord is often used for arterial ligation. Strangely enough catgut cord was tried and rejected by Sir Astley Cooper.

The anterior or inner margin of the sterno-cleido-mastoid muscle serves as a guide to find the primitive carotid in a great portion of its course; but as the artery ascends, it inclines inwards from the muscle; and the result is that in its upper portion, the artery has but a slight covering of soft parts, while near the sternum, the vessel lies behind the sternal portion of the muscle; and this has led one surgical authority to give the rule to seek for the vessel in the interspace between the sternal and clavicular portions of the muscle. Though the inner edge of the muscle serves as a guide to the artery, yet a more satisfactory guide is a line drawn from the slight fossa behind the lobule of the ear to the sterno-clavicular articulation; and such a line below will lie over the inter-muscular interstice just named. This cutaneous line above, lies over the external carotid artery, and, hence, it enables one to find this vessel also.

By the aid of the guide given, it is easy to find the common carotid artery, in the lean subject; but in one of short, thick, rotund neck, in which there is a deep layer of fatty tissue, the ligation becomes a more difficult undertaking: the primary cut must be longer than usual to permit of penetration to the vessel.

The patient must lie on the back with the shoulders uplifted upon a pillow, or cushion, so situated that the head will fall backwards, and the neck will be accessible. This position shifts the artery, somewhat in reference to the adjacent muscle: especially in its upper portion. The pulsating movement of the artery indicates its position; yet, sometimes this movement is so feeble that it is scarcely sensible to the touch; and this feebleness is especially present in cases in which the heart has been weakened by the loss of much blood: also in the patient who has been profoundly anæsthetized.

In the emaciated subject, a short cutaneous cut made in the carotidean landmark will suffice; but if the subject be one of short, thick neck, then the outer cut must be a long one; and the incision should be made by first penetrating quite through the skin: an act in which the scalpel stands upright; then the

handle of the instrument should be lowered, but raised to a perpendicular again when it reaches the end of the incision. By thus incising, no space will be lost at the ends through the skin having been incompletely divided. The blunt-pointed retractors are to be inserted, and committed to an aid, who has been instructed not to displace the wound by pulling the lips too much towards one side, or the other. As the work proceeds, the sterno-cleido-mastoid muscle will be encountered, and, unless the ligation be in the lower fourth of the carotid, the muscle must be pulled externally, by inserting the retractor under its margin. But if the tying be done near the sternum, then it is recommended by Zang that the incision be made between the sternal and clavicular portions of the muscle; and to obtain room the sternal portion must be drawn inwards. Or, in this inferior ligation, the plan of Coates may be followed, which was to make an incision on the inside of the sternal limb of the muscle, and then having passed a grooved guide under this portion, the latter is to be severed from the sternum. The writer may state that in a few ligations below the omo-hyoid muscle, he has found it possible to reach the vessel by a cut made between the trachea and the muscle; and when the inner edge of the latter is exposed, if the head be pulled to one side, the muscle may be drawn outwards and the vessel reached.

In making this cut to reach the vessel, small vessels, chiefly veins, are often met; and as a bloodless field is necessary to enable the surgeon to carry his work to completion, these vessels should be caught and subjected to torsion, so as to close them: torsion is better than tying, since the latter would leave material in the wound that would retard immediate closure.

There is no point where the artery cannot be reached, if the operator has freshened his anatomical knowledge by a recent rehearsal on the cadaver; and disciplined by such rehearsal, the operator will encounter no difficulties which he cannot vanquish, *tuto et jucunde.* The artery lies in a sheath-like envelope along with the internal jugular vein and the pneumogastric nerve; and the latter two must not be included in the ligature. The sheath should be caught up with the forceps, and uplifted so as to form a conoidal figure, of which the apex is held by the forceps. This act, though simply told, is less simple in accomplishment: for in catching the sheath, it is easy to include the tunica adventitia of the artery: and to be sure that the latter is not seized, the uplifted cone should be moved in different direc-

tions, when the seizure or exclusion of the artery will be determined. Should the error be committed of including the arterial wall, then in the section of the uplifted cone, the artery might be opened, or wounded. The inexperienced may have trouble in distinguishing the sheath from the outer arterial tunic, especially if there be adhesion between the parts due to some morbid action: yet in normal state, the sheath is easily moved on the artery.

Should the operating hand be inexperienced, and the index not versed *to the nail* in finding the right way through the tissues, then instead of thus uplifting the vaginal cone, the operator had better substitute the simpler plan of scratching through the sheath with a grooved director: and as evidence that he is wounding the sheath and not the artery, will be the slight bleeding from opening the vasa vasorum which abound in the sheath; and also that as soon as this latter has been perforated, the grooved director can be inserted between the vessel and the sheath. That these minute directions are not pedantic refinements more calculated to mislead than to guide, the writer is certain; experience may not need them, yet inexperience will have use for them.

The next step, when the sheath has been opened, is to extend this opening a quarter of an inch upwards and downwards, in a longitudinal direction: and this can be done with a blunt bistoury on the grooved director; or with small blunt scissors. Through the opening thus made, the aneurismal needle can be passed and carried underneath the vessel, so that its point will emerge on the opposite side near where it entered: and if this be carefully done, the vessel will be included in the hollow of the needle, with but slight disturbance of the sheath. In this act, the sheath should be detached as little as possible from the artery. When the aneurismal needle has thus been carried underneath the artery, the thread must be passed into the needle's point, and the instrument removed so as to draw the thread beneath the vessel. The aneurismal needle may have a movable point, which can be detached; and this form, which is known as Mott's needle, is easily used, since when it has been passed beneath the artery, the point can be unscrewed and removed; thus the attached thread will be carried under the artery. This needle is accompanied by a key which is used to detach the movable point.

In the absence of the Mott needle, or that with immovable point, the surgeon can easily construct a substitute: a piece of

iron wire bent on itself so as to be in loop-form, can be inserted in the fenestra in the sheath, and carried beneath and around the vessel; and when the loop appears, the thread can be passed through it, and drawn beneath the vessel. From experience, the writer can bear witness to the facility with which the ligature can thus be carried around the artery.

Of the materials used for ligature, viz., thread of cotton, linen, catgut, silk, or wire, the author prefers the simple silken thread: and before using this, it should be immersed in alcohol for an hour, by which it is rendered aseptic. The tying is next to be done, and this must be effected by a simple square knot. The old method of drawing the thread so tightly as to divide the inner and middle coats of the vessel is unnecessary; the purpose will be accomplished if the constriction be carried to the extent of bringing the inner walls together, so as to entirely close the artery and prevent the passage of the blood. It is not necessary to divide the artery as was ultimately accomplished by the former method of very tight tying. When done with aseptic silken thread, the latter is cut short, and finally becomes encapsulated in the tissues.

The tying being completed, there should next be laid a thread or two of aseptic silk, or catgut, in the wound, so placed that one end will hang outside. This thread replaces the drainage tube, formerly used; and it serves as a vehicle for conducting outwards the excreta which may form in the cavity of the wound. Next a sufficient number of sutures must be inserted to close the wound. Over the wound, lint saturated with alcoholic lotion (twenty-five one-hundredths) is to be placed, and retained in site by a circular bandage. The lint must be retained moist by occasionally remoistening it with the lotion. The threads for drainage are to be daily observed, and on the second or third day, one may be removed; and as soon as all excreta cease to appear, the last thread may be removed. The excreted material is usually small in quantity; and the wound will heal in a few days: complete closure with firm union of the walls of the wound can be obtained in from ten to fourteen days. To favor rapid healing, the patient should lie in bed, and the head should be retained as nearly motionless as possible, during the treatment; and care should be used to avoid much movement of the neck, for at least twenty-five days: for this precaution being neglected, the site of the wound may be inflamed and suppuration take place; and such accident occurring, not only is the

treatment prolonged, but there is the risk of secondary bleeding. The author had a case which took this unfortunate course, and, despite the various means that were tried to control the hæmorrhage, the bleeding recurred from time to time, until life was terminated by exhaustion. To avoid such catastrophe, the patient should be enjoined to keep the part at rest, for at least a couple of weeks after the wound has healed.

The carotid has also been tied for the relief of epilepsy or neuralgia seated in the head. When the brain of the epileptic subject is seen during his convulsive paroxysm, the anæmic condition in which it has been observed by Brown-Séquard and others, would contraindicate ligation as a means of relief: indeed, the consequent detraction from the normal supply of blood, should assist, and not resist, this reported causal agency of epilepsy. In the light of present knowledge, the author neither counsels nor rejects this procedure, since it may be said to be on trial as one of the heroic measures for the cure of epilepsy. Epilepsy finds its causation in so many agencies located centrally or peripherally, that he who treats the disease is warranted in freighting his therapeutic sling with many pebbles; and if he includes this one from the stream of surgery, it cannot prove more valueless than many others which he may essay; and should it cure the patient, the latter will be content, and the physiological therapeutist will have had an experience which he may share with the empirical practitioner who is satisfied with effect, but leaves to the scientist the search for a cause.

The ligation of the carotid for the relief of cranial or cephalic neuralgia has proved successful in some cases; and its mode of action consists in diminishing the amount, and, consequently, the pressure of the blood, in the affected part. After ligation, the pulse-wave vanishes, for a time, in the branches of the tied carotid, and though blood reaches them through compensating channels, yet it is a long time before normal pressure and pulsation are restored: meantime, pain may disappear through the affected part being restored to integrity. There is a risk that the cure will not be permanent, and that, when the circulation becomes normal, the neuralgia may return. An example of this fell under the writer's observation. In 1868, in a man who was the victim of atrocious pain on the side of the head, especially in the temporal and parietal region, other means having failed to relieve, the writer tied the right carotid artery. The patient was, at once, free from his pain; and this relief continued for nearly a

year, when the trouble reappeared, and continued until the man's death, some two years afterwards.

In 1867, Carnochan advised and practiced ligation of vessels for the cure of elephantiasis; thus he successfully treated a case of elephantiasis of the face: he first tied the corresponding primitive carotid; and six months afterwards, he tied the other carotid. The result was a gradual shrinkage of the hypertrophied structure, which continued for eight years.

Ligation has sometimes been done as a preliminary step to the removal of growths in the region supplied by the vessel; for this object, such ligation has been strongly advocated by Verneuil for the subjoined reasons: it guards against exhaustive hæmorrhage, and thus the surgeon is not disturbed by bleeding from vessels which he may wound during his operative work; and finally, through the lessened afflux to the parts operated upon, the subsequent inflammation will be lessened or quite prevented. Richet opposes the procedure, claiming that in the rapid reappearance of the blood in the vessel beyond the ligated point, the loss of blood is by no means avoided; and a still graver objection urged by Richet is in the encephalic disturbance which the ligation can occasion.

For many years the writer has practiced preliminary ligation of the carotid in cases in which the internal carotid or the external carotid artery might be opened in surgical operations: and he has not encountered severe bleeding from the reappearance of blood in the opened vessels; nor in the cases thus treated has cerebral disturbance arisen. Hence he advocates preliminary ligation of the carotid in operations which otherwise must be attended by much loss of blood; an exception to this would be where the preliminary tying of the external carotid would serve a similar purpose. In the amputation of limbs the author's custom has been, as a substitute for the tourniquet, to preliminarily tie the main artery a short distance above the site of amputation; thus doing, the operator greatly lessens the loss of blood, and husbands the vital resources for the demands which are about to be made on them.

Reference has been made to the disturbance which can be caused in the head by ligation of the carotid artery. That such complication is not infrequent appears from the figures of Pilz of Breslau, who finds in a list of six hundred ligations that cerebral symptoms arose in about one-third of the operations; and of these, fifty-six per cent died. These figures vary somewhat from

those reported by Reis in the Archiv für Klinische Chirurgie: he presents a collection of seventy-three ligations, in which cerebral disease appeared in seventeen cases, viz., about twenty-three per cent. From the writer's personal experience, and from observation of the operations of others, he is convinced that these figures are too high. The diminished frequency of such cerebral complication may be attributed to the superior methods which obtain in the surgical work of the present time. The quondam outhanging thread that was suspended to the artery, besides being a standing menace of secondary bleeding until its detachment and closure of the sinus in which it lay, also maintained a chronic inflammation of the site of ligation: an inflammation that may implicate the sympathetic plexus of nerves which embrace, or lie near, the carotid artery. The rapid cure now effected by the buried aseptic ligature lessens or prevents such irritation: so, that in future, it is probable that such cerebral complication will be a matter of infrequent occurrence.

Cerebral complication following carotid ligature has appeared at once, after the operation, or it has supervened at a later period.

As primary or immediate consequences are dizziness, tendency to sleep, palpitation of the heart, and painful or abnormal sensations on the side of the head corresponding to the ligature. There may be cough, and muscular spasms general, or limited to one or more groups of muscles. The muscles of the larynx and of the pharynx are sometimes implicated, inducing aphonia and difficulty of swallowing. The muscular disturbance may be confined to one side of the body, or both sides may be affected. These disturbances may be transient; or they may appear and disappear; or they may continue for a considerable period.

Instead of appearing immediately the morbid phænomena caused by ligation may occur some time after the operation. These disturbances can be divided into three classes: mental, sensory and motor. Mental disturbance commonly presents itself in the form of lessened power of the mind, viz., loss of memory, and inertia of the thinking power, which may reach to absolute dementia; the patient then quite loses the capacity of caring for himself.

Sensory disturbance may exist in perverted function of one or more of the special senses, especially of vision; also of common sensation, which may be unilateral or universal in extent. Deafness has also been observed.

As result of ligation of the carotid, motor power may be lost on one side of the body; and this is on the side opposite to that of the ligation for all portions of the body except the face, where the palsy corresponds to the side ligated. Palpitation of the heart and difficulty of breathing have been so violent in some cases as to speedily terminate life.

Aphonia arising from ligation of the carotid has been studied by Ehrmann, who published a dissertation on the subject in 1866, in which he states that writers have disagreed in reference to the causation. Horner finds the cause in an increased afflux of blood to the thyroid gland; Bertherand refers it to the lesion, or inclusion of filaments of the sympathetic nerve in the ligature; Giraldès attributes the loss of voice to swelling of the wound that crowds on the vagus nerve; Broca thinks it may be due to a neuritis of the vagus through lesion of the nerve. In a case of ligation done by the writer in which the cause was evidently referable to inclusion of the sympathetic nerve, the aphonia was not complete, yet it remained until the death of the patient, some weeks afterwards.

As a rule, this aphonia is not permanent: in one case it disappeared after two weeks; and in others it vanished after some months. It is, also, of infrequent occurrence; for Ehrmann found that in a series of two hundred and seventeen ligations it was rarely observed. In one case in which a necropsy was made, the vagus was found divided by the ligature. And in another case of aphonia, there had been thrown a provisional ligature around the external carotid, and though the knot was not tied, yet the voice was extinguished.

The writer believes that such aphonia is wholly due to lesion of nervous filaments in the work of tying: such lesion arising from mal-adroit manipulation in exposing the vessel, and passing the thread around it. In the case seen by the writer, the patient was bleeding from a wound of the external carotid; and so profuse was the hæmorrhage that precipitate haste was necessary in order to rescue the patient from fatal bleeding. Though the conditions were not verified subsequently by a necropsy, yet there is no doubt that in the hasty manipulation, the vagus was included.

In regard to most of the accidents enumerated which may follow ligation of the carotid, whether occurring primarily or ulteriorly, they may be referred to disturbed encephalic circulation, through the closure of a channel through which the brain receives

more than one-fourth of its supply of blood. In this condition, the nutrition of a portion of the brain must be disturbed; for a time, the current, in which the blood reaches its destination by stagnant reflux, rather than by normal afflux, fails to maintain those fine metaplastic processes of elementary interchange, by which the normal life of animal tissue is maintained. Another agency which may have a disturbing influence may be an irregularity in the formation of the circle of Willis: thus, as the writer has observed in dissection, one of the posterior communicating branches which connect the internal carotids with the posterior cerebral arteries may be unusually small; and also the anterior communicating trunk of the circle may be small. Such an irregularity must have an important bearing after ligation of the common carotid, or vertebral artery.

That the work of molecular interchange may be disturbed by ligation of the carotid was illustrated in a case in which the writer ligated the vessel as aid in an extensive operation done for the removal of a cancer involving the side of the tongue and the pharynx. A few days after the operation, the patient became hemiplegic on the side of the ligation. As the palsy appeared almost instantaneously, it was deemed to be dependent on the sudden rupture of a vessel: and with the hope of finding a thrombus that could be removed, and relief thus obtained, the cranium was opened and the brain exposed corresponding to the motor tract. No clot was found, and the uncovered cortex instead of being the site of hyperæmia, was pale, and the vessels of the investing pia mater were nearly empty of blood. The cerebral structure was abnormally soft, and was in the initial stage of softening. And along with the motor tract the contiguous surface of the cerebrum participated in the structural degeneration.

Besides the interruption and disturbance of the blood supply, just assigned as causation of the cerebral trouble, it is probable that there are faulty or dyscrasic conditions of the body which are predisposing contributory agencies; and as examples of such agency may be cited that of vitality depressed through renal disease, ill assimilation of nutriment, or other enfeebling ailment. In the presence of such constitutional condition, any severe surgical assault is ill tolerated; and if delay be permitted before operating, the surgeon should subject his patient to treatment which will improve his condition, and add to his power of resistance; in some cases, unfortunately, the urgent demand

for immediate ligation gives no truce for preparatory fortification.

Ligation of Both Primitive Carotids.—The essays in the work of simultaneously tying both carotid arteries have almost uniformly terminated disastrously. Valentine Mott reports a case in which he tied at once the two vessels, and death occurred a few hours afterwards. Key, of London, tied the right carotid, and death having quickly followed, the necropsy showed that the left carotid was nearly obliterated, and that the fatal result occurred under conditions similar to simultaneous ligation of both vessels. The result has been different where an interval of a week or more of time has intervened between the ligations. And experience in this operative field has shown that ligation of both vessels with a considerable interval of time between the two operations is not only tolerated, but that the chance of cerebral disturbance, occurring after such double ligation, is not greater than after single ligation.

The writer has demonstrated that simultaneous ligation of both carotids is possible without any ill result to the patient. Six years prior to the date of this writing, in the removal of an epithelial cancer which occupied the right side of the base of the tongue, and the right pharyngeal arch, the internal carotid was opened, and despite ligations of the right carotid, the hæmorrhage recurred so profusely that the patient's death was imminent. Compression within the throat did not check the bleeding; and when the patient was moribund, the left primitive carotid was reached by a rapid incision through the skin, and quick digital penetration to the vessel, when the latter was tied. The left carotid artery was ligated in less than one hour after the right one had been tied. And even this double ligation did not prevent some oozing of blood from the pharyngeal wound: a fact demonstrating how rapidly the blood of the vertebral arteries traversed the circle of Willis and reappeared in the carotids. This patient made an uninterrupted recovery, disturbed by no cerebral or other complication; and the freedom from such complication the writer refers to the loss of blood which occurred: and should he find it necessary to perform simultaneous ligation where such loss has not already occurred, the author would premise the work by a vigorous bleeding. The history here referred to is interesting, as this is the first case of simultaneous ligation of the primitive carotids which has terminated successfully.

Ligation of the External Carotid Artery.—In recent years the

ligation of the external carotid has been advised and practiced as a substitute for the ligature of the primitive vessel. The leading argument in its favor is that thus the encephalic circulation not being interfered with, the danger of cerebral complication is avoided.

The cutaneous landmark for finding this artery has been given: it is a continuation of that for reaching the common carotid, viz., the upper third of a line drawn from the sterno-clavicular joint to the fossa behind the lobulus of the ear. Writers are not in accord as to the ease or difficulty with which the external carotid can be displayed for ligation. Allan Burns says that "it is much easier to pass a ligature around the external carotid artery than either the internal or the common carotid artery: for both the latter are in contact with large nerves and the internal jugular vein." Chelius says: "Tying the external carotid artery is considered one of the most difficult operations, on account of the vessel being surrounded with arteries, veins and nerves: and, therefore, it is usually recommended to tie the common trunk instead of it." It was tied first in 1827, by Bushe, for the arrest of hæmorrhage which followed the excision of an anastomotic aneurism located in the temporal region. And as a prophylactic precaution against the loss of blood in the removal of growths seated in the maxillary or cervical region, the artery was ligated by Mott, Lizars and other surgical operators. The manner of reaching and displaying the vessel for ligation was first accurately described by Diedrich, in 1831. His incision consists of a cut through the skin which is a half inch inside of the inner margin of the sterno-cleido-mastoid muscle, and which, commencing on a level with the upper margin of the thyroid cartilage, ends above, a little below the inferior margin of the lower jaw. If the wound be dilated by retractors, the sterno-cleido-mastoid will be seen on the outside, the corner of the hyoid bone on the inner side, the sub-maxillary gland in the upper angle, and the omo-hyoid muscle at the lower end. As the dissection penetrates, there will be reached the thyroid, lingual and facial veins, which converge and uniting form a trunk of considerable magnitude, which passes to the internal jugular vein. This vessel will bleed profusely if opened; and, if it is necessary to divide it, it should first be doubly tied and divided between the ligatures.

The depth to which the dissection must proceed before reaching the vessel varies in the obese and emaciated subject: in the

latter, the vessel is near the skin; but the distance may be an inch in a subject of short, thick neck, laden with adeps. And these conditions determine the facility or difficulty of the work; nothing in the list of ligations can be easier than the one, and nothing more difficult than the other: hence arise the discordant statements about this matter.

The dissection having penetrated to the internal and external carotids, how may these be distinguished? The external carotid lies anterior to the internal one; that is, the external carotid is nearer the median line of the neck than is the internal one. Between the two there is but little appreciable difference in magnitude. The best differentiating means is the fact that vessels arise from the external one, while normally, no branches spring from the internal carotid. In exceptional cases vessels have been found to proceed from the internal carotid: viz., vessels which should arise from the external vessel. Again, the common carotid, in a case seen by Allan Burns, and in one seen by the writer, ascended almost to the base of the skull before it bifurcated: and then the branches which normally originate from the external carotid, arose from the primitive carotid. Such knowledge of anatomical anomalies should be stored in the memory of the surgeon who would be ready to meet every emergency which his knife may encounter in operating on the neck. The general rule is that the blood-supply to the side of the neck, tongue, face and temporal region is from the branches of the external carotid; and hence the latter is named, sometimes, the facial carotid.

The numerous branches given off by the external carotid led to the belief that, if tied, the vessel would not become occluded, and, hence, that such tying would end in secondary hæmorrhage. Guyon's researches and work in this field showed that such fear was groundless; and Madelung, on the same subject, collected a series of sixty ligations, of which thirteen died: and of the fatal cases Madelung showed that death in seven patients was not caused by the ligation. The writer has done this ligation seventeen times, and all ended favorably except one, in which death arose from cerebral trouble caused by ligating the primitive carotid on the other side. In only one patient, elsewhere referred to, did secondary bleeding take place; and to arrest this, the common trunk was ligated. A few days afterwards there was another profuse hæmorrhage from the original wound, which was controlled by a piece of aseptic sponge crowded into the wound, and

retained there by digital compression. This sponge was occasionally replaced by a new one; the compression was continued until the wounded vessel was closed and the patient's recovery insured.

The vessel having been reached, it should be so displayed as to present the thyroid, lingual and facial branches which arise from its anterior side; and the ligature may then be placed in the space between the first and second, or between the second and third of these vessels: as a rule, there is the most room between the thyroid and lingual branches. Should the space be short, as may be in a subject of short neck, then, as the author did in one case, besides the external carotid, the superior thyroid artery may be tied, also. Thus the formation of an occluding clot is insured.

After the exposure of the vessel, should another point appear more favorable for applying the ligature than the one just indicated, then the work should be done there: the rule for observance being to place the ligature as far as practicable from a branch, or branches, which would interfere with the formation of an occluding thrombus.

The ligature having been placed and the cord cut short, the wound is to be closed and treated in the same manner as that detailed for the ligation of the primitive carotid.

Certain branches of the external carotid are sometimes tied: and those in which this is chiefly practiced are the superior thyroid and the lingual arteries.

The superior thyroid is sometimes ligated as an antecedent step to removal of the thyroid gland: also, as a means to arrest the growth and induce atrophy of the enlarged thyroid gland. The method proposed by Linhart, of Munich, to find the vessel is to expose the external carotid, and then tie the first branch which is given off. And in the same way, he would search for the lingual artery, which is the second branch given off from the inner side of the external carotid. The author has already given a rule for finding the lingual: but in case the operator loses his way, or from any cause becomes embarrassed in his search, then he may follow the method of Linhart for finding the lingual. To eliminate all uncertainty, when the method of Linhart is practiced, the incision should be long enough to expose the bifurcation of the common carotid: otherwise, error can arise in the enumeration of the branches given off from the external carotid; for example, the lingual might be mistaken for the facial, or superior thyroid,

but if the bifurcation be found, then the first branch above must be the superior thyroid, and the second branch the lingual.

Should the internal carotid be the one which it is intended to ligate, then a cut is to be made similar to that for the external carotid: the dividing point of the common carotid into its two branches must be sought for; and when found, the posterior branch will be the internal carotid, which is close to, and partly covered on its outer side by the internal jugular vein. From the proximity of the internal carotid to the external carotid on one side, and to the internal jugular on the other, it is a difficult act to pass the aneurismal needle underneath it: and as prelude, the external carotid must be detached and drawn inwards, and the internal jugular detached and drawn outwards; and for this work blunt hooks, or small retractors, should be used. The internal carotid has very intimate relations with the sympathetic nerve, which forms a sheath-like plexus about the artery: and this nervous structure should not be included in the ligature. Besides the obstacles enumerated, the operator will find some trouble in uplifting the vessel; for the writer's experience in this work has shown him that the artery is rigidly stretched between the primitive trunk and the bony canal through which it enters the petrous portion of the temporal bone. Nevertheless, despite these difficulties, by patient effort, the ligature can be passed and the tying done. Owing to the rigidity of the artery, in tightening the ligature, care must be used not to cut or break the vessel.

The ligation of the internal carotid can cause cerebral disturbance in the same manner as ligation of the common trunk, already mentioned; but as there is an intercommunication between the external and internal carotids in the orbit, the chances of restoration of the circulation after tying the internal carotid must be better than after the ligation of the primitive trunk. The difficulties, however, which beset the operator in reaching the internal carotid are so great that it is not probable that this ligation will supersede that of the prime trunk: certainly not in the subject of short, thick neck, in which the internal carotid is very short.

The marvelous progress which has been made elsewhere in operative work has also extended to the cervical region; and arteries which hitherto had been exempt from interference, have recently become the occasional subject of ligation. An example of such operation is the tying of the vertebral artery.

The vertebral artery, as will be remembered, is the first

branch given off from the subclavian, and, a variable distance beyond its origin, the vertebral enters an interrupted, bony canal which traverses the transverse processes of the six upper cervical vertebræ; that is, all of these vertebræ except the seventh; then the vessel enters the foramen magnum, and becomes one of the four vessels which furnish blood to the brain. From the basilar prolongation of the confluent vertebral arteries emanate the posterior cerebral arteries, which aid in forming the circle of Willis: and, as has already been pointed out, one of the posterior communicating branches, which connect the posterior cerebral arteries, may be very diminutive: so much so as to be an obstacle to restoration of the circulation after ligation of the vertebral, or the common carotid artery.

The aid of the surgeon, as before stated, has recently been invoked in the treatment of epilepsy; and, besides the ligation of the common carotid, or the internal carotid artery, the tying of the vertebral artery has lately been advised and practiced, as a means of curing this disease. In regard to the value of this procedure experience has not yet pronounced its verdict. But as the Comitial" disease usually begins in childhood, and, according to the Hippocratic aphorism, may vanish before puberty, hence in that period of life many remedies acquire the credit of curing; but, after twenty-five years, the disease, as a rule, only "dies with the patient," and during this period, epilepsy seldom surrenders to ligature or trephine.

The more usual purpose for which the vertebral is tied is to control hæmorrhage from the wounded vessel: and such hæmorrhage, as well as its control by ligature, has been studied by Kocher, who has collected twenty-one cases, one of which he treated himself. In his case there had been a stab which had penetrated about one inch outside of the median line of the neck, in the region of the fifth or sixth cervical vertebra. After three weeks of constant bleeding, he cut down and sought for the vessel; the proximal end of the vertebral was caught and tied, while the return of blood from the distal end was controlled by tamponing with a styptic plug. The patient recovered, though an attack of erysipelas occurred during the treatment.

There is difficulty in distinguishing whether such a wound has opened the vertebral or carotid artery: for compression on the tubercle of the sixth vertebra, presses both on the carotid and vertebral artery: and to accurately discriminate, one must make pressure from without inwards, testing each part in suc-

cession. The carotid is best compressed by including it along with the sterno-cleido-mastoid muscle.

The vertebral artery is only open for ligation for a little over two and a half inches: viz., from its origin to its entrance into the sixth cervical vertebra.

The Hunterian ligation, which is not advised by Köcher, is made by a cut along the outer side of the sterno-cleido-mastoid. In case of a wound of the vertebral, he prefers the old plan of Anthyllus, in which a cut is made down on the wound, and the ends there ligated.

Fracy, in 1847, writing on ligation of the vertebral, advises to make a cut upwards, from the sterno-clavicular articulation on the inner side of the sterno-cleido-mastoid muscle, and, when the vascular group is found, it is to be drawn outwards along with the overlying muscle: then the vertebral artery will be found in the triangle between the scalenus anticus and longus colli muscles. Tie one inch below the carotid tubercle. In this work, the inferior thyroid artery and the sympathetic nerve are endangered.

In 1867, Gherini wrote on wounds of the vertebral artery, from a collection of ten cases; and he finds it hard to decide, in penetrating wounds in this region, whether the carotid or vertebral artery be wounded. He finds, also, that aneurism of the vertebral artery has usually been mistaken for that of the carotid; and the mistake has been made of tying the latter; and as treatment, Gherini would first try compression, and, this failing, he would endeavor to tie the vertebral.

Gherini's plan is to circumscribe the artery by means of a thread passed between two of the transverse processes through which the artery passes; a serious objection to this is, that important parts, as nerves, might be included in the ligature. Others, again, have simply stitched up the wound; but this plan is faulty, since the opened artery would continue to pour out its blood into the tissues, and produce a false aneurism. Kocher finds that some cases have been cured by simple compression on the wound, while the head is maintained at rest.

The mode of ligating the vertebral artery as prescribed by Farabeuf, is as follows: first seek the carotid tubercle of the sixth cervical vertebra, which, according to Chassaignac, becomes unduly prominent and distinguishable, through the effacement of the anterior tubercle of the seventh vertebra by the action of the vertebral artery that rests on it: and immediately below this tubercle is the artery. Incise along the outer border of the

sterno-cleido-mastoid muscle, similarly to the cut made for finding the carotid artery. When the vasculo-nervous group of structures is found, pull them inwards, when the vertebral artery will be seen and the ligature can be passed around it.

Albert of Vienna, writing in 1881, says the ligation of the vertebral is very difficult, and, till that time, had only been tied three times. To do the work, make an incision on the outer margin of the sterno-cleido-mastoid, from the point where the external jugular vein crosses the muscle to the clavicle. This cut is about two inches long. If the vein is in the way, it may be tied. The sterno-cleido-mastoid muscle and the vessels and nerves are to be caught with a retractor, and drawn towards the trachea. At this point it will be of aid, if the head which was previously bent backwards be bent forwards. The carotid tubercle which lies about three fingers' breadth above the clavicle, is next to be found. The artery is now to be ligated below this eminence; and the vessel lies there somewhat inwards, between the insertions of the scalenus anticus and longus colli muscles. The vertebral vein lies on the outside of the artery, and in throwing the ligature around the latter, the vein must be pulled outwards. Instead of doing the work thus, one may do as Maisonneuve did, viz., make the incision on the inner side of the sterno-cleido-mastoid where both the vertebral and inferior thyroid arteries may be tied.

To compress the vertebral artery, Fracy directs to make pressure on the lower part of the neck, against the carotid tubercle; such compression acts both on the carotid and the vertebral artery. If compression be made higher up, then the common carotid only is acted on; this was proven by Fracy by injecting into the aorta during pressure made separately on each of the two points; in the case of pressure made low down, the injected material did not enter either carotid or vertebral, but when made above the carotid tubercle, the material only enters the vertebral artery.

Subclavian Artery.—A great part of the subclavian artery is situated in the lowermost portion of the anterior cervical region. Functionally, this artery ranks with the most important vessels of the body; through the two subclavians nearly one-half of the blood supply to the brain is furnished; and the upper extremity derives its blood through the same channel. The right and left subclavian arteries differ from each other; the right springing from the innominate is shorter, and more superficial than the left artery.

For convenience of description and guidance in operative work, the surgical anatomist maps off the course of the vessel into three sections: the first of these extends from its origin to the inner border of the scalenus anticus muscle; the second portion lies between the anterior and posterior scalene muscles, and is the shortest section of the three; and the third and terminal section extends from the inter-scalene space to the lower border of the first rib, where the vessel becomes the axillary artery.

The ligation of the subclavian artery has been done for three purposes: to control bleeding when the artery has been wounded; for the cure of axillary aneurism, and in Brasdor's and Wardsop's operation for relief in aneurism of the innominate artery. It should be done as a preliminary step in the amputation of the humerus with the scapula. The author has tied the vessel twice in cases of innominate aneurism, and twice for the cure of axillary aneurism.

In case of stabbing wounds of the vessel, or of fracture of the adjacent rib or clavicle, in which a fragment has pierced the artery, it might be necessary to seek the vessel and ligate it on the proximal side of the wound; such an operation would be involved in great difficulties; for the structures saturated with ecchymosed blood would obscure the anatomical landmarks, so that the surgeon would be forced to trust to touch, rather than to sight.

In cases of aneurism seated in the axillary artery, ligation of the subclavian has been done. Early in this century the operation was attempted by Astley Cooper on a patient, in whom the tumor involved a part of the third portion of the subclavian: the aneurism so uplifted the clavicle that this celebrated operator was baffled in the attempt to pass a ligature around the vessel. Near the same time, in 1809, Ramsden, of St. Bartholomew's Hospital, tied the subclavian; yet the patient lived but six days. These pioneer surgeons found much trouble in passing the ligature around the vessel, owing to the want of an instrument properly constructed for the purpose. Invention has since remedied this in furnishing devices which easily carry the thread around the vessel; and of these, one of the best is that used by Valentine Mott, of which the curved point can be attached and detached, and the thread thus carried beneath the vessel.

The ligation is most easily done in the third section of the artery; and if the work cannot be done there, the vessel may be

sought between the scalene muscles and there tied; and should approach to the vessel in its third or second portions be impracticable, then the work may be attempted in the initial section of the artery.

The subclavian artery was tied in the first part of its course by the Irish surgeon, C. Colles, in 1813, who pronounces the feat not difficult on the right side, for one who has a steady hand, and is a good anatomist; but Colles finds it far otherwise, on the left side; here it may be declared to be an impossibile undertaking. Here, as Colles shows, and as Hyrtl indicates in greater detail, the left subclavian is contiguous to the vagus, phrenic, sympathetic and inferior laryngeal nerves; also, the thoracic duct is near by, and likewise the apical saccule of the pleural cavity. Danger in this field, as elsewhere, stimulates to daring: and despite the deterrent caution of Colles, and undismayed by the failure of others, the ligation of the left subclavian in its incipient portion, has frequently been essayed, and properly, too, the author thinks, since such operation, if it does not save life, may sometimes prolong it.

The subclavian is usually tied in the third section, beyond the scalene muscles. As cutaneous guide to find the vessel, Allan Burns directs "to draw a line from the junction of the clavicle and coracoid process to the cleido mastoid muscle, two inches in the adult above the sternum." The subclavian lies below this line, and the arteria transversalis colli and arteria cervicalis superficialis lie above it. To find the subclavian, make an incision below this line, parallel with and above the clavicle, two and a half inches long. This incision, if carelessly made, may cut the external jugular vein: shun this "reef" as Farabeuf calls it, by pulling the vein aside. To best display the artery, let the patient lie with the thorax somewhat uplifted, and the shoulder of the side to be operated on inclined backwards. An aid will assist by making downward traction on the arm. As soon as

resumed his business as watchman: he lived but six months, death being caused by pulmonary disease which was indirectly induced by the pressure of the aneurismal tumor on the summit of the right lung.

Ligation of the External Jugular Vein.—From wounds of the external jugular vein, there may be so much bleeding as to require ligation; and this may be done by percutaneous suture in which a needle armed with silk thread is carried through the skin and platysma myoid muscle beneath the vein, so that when the thread is tightened, the vein is included with a portion of the skin. And such a ligature should be double, viz., one on each side of the wound. In this work aseptic thread should be used, and the skin well cleansed before ligating. On the fourth day, the thread can be cut and removed.

Sometimes projected surgical work on the neck will involve the external jugular vein; and not unfrequently in such proposed work, as a preliminary act, the writer has resorted to percutaneous circumscription done in the way just described, above and below the contemplated wound. The superficial venous circulation of the front of the neck may consist, on each side, of an anterior and posterior external jugular vein; and there may even be a third vein between these two. This increased number of veins necessarily lessens the calibre of each vessel; thence arises the variability in the caliber of the external jugular vein. The external jugular is constituted of trunks which collect the blood from the temporal, auricular and maxillary regions; these trunks fuse into one trunk at the angle of the jaw, which runs thence on the side of the neck to the middle of the clavicle, where it ends in the subclavian vein: thus its course traverses the field which is so often the scene of operative action. If this work is of a character to consist only of longitudinal incisions, then the external jugular vein, as well as the anterior and median ones, can often be shunned by a cut which lies alongside of the vessel, so that with a retractor inserted into the wound, the lip containing the vein can be pulled aside, and the vessel thus left unopened. But should a transverse incision also be necessary, then percutaneous circumscription may be resorted to; or what the writer has often done, the vein having been dissected up for a short space, it may be seized with two pairs of forceps, and divided between these; and then each end is to be twisted on its axis, at least six times. Closure being thus done, air cannot enter the vein, as has been recorded to have occurred after wounds of

this vessel. The aspiration of air is favored in cases in which the vein is unusually large; and also when in the operative work, the lip of the transverse wound has been uplifted so as to open the vein. As a precautionary measure where the vessel has not been closed by torsion or circumscription, the surgeon should direct an aid to maintain compression over the vein on the cardiac side of the wound; that is, above the middle of the clavicle: yet, as before said, it is always safer before opening the vessel to occlude it by torsion or ligation.

Wounds of the Internal Jugular Vein.—When the internal jugular has been opened freely, the resultant bleeding is profuse; and if the wound has been made by the surgeon himself, the scene initiated is one of the most startling emergencies which can arise in operative work. On such occasion the field is instantly inundated with a wave of dark blood, that fills the wound and conceals everything there: and to this occurrence, quite terrible enough, may be superadded that of another yet more alarming, viz., the sound of air inspired into the wound. The blood-wave may be met and stayed by the disciplined hand of the surgeon: but the air aspirated in large amount penetrates to the heart beyond manual reach, where it may speedily end life.

The internal jugular is often endangered in the removal of the tubercular glandular tumor or malignant growths, which are adherent to the vessel. A number of lymphatic glands lie in chain form along the track of the cervical vessels; and they are in close relation with the veins. As result of this contiguity, the gland, when it enlarges and inflames, becomes closely connected with the vein, and may involve and weaken the wall of the latter. In fact, cases are recorded in which the venous wall opened and the cavity of the gland became filled with blood. The malignant lymphoma does not contract adhesions to the vessels: indeed, a thing remarkable in the removal of this growth is the facility with which it may be enucleated without disturbing the adjacent vessel. But the conditions of the tubercular lymphatic gland are far different: in many cases the separation of the multiple tumors from the vessels is a task which tires head and hand. And instead of complete removal of the entire gland, the knife and blunt dissector, near the conclusion of the work, should be replaced by a blunt curette, with which along the line of danger the work of fragmentary detachment can be pursued a little further. Since the introduction of

iodoform as a remedy against such glandular disease, the local use of this agent lessens the work of the knife.

In cases in which the walls of the vein are found diseased, or in which during the removal of a tumor a laceration of the vein is unavoidable, the precautionary step should first be taken to tie the vein at two points, viz., above and below the part that is endangered. The ligation of the vein, whether done singly or doubly, as here advised, is free from danger: in fact, as the writer has repeatedly verified, no inconvenience arises from it, for there remain intact abundant anastomotic routes through which the blood can reach the heart.

Instead of removing tubercular glands through a free incision, the work is sometimes done by making a small cut to the diseased gland, and through this, reaching and scooping out the affected structure. Operating in this blind way endangers the vein much more than by a free incision and exposure of the part. In operating thus in two patients, the writer has had the misfortune to lacerate the wall of the vein, and, as result, to have caused an unexpected hæmorrhage which was only controlled through ligation of the vein on each side of the breach in its wall.

In the presence of such a wound two things demand immediate attention: the prevention of the entrance of air into the wounded vein, and the arrest of hæmorrhage. The entrance of air is prevented by pressure made over the vein, on the cardiac side of, and close to, the wound; and prophylactically, such pressure should be made in all cases in which there is a probability that the vein may be opened. To arrest the hæmorrhage, the surest means is to tie the vein on each side of the opening; and in doing this, besides compression on the carotid side, pressure must be made above, or on the peripheral side of the wound. The pressure on the peripheral side prevents the blood from reaching the wound and disturbing the search for the vessel; and when the latter is found, and doubly tied, the result will be favorable, as has invariably been the case in patients so treated by the writer. In this double ligation, the ligature on the cardiac side guards against the inspiration of air into the vein; while the other ligature prevents further bleeding. Such ligatures should be near the wound: for if they be distant, blood might still reach the wound through an intercommunicating vein.

In another case treated by the writer, during the removal of a glandular tumor which was attached to the internal jugular vein where it commences at the foramen lacerum posterius, the

vein was torn open, followed by a great gush of blood. To ligate on the cranial side of the wound within the foramen posterius was impossible, and the only refuge was in an occluding tampon. Such a tampon was devised from a piece of sponge rendered aseptic by alcohol, and was pressed down to the wounded vein and held there by the finger. This occlusion was so done as not to interrupt the current of blood: a condition necessary for the recovery of the patient; for, had the venous channel been wholly closed, an intra-cranial thrombus might have formed and closed the lateral sinus, with action disastrous to the integrity of the encephalon. As stated, the fenestra in the vein was closed by sponge that was retained in site by pressure of the index finger of a trustworthy nurse, whose hand was occasionally relieved by the hand of the patient. This work was continued for four days and nights by one of those unsleeping sentinels which it is the privilege of the surgeon to occasionally meet as a second in his work. For such service, superhuman endurance and self-sacrifice must be united.

After this compress had been kept in position for four days, the removal of the sponge was commenced by carefully loosening its outer portion. The outer part so detached, gradually expanded, and, in doing so, drew on the part which lay deeper in the wound. In this way the tampon was latently extracted; and after its removal, the wound, which was watched, soon closed. The compression here mentioned might be done by some tourniquet-like device, yet a nurse of proved fidelity would accomplish the work still better, since finger and eye would stand watch together.

In 1867, S. W Gross published his studies upon wounds of the internal jugular vein; he finds such injury more dangerous than that of the common carotid: since, to the danger of hæmorrhage, there is added that of the entrance of air into the opened vein. He finds no recorded case of recovery after a gunshot wound of the internal jugular, while he does find it after such wound of the carotid.

In twenty cases of death from wounds of the internal jugular vein, one-fourth died from entrance of air into the vessel, one-fourth from primary bleeding, one-fourth from secondary hæmorrhage, and the remainder died from pyæmia.

Arterio-venous aneurism was seen in ten patients in whom there was simultaneous wounding of the internal jugular and the carotid artery.

Gross found that in forty-one cases of extirpation of cervical tumors the vein was opened, and tied; and of those so treated, but one died. Death following the ligation of large veins usually occurs from secondary bleeding.

As means of treatment which have been resorted to, are compression and ligation. In fourteen cases compression controlled bleeding, yet this is painful and may cause suppuration. In some cases treated by pressure, though secondary hæmorrhage occurred, yet under a continuance of this treatment, the patients were cured. Complete division of the vein diminishes the bleeding and renders it easier to carry out compression.

The fear of awakening phlebitis has deterred from ligation, yet Malgaigne declares that tying the internal jugular vein is not more dangerous than that of the carotid artery. Ligation of the internal jugular is not a new operation: Thomas Gale writes that it was done in the sixteenth century.

Parietal ligation, done by Travers in 1816, on the femoral vein, was tried by Wattmann on the internal jugular vein; the method is unsafe and has been discarded. Instead of this plan in which only a section of the wall is included, the proper way is to tie at two points and divide between.

In wounds of the internal jugular Langenbeck tied the common carotid. The peripheral anastomosis of the vein and artery do not justify such ligation; and Bardeleben writes that he saw a case in which, though the carotid had been tied to control bleeding from the wounded internal jugular, yet hæmorrhage from the latter was not controlled.

When a vein is included in a single ligature, Gross finds that it becomes closed by a thrombus on the distal side, while the cardiac side is closed by the inner tunic adhering to itself.

In case the wound were in the lower part of the internal jugular vein, close to the subclavian vein in which it terminates, then the plan of treatment which suggests itself to the writer would be to tie the vein on the distal side of the wound, and then apply an aseptic sponge tampon on the wound, and retain this in site by digital or mechanical means.

The admission of air into the opened cervical veins, especially the internal jugular, has been mentioned: and as it is a matter of much gravity, the matter merits detailed consideration. In surgical work done on the neck, on more than one occasion the writer has observed slight aspiration of air into a wounded vein; yet pressure instantly made on the wound, and compression on

the cardiac side continued during the remainder of the operation, forestalled further trouble which otherwise might have occurred. The rapidity with which life may be extinguished by aspirated air was observed by the author in a man from whom an immense growth had been removed from the axilla, and when healing seemed assured, secondary bleeding occurred from the axillary vein. The patient being nearly moribund, it was decided to resort to transfusion; and as no proper instrument was at hand, a common syringe was used: but owing to the haste which the occasion demanded, and inaccurate manipulation due to inexperience, when an amount of blood had been injected into the axillary vein, probably sufficient to rescue life, some air was admitted, and ended life as quickly as could be done by an electric stroke: one croaking gasp, and life was extinguished.

Death from entrance of air into the veins was observed and mentioned by Redi in 1667; and early in the present century, death from this cause was observed in dogs who had been the subjects of experiment. In 1842, there were recorded several observations of death thus occurring in man. Simon mentions a case in which death was perilously near ensuing from the entrance of air into the basilic vein, as the result of an opening made for ordinary bleeding.

Various explanations of the way in which death is thus produced, have been offered: Marchal maintained that through the contact of the admitted air with the blood, carbonic acid is evolved which acts as a toxic agent. Mercier claims that the air mingles with the blood, and that the mixture thus formed becomes an elastic one, and cannot be propelled by the heart's walls, but regurgitates into the veins: and further, that such a compound of air and blood cannot pass through the lungs, even though it reach these organs.

Wattmann, also in 1842, wrote on this subject. He finds that air is apt to be aspirated, when the veins are rendered tense, or are being pulled on when they are wounded. Again, when the walls of the vein are thickened from any cause, and but partly divided, then, during inspiration, air is apt to be aspirated, especially if the patient is erect. When such accident happens, it is announced by a sharp hissing sound; or by a dull gurgling sound: and in the latter case, blood and air are commingled. The patient makes a sudden outcry; he is pale, perspires, and may faint or be thrown into convulsive movements. As treatment, Wattmann would lower the head, throw water on the face, and

give stimulants. He does not approve of bandaging the chest, nor the sucking out the air with a tube, nor tracheotomy, nor the injection of fluids into the veins: means advised by some authorities.

In 1843 Erichsen, writing on this matter, offers the opinion that the air mixes with the blood and forms a foam which cannot pass through the lungs. Elliott claims that the air reaching the heart cannot pass beyond it, since the cardiac valves are so constructed that they cannot force the air outwards, but when it enters the right ventricle it returns again to the auricle: and thus the air is alternately moved backwards and forwards. Also in the heart the air expands so as to hamper the movement of the organ; and finally, should the air reach the lungs, it would be cooled there and forced back to the heart.

Where such accident is feared during an operation Erichsen counsels to bandage the chest so that a deep inspiration cannot be made. And in a patient in whom such accident has occurred, he would lower the head and bandage the limbs, so as to force the blood to the nerve centres.

In 1850 in the removal of a tumor from the arm-pit by Gay, air entered a vein and the patient fell into syncope and did not rally for an hour. Lane, who was a witness and reporter of the accident, claims that the following are the disposing agencies to such aspiration: deep breathing by which the blood is moved towards the heart; traction on a vein by a tumor, or by an overlying muscle, favors the entrance of air into the vessel when opened. The trapezius, sterno-cleido-mastoid and the platysma myoides are muscles which may cause such traction.

Poiseuille taught that if the opening in the vein were an inch distant from the thorax, the air would not enter, since its admission would be prevented by the pressure of the external air.

Necropsy after death from this cause has discovered that the left ventricle was contracted, while the right side of the heart, especially the right auricle, was found full of blood mixed with air; also, blood mixed with air was found in the pulmonary artery; and the lungs were congested and contained blood mingled with air. Hence death is from asphyxia, and is not from the friction of the air in the vessels of the brain, as Bichat thought; nor is it from palsy of the heart, or the presence of carbonic acid there, as others have taught.

As means of resuscitation, Lane recommended stimulants, brisk friction of the skin, and artificial respiration.

Couty, of Paris, writing in 1876, opposes the notion that the ill effect of admitted air is due to embolic obstruction of the lungs: he thinks that death is caused by asystole of the right heart, resulting from the presence of air there; and as final result, death ensues through suspension of the pulmonic circulation. The action of admitted air is classified by Couty under four heads: (1) diminished aortic pressure and increased cardiac action; (2) aortic pressure still more diminished, and action of the heart still further increased; and in this stage the conditions present are paleness, syncope, rapid breathing, and dilated pupils; (3) blood pressure vanishes, breathing is slow, and the urine and fæces escape involuntarily. In the fourth or final stage, there is cessation of breathing, and later, cessation of the heart.

In 1876 Picard experimented on animals in which he admitted air into the portal vein, with the result of inducing hyperæmia in the rootlets of the portal system. Besides this, the heart's action was increased, and the respiration was rendered slower; and the general temperature was lowered.

Fischer, in 1877, in Volkmann's Klinische Vortiage, wrote on this matter. He had observed two cases in which air was admitted, and yet the patient recovered. He refers to Langenbeck's advice to first dissect bare the vein which may be injured: this cannot always be done, owing to a tumor lying in the way; or the parts may be diseased. In Fischer's cases recovery took place through coughing, which forced out the air through the wound; and hence the subject of such accident should be made to cough, sneeze or vomit: for thus the blood is forced back and out, and carries the air with it.

Vivisective experimentation has lent its aid in the study of the aspiration of air into the veins. In 1859 and 1860 Dr. E. S. Cooper exhibited before a class of medical students in San Francisco the effect of throwing air into the veins. The femoral vein of a dog being exposed, a tube was passed into it, and air was forced into this by means of a syringe. The dog ceased to breathe, and seemed to be dead; the handle of the syringe was then drawn back and blood and air withdrawn, with the effect of restoring the dog to life. He never had an opportunity of applying this means of restoration in the human subject: yet the writer thinks it might be done; and in the attempt to do so, he would use, if possible, the vein that had been opened.

In Berlin, in 1870, some experiments were made by Uterhart on dogs, in which he injected air into the veins. He found that

when the air was introduced into a vessel remote from the heart, as for example the crural or femoral vein, then no injury resulted from it: but if the air was injected into the external jugular vein, then death quickly ensued under symptoms of cerebral anæmia. But if the air was thrown into the arteries, no ill resulted to the animal, no matter whether the point of injection was near or remote from the heart.

CONGENITAL DEFECTS OF THE SPINAL COLUMN (SPINA BIFIDA).

A congenital deformity not unfrequently seen is that in which the arch of one or more vertebræ is defective, that is, the arch is bifid, or from arrest of development, the spinous process has not been developed. And this defective formation may extend further forwards: in fact, to such an extent that the containing wall of the spinal canal is quite wanting behind, and at the sides. This defect occurs much oftener in the lower part of the spinal column than in the upper portion; yet it has been observed in the region of the atlas, and it involved the occipital bone. And this might have been apprehended, when the fact is recalled that the occipital bone in its growth and form so nearly resembles a vertebra, that the bone is evidently a transformed vertebra This theory, the induction of a Gœthe's fancy, has been confirmed by the comparative anatomist: and additionally established by the observation of the pathologist, that the occiput may present an opening similar to that of a bifid vertebræ, which has been imperfectly developed.

As a consequence, or accompaniment, of such breach in the spinal canal, there protrudes through the opening a pouch-like tumor, which contains a fluid similar to that normally existing in the spinal canal. This fluid is always contained in the meninges of the cord: but in relation to the spinal medulla, the fluid may develop within the primordial central canal of the cord, and so increase in amount as to rupture its medullary wall: and then the normal meninges will be the containing tunic: or the fluid, identical with that of the cerebro-spinal, may lie outside of the cord, and be contained within the dilated meninges.

As stated, the condition of the cord differs according to the site of the fluid: when originating centrally, the cord may be attenuated to a film-like structure; but when the fluid arises and lies eccentrically, then the normal integrity of the cord may not be altered.

There may result serious nervous disturbance from the cleft spine; or the organism may suffer but little from it; and these differences probably depend on the central or eccentric site of the fluid.

Though much oftener in the lumbar and sacral region than in the upper part, yet it is not infrequent in the cervical region: two cases have been seen by the writer in which the tumor was large and was located in the region of the fifth, sixth and seventh vertebræ; and the patients had reached adult age, and possessed average strength of body. The spinal cord must have been intact in these cases. In another patient, the defect was in the lumbar region, and evidently had implicated one-half of the cord, since one limb was paralyzed, ill developed below the knee, and the foot was in the position of varus. And should a specialist, whose knowledge does not extend beyond one narrow angle of the human fabric, attempt to correct such a club-foot by mechanical appliance, then nature would avenge such blundering by extensive sloughing. In such cases justice unfortunately misses its aim, and the forfeit demanded is vicariously paid by the guiltless patient.

The tumor of spina bifida may have a wide and free communication with the spinal canal; that is, the tumor is sessile, and has no intermediate connecting foot-stalk; or there may be a narrow opening into the canal; and then the tumor is, in a manner, pedunculated, and capable of being isolated from the spinal canal. And this character is determined by the breadth or narrowness of the osseous vertebral cleft; for when the spinal breach is wide, the tumor rests on a broad base: but when the opening is a narrow fissure, the base of the tumor may be so compressed that it has a pedunculated form.

If the narrow cleft should close, then there will remain a cyst-like tumor, which retains its volume under pressure: but in the usual form of spina bifida, pressure on the tumor lessens its volume by forcing the liquid content into the spinal canal; and if the fluid be great in quantity, then reduction of the tumor will cause symptoms of cerebral compression; similar to what takes place when pressure is made on the protrusion of meningocele.

The diagnosis is not difficult; the location of the tumor in the median line behind, its reducibility by compression, and the effect of such compression on the subject with the history of congenital appearance, would indicate the true nature of the tumor. And the withdrawal of some of the fluid by the aid of

a hypodermic needle would furnish additional proof of the nature of the tumor, and would distinguish it from a lipoma, with which it is possible to confound spina bifida. The lipoma has the characteristic that when one attempts to displace the skin covering it, the latter becomes mapped off into quilted sections corresponding to the convolutions of the lipoma; but in spina bifida, such configuration of surface is absent.

If the tumor be of small volume and pedunculated, it is curable: but if it be voluminous, with large communication with the spinal canal, the attempt to relieve encounters many difficulties. And finally, if other defect coëxist, such as deformity of the face or head, even though the surgeon remove the spinal tumor, he is confronted with a more difficult task in the treatment of the other deformities. And should there be rhachischisis, or cleft of the cord, complete or incomplete, as has been observed by Koch, then the case will not lie within the range of much amelioration by surgeon or physician. But if the defect be confined to simple spinal meningocele, the case may be improved or cured by surgical means.

Treatment.—The modes of treatment may be placed under four heads: compression, obliterating injection, obstructive constriction, and excision and closure by plastic work.

Compression may be maintained upon the tumor either by means of a truss-like appliance, in which a compressing pad is held in place by an elastic band which surrounds, or, in some way, clasps the body. Such compression may be made as a means of protection against external violence; or it may be used as a means of cure. As a protective agent the compress is oftener used in the adult; but it may be used in the infant to repress the fluid during the time that the congenital breach is gradually closing during the growth of the child. The hope of such occlusion is rarely realized; so that compressive means, when employed, are used rather for the purpose of protecting the tumor against violence, than of causing its disappearance.

A second method of treatment consists in the injection of some irritating agent which will lessen and perhaps finally occlude the cavity of the tumor. Such agent is the tincture of iodine, or a solution of the chloride or sulphate of iron; the former has been most frequently used. Brainard, of Chicago, reported cures effected by the use of injection of iodine. To accomplish occlusion in this way, the tumor must have but a small communication with the spinal canal; which, through the

occlusive action of the injected iodine, will be closed, and then a cyst-like cavity will remain, which may, also, finally become smaller, and disappear through absorption. This plan of treatment has so often failed that, similarly to what has occurred in hydrocephalus, it has fallen almost into disuse. Its use should certainly be limited to those cases in which the conformation of the tumor is such as to be easily isolated from the spinal canal.

A third method of treatment is like that once in vogue for the cure of umbilical hernia: it consists of a constricting clamp which having included the base of the tumor, the clamp is so tightened as to interrupt the circulation, and cause sloughing, and consequent destruction of the tumor. For this plan to be successful, the tumor must be pedunculated, or capable of being isolated from the adjacent spinal canal. Chaffy, in 1881, successfully treated a case in this manner; and as constricting instrument, he used the clamp employed by Spencer Wells in ovariotomy. Having applied the clamp, Chaffy excised the part beyond and then let the clamp remain in place for four days. The healing was by granulation.

A plan cognate to the preceding method is to include the neck of the sack in a subcutaneous circumscribing ligature, which, being tightened, isolates the cavity; and when the isolation is thus complete, the part beyond the ligature may be excised.

The fourth method which has been successfully practiced by the writer is to excise a portion of the wall of the tumor; also dissect from the remaining wall its serous lining; and then having juxtaposed the raw surfaces, unite these by suture.

In a communication read at the recent International Medical Congress at Rome by Mayo Robson, of England, there were reported twenty cases treated by the last method, with such satisfactory results that the writer urgently advocates the procedure. His plan consists, in the main, of dissecting the serous sac from the skin, and then having removed the excess of the sac to close this by buried sutures; and lastly, so close the skin that the buried and dermal sutures will not lie one on the other. Robson finds that this plan may be successfully employed in all cases of spina bifida, in which the patient is not hydrocephalous, paraplegic, or in a state of marasmus.

In a case of spina bifida treated by the writer, the base of the tumor was sutured in sections; the tumor beyond was excised, and the remaining wound soon healed under alcoholic dressing. Hence of the four methods of treatment described, the author prefers that of simple excision and closure by suture.

Besides the bifid cleft described, which may deform the spine, there are other defects, which, though rare, should be noted.

One or more vertebræ may be imperfectly developed; and thus lateral or antero-posterior curvature, or deviation of the column, may arise. Also the two halves of a vertebra may remain ununited; whence abnormal mobility may arise.

Should such defect be recognized, the surgeon may use a corrective appliance, designed to maintain the column in proper line: and as examples of such apparatus may be cited the orthopedic appliances employed in spinal curvature.

A congenital abnormity sometimes seen in the lower part of the neck, is an elongation of the transverse process of the seventh cervical vertebra. Or this process may be transformed into a supernumerary rib; and then, as Luschka has observed, such costal anomaly may be a fragmentary rudiment, consisting merely of a head, neck and tubercle; or it may extend further forwards, and then represent a false rib, at the upper end of the thorax; and, lastly, there may be a completely formed rib, attached to the spine behind and sternum in front.

In the second form, in which the rib ends by a free point in the subclavian triangle a little above the clavicle, the terminal end may infringe on the constituent trunks of the brachial plexus, and cause pain extending along one or more of the nerves distributed to the arm. Such anomalous rib might endanger the subclavian artery which lies in contact with it. The writer has seen an example of such anomaly, which in its development was impaled or imbedded in the brachial plexus, and caused severe pain. Relief was obtained by an incision exposing the rib, of which an inch of the free end was excised. The work of excision was difficult and perilous, owing to the contiguous subclavian artery, which, with much difficulty, was so pulled aside as to permit the section of the rib. The operation was successful in delivering the patient from the pains in the arm with which she was previously tormented.

CHAPTER XXXV

LUXATION OF THE CERVICAL VERTEBRÆ.

SURGICAL authorities in the early part of this century were united in the opinion that isolated vertebral luxation is an impossibility. Delpech declared that dislocation of the vertebral body cannot occur. Abernethy says, "There can be no such dislocation, surgically speaking:" or, rather, if such accident occurs, there must be, at the same time, a fracture. Sir Ashley Cooper asserts that if such injury ever does occur, it must be extremely rare; and in the numerous instances of injury of the spine which he had seen, he had never observed the separation of one vertebra from another, without a fracture of either the articular process or the body of the vertebra. And Boyer doubted though he did not deny the possibility of vertebral luxation.

Since this period of skepticism in regard to vertebral luxation, the sphere of observation has widened, and the possibility of such injury has been verified by the observation of this luxation in the living subject, and still further demonstrated by experimentation on the cadaver.

In 1871 Stephen Smith, of New York, made experiments on the dead subject, in which fracture and luxation in the region of the atlas and axis were studied. He finds that the atlas belongs fundamentally to the head, and the odontoid process of the axis is the center of the movements of the atlas and head: and those forces which act from the head on the spinal column, and those from the spine below which act on the head, are directed towards, and are exerted on, the odontoid process. The alar or check ligaments which extend from the summit of this process to the occipital bone, in the work of limiting movement must bear much; and much resistance must be offered by the base of the odontoid process, on which a lever-like force is exerted.

Smith concludes that when a person falls on his head, the

violence is directed against the alar ligaments and the base of the odontoid process. The odontoid process must support more than the anterior arch of the atlas, or the transverse ligament. If violence be applied to the part, the axis will break before its odontoid process; and this process does not break when it is forced against the anterior arch of the atlas, or the transverse ligament. The alar ligaments have more strength than the odontoid process.

FIGURE 108. Exhibiting complete antero-posterior luxation. (From Albert.)

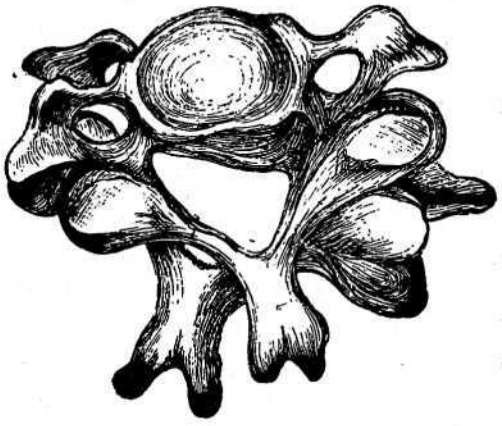

FIGURE 109. Exhibiting bilateral luxation. (From Albert.)

Vertebral luxation may be, according to the extent and character of the injury, divided into two classes: complete and partial. In the complete form, the vertebra has its articulating facets displaced entirely from their normal location: and the displacement may be forwards, or backwards, as shown in figure 108. In the incomplete form, the displacement may be unilateral, in which the luxation is backwards or forwards: or it may be bilateral, in which the vertebra is turned about its vertical axis, with luxation backwards on one side, and forwards on the other, as shown in figure 109.

Along with vertebral luxation there must be rupture of the inter-vertebral ligaments: and that such rupture may occur, greater violence is required as one descends in the column. This fact was demonstrated experimentally by Malgaigne, on the cadaver. He found that to rupture the intervertebral ligaments required one hundred pounds force in the cervical region; one hundred and fifty pounds in the thoracic region, and from two hundred and fifty to three hundred pounds in the lumbar region.

In case, however, the subject be an old one, then the partial or entire ossification of the connecting ligaments may give them so much resistance that fracture, and not luxation, ensues. The elastic ligaments of the child and youth permit of movements at that age, which cannot be made in later life. Long continuance of the upright position temporarily exhausts the elasticity of these ligaments; hence the lessening of stature of him who has been standing for many hours.

The age of the subject has an important influence on the occurrence of vertebral luxation: in childhood, and prior to complete growth, the bones are not fully ossified from their early cartilaginous stage, and the ligaments are extensible: hence, at this period of life, though the spine is often subjected to violence from accidental or voluntary movement, yet luxation or fracture is seldom seen; but such injury is seen oftener in mature, or advanced age. This accords with the experience of Porta, who made a study of these injuries.

In 1865, Porta published a work on luxations in all parts of the body, comprising a series of five hundred dislocations, of which twenty-seven were of the vertebral column: and of the latter seven were of the cervical vertebræ. An important diagnostic distinction which he indicates between luxation and fracture of the spine is, that a simple fracture leaves no perceptible displacement or irregularity in the outline of the column: but if the case be one of luxation, there is evident deformity. In the cases seen by Porta, the subjects were adults; and the causal agency was a blow, or a fall. He finds that the anterior longitudinal ligament is stronger than the posterior one; and the intervertebral disks and articular ligaments are easily torn. The interspinous ligaments of the dorsal region are so strong that unless the spinous processes are broken, the ligaments prevent displacement. Hence the usual coincidence of fracture and luxation.

The prognosis of luxation in the cervical region is unfavorable: for death can occur at once, on the receipt of the injury, or at an early period, from acute inflammatory action; or the case may end fatally after an indefinitely long duration. The spinal injury may be associated with other complication caused by the lesion of the cord: such trouble may be tetanus or encephalitis; likewise, sloughing from pressure of the recumbent body; there may also be vesical atony in which the urine is retained, or is voided involuntarily.

Though death, as a rule, follows such luxation, yet exceptionally, recovery may occur. As treatment, Porta does not favor an operation; but on the contrary, reduction should be attempted by extension and counter-extension; and means designed to limit inflammation, should be employed.

Hueter, in 1868, from his personal studies offered a new classification of vertebral luxation: he makes two classes founded on the manner in which the causal violence acts: luxation from rotation or abduction, in which the dislocation is caused by torsion of the spine; and luxation produced by flexion. He discards the terms lateral and anterior dislocation. In brief, Hueter refers all spinal luxation to violence which acts by twisting, or by bending the vertebral column.

The spinal cord may be injured by the displaced vertebræ; yet when the luxation has taken place, it seems that the primary pressure gradually lessens; or the cord acquires a tolerance of the compression. As consequence of the injury there may be palsy from pressure on the nerves where they emerge through the intervertebral foramina.

In his treatment of the injury, Hueter does not approve of the methods of extension and counter-extension which are employed by Schuh, Martin and others; but instead of these methods, Hueter advises one which seems to have originated with Richet. This plan consists in bending the head towards the shoulder, towards which the head is abnormally directed: that is, towards the shoulder of the side on which the chin is uplifted; and when this is done, turn the head so that the ear which was inclined towards the shoulder shall be directed forwards, and the other ear backwards. This plan is suited for reduction of the first species of the injury, viz., that arising from excessive torsion; and in this way Hueter accomplished reduction. But if the luxation be from violent flexion, then the same method may be resorted to; and one must resort to it on one side, and then on the other.

Wagner, in 1884, from the study of two hundred cases of vertical luxation which he found in surgical literature, published the following: in forward luxation the head is not always bent directly forwards: there is no definitely typical position. And where the luxation is caused by excessive rotation, the position of the head differs according to the relative position of the displaced articular processes. When unilateral luxation is complete, the head is bent towards the displaced side, and the chin is rotated towards the sound side.

As treatment, Wagner counsels in cases of incomplete dislocation, simple rest and fixation; but if the displacement be complete, then he would try to reduce, after placing the patient under chloroform.

From a study of occipito-atloid dislocation, Malgaigne has found that the head might be luxated backwards, or the atlas forwards. The atlas may be so tilted forwards as to greatly incline the head forwards: and then the odontoid process may so press on the cord as to cause instant death: or the displacement forwards of the atlas may be yet greater, causing more or less palsy; and, again, the atlas may be rotated on one side, only. Where the atlas is luxated forwards, the chin is caused to approach the sternum; but if the displacement be unilateral and has arisen from torsion, Malgaigne found the head inclined towards the luxated side, while the face is directed towards the sound side. In these high luxations, something may be learned by a digital examination of the pharynx. As treatment Malgaigne counsels rest in the horizontal position; and in the worst cases, he would attempt to reduce by flexion, extension, traction and counter-traction.

The following is a summary of the plans of treatment which have the sanction of authority. In mild cases, which may be named subluxation, authorities have concurred in limiting treatment to rest in the horizontal posture; but in more extensive injury in which the dislocation is complete, the plan has generally been to attempt reduction by forcible movement, which may be done in one of the following directions: extension and flexion; abduction to the right or left; rotation to the right or left; traction and counter-traction. That movement in each case should be selected which will act correctively on the existing displacement. And one should not limit this manipulative treatment to cases of complete dislocation, it should also be tried in those of subluxation.

It must be confessed that these methods are not exempt from peril: for despite the most diligent diagnostic exploration, the exact conditions may not be determinable; and then the manipulative procedure, in place of restoring the vertebra to proper position, may add to the existing displacement: and then if the injury be high up, fatal injury to the cord might be inflicted. The deplorable condition of such patient, deprived as he is of sensory and motor power, justifies resort to a hazardous venture: for to the victim of such condition death is better than life.

A resort to operative work as a means of relief seems to have seldom been tried: yet in a case of anterior luxation of the atlas, the writer availed himself of this method. This case was as follows: from a fall, the patient remained with fixation of the head, and with the chin directed forwards, without elevation or depression. When seen the condition had existed for nearly a year: the man was unable to move the head, the eyes were unduly prominent; the power to form articulate speech was very defective; there was partial loss of motor power to such a degree that the patient was unable to walk without assistance. There was continued pain at the site of injury; and a depression could be distinguished beneath the occiput. The diagnosis was anterior displacement, and it was decided to cut down posteriorly, and having exposed the parts, do what might be possible for relief. This was done: through a vertical incision the posterior portions of the axis and atlas were brought into view. The atlas was found displaced forwards to the extent of a quarter of an inch, so that its posterior arch was crowded against the cord. It being evident that an attempt at replacement would be fraught with more danger than prospect of relief, it was decided to remove the posterior part of the atlas, which was done by dividing the ring on each side, so that a small segment could be removed. This was easily done with bone forceps. After the removal of the small bridge which was crowding on the cord, the latter at once rose in the interstice, as if it had previously had insufficient room. This work was done without any lesion of the structures within the canal; and as soon as the man passed from the influence of the anæsthetic, there was found some improvement of motor power in the arms and legs. This amelioration in the patient's power of movement was followed, a few days after the operation, by symptoms of acute myelitis and encephalitis: there appeared spasmodic movements of the limbs, and the patient became wildly delirious, in which he required restraint to prevent him from doing violence to those attending him. On reopening the wound, the cord was found swollen and protruding through the breach which had been made in the vertebral canal. The patient died two weeks after the operation. It is possible that in case of an irreducible luxation lower down in the spinal column an operation might eventuate more favorably, since it would permit of better immobilization than is possible in the region of the atlas, which is near the pivotal point of the movements of the head upon the trunk.

Fracture of the Vertebræ.—The spinal column may be broken at any point, yet conforming to the scope of this work, the present chapter will, in the main, be briefly devoted to fracture of the cervical portion of the column.

The vertebra is constituted of several parts which functionally differ: viz., a body, seven processes and two lamellæ. The processes aid in articulation, or serve as points for the attachment of ligaments and muscles; and the lamellæ form the lateral and posterior walls of the spinal canal. And as one or more of these constituent parts may be broken, there may be isolated fracture of the body, lamella, articular, transverse or spinous process: or two or more of these parts may be fractured conjointly.

Vertebral fracture may arise from violence indirectly or directly applied; that from indirect force occurs oftener than that from direct.

Molliere, of Lyons, in 1887 wrote on spinal fracture caused by indirect violence; and in his researches of the subject, he made experiments on the cadaver. In these experiments the body was fixed in a sitting posture, and then violence was applied directly downwards; or it was done by bending the body backwards or forwards; and the following results were noted: (1) Only when the intervertebral ligaments remain intact, does crushing of the vertebral bodies take place. (2) Fracture of the vertebral arches only takes place when the bodies remain intact. (3) When one produces fracture by violently flexing the body, then the fracture will be found in the vertebral bodies; and these bodies will be found crushed in their anterior portion. (4) Fracture occurring in the dorsal region is accompanied by costal fracture, or sternal fracture, or by injury of the costal cartilages. If the flexion be confined mainly to the spinal column, then fracture is oftenest in the dorsal region; but forcible flexion of the trunk is more apt to break the spine in the lumbar region.

Mollière has found these results verified in surgical practice. In twelve cases of spinal fracture caused by falling on the feet, gluteal or sacral region, the fracture was found in the lower part of the spine, viz., the portion between the eleventh dorsal and the third lumbar vertebra. And in eight cases in which the violence was from falls on the head, the site of fracture was in the dorsal region.

An epitomized summary of Mollière's researches is the following: fracture of the spine occurs indirectly from forced

flexion of the entire trunk; or it may arise from forced flexion of the normal curves of the spine; and in the latter case the violence acts on both ends of the column. And, finally, violent flexion can break the spine by acting on one end.

Fracture may arise from violence acting directly on some part of the median line of the back: and the causal agent may, or may not, penetrate the soft parts. Excepting the projectile, such causal agency is rare: for spinal fracture originates, as a rule, from indirect agency: for example, a fall on the feet or on the buttocks may break the spine. In the history of this injury, there are many cases recorded in which it occurred from the subject falling head downwards, and so striking, that the violence traversed the head, neck and expended its force on the spine. A great weight falling on the head, inclined neck, or shoulders, has broken the spine, and such force usually fractures at some point in the upper part of the column. Dupuytren saw a case, in which a slaughtered ox thrown from a wagon upon the shoulders of a man caused fracture of the processes of the fourth, fifth and sixth vertebræ. In the work of mining, a mass of over-hanging earth or rock falling on the shoulders of the laborer may fracture the spine: a few cases thus occurring, have fallen under the observation of the author. In athletic sport, in the act of turning about a bar, a young man fell striking on his head and received an injury in which all parts below the neck were paralyzed, and death occurred within an hour. From the simple overthrowing of a wagon, the spine was fractured near the middle, in a case seen by the writer.

An accurate diagnosis between vertebral luxation and fracture is difficult to be made: in fact, the change of form caused by the two, and the morbid conditions resulting from them, are often so similar as to baffle the attempt at differentiation: and the difficulty is further augmented by the fact that in many cases, luxation and fracture coëxist. The body of the vertebra, for example, may be fractured, and its articular processes luxated, so that the vertebra is displaced backwards, forwards or laterally.

Vertebral fracture is usually limited to one vertebra; exceptionally, two vertebræ are involved, and more rarely several vertebræ may be implicated in the injury. In case of multiple fracture, the injury is usually in the arches.

If vertebral fracture were an isolated lesion, it would not be a matter of great import: but as the spinal cord is commonly

involved, the gravity of the injury is dependent on the location and extent of the lesion of the cord. If the cord be severed, or so crushed that the part beyond is rendered functionless, then the effect is disastrous to the part of the body which receives its supply of nerves from the portion of the cord which has been cut off.

In degree or extent, the fracture may vary from that which is simple to that which is very extensive: viz., from a lesion indiscernible, to one completely crushing the vertebra: and from such varying conditions, there may be founded a classification into that of mere seam or fissure, compression, and a still higher degree, in which the vertebra is broken into two or more pieces, and these may or may not be displaced.

The fissure may be nearly or quite invisible; or it may slightly gape.

In the second form, the upper and lower faces of the body may be flattened and caused to approach each other: and along with the vertical thickness of the vertebral body, the interverte-

Figure 110. Showing complete fracture of the vertebral column. (From Albert.)

Figure 111. Showing fracture of a vertebra. (From Albert.)

bral disk is crushed and forced from its place. The compressive force may merely act on the borders of the articular facets of the body; or the violence may be such as to essentially shorten the vertical thickness of the body: in the former case, the cord would escape all pressure; but in the latter, the canal would be encroached on, and the cord subjected to some pressure.

Where the vertebral body has been broken into two or more pieces, the line of fracture is usually oblique or horizontal; and

this is usually nearer the upper surface than the lower one: and then the smaller upper fragment is displaced forwards; and along with this, the superincumbent column above is carried forwards. In such displacement, the spinal cord is pressed on by the upper displaced portion of the column; and if the displacement be considerable, the cord may be lacerated, or even entirely severed. Examples of vertebral fracture are seen in figures 110 and 111.

The proof that the spine has been broken and the cord injured is furnished by the impairment, or entire loss of motion and sensation in the parts deriving their nerves from the portion of the cord that lies below the fracture. As there are many varying conditions conceivable in the injury, so there may be variety in the functional disturbance. Charles Bell discovered and proved that the anterior portion of the cord is the source of motor innervation, and that the posterior portion is concerned in sensation. As a result of such anatomical disposition, it is evident that a lesion limited to the anterior or posterior portion of the cord would have the effect of destroying or disturbing motion or sensation in the parts below the injury. As the canal is larger in the upper part of the spinal column than in the lower portion, hence functional disturbance would ensue from less displacement in the lower than in the upper part of the spine.

If the displacement were lateral, or in the direction of torsion, and were slight, then the cord might escape pressure, and the constriction be limited to the nerves which escape between the displaced vertebræ: and in such a case, the nerves which are given off beneath the injury, would retain unimpaired function: and the remarkable condition would be present that a zone of the body would present impaired movement and feeling, while above and below such zone, there would be integrity of movement and sensation.

Again, the displacement may be slight in any of these directions, yet from lesion of blood-vessels, a clot may form and produce pressure on the cord, and thence conditions can arise which are similar to actual severing or laceration of the cord. But as the clot would lessen through absorption, the paralytic condition would gradually disappear. And it is probable that in those cases in which the subsidence of the paralysis is referred to accommodation of the cord to the compressing vertebra, the actual condition has been one of compressing clot rather than vertebral displacement.

Observation has often found that the sphere of sensory impairment is less than that of loss of movement; for example, muscular power may be abolished in a limb, while the sensory endowment is not completely extinguished. An explanation of this may be found in structural difference between the anterior and posterior roots: the posterior roots are larger than the anterior ones; and the posterior roots have a ganglionic enlargement, in which there is resident some sensory endowment probably independent of the cord. The position of this ganglion in the intervertebral canal may protect it from lesion of the adjacent bony structure. These anatomical conditions give the posterior or sensory trunks an advantage over the anterior ones. Another circumstance which may have an influence is that in antero-posterior displacement (the usual one), the cord is more infracted in its anterior than in its posterior section; and thence may arise a greater disturbance of motor than of sensory function.

The area of paralysis may be irregular below the site of the injured cord: for example, it may be hemiplegic; and again, it may be complete on one side and incomplete on the other. A reason which may be suggested for this inequality is that in the injury, some of the nervous fibrillæ of the cord may remain undivided, or but slightly compressed: and hence the continuity of innervation is not wholly interrupted.

The remarkable condition in which nerve function is not wholly annulled in parts below the spinal injury may be explained in yet another way, which, though a conjecture, seems to the writer not improbable. If one studies the sympathetic nervous cord, there are found to be numerous intercommunicating trunks which connect the sympathetic to the spinal cord. And through intercommunicating bands, in the case of rupture of the cord, there remains an indirect channel of connection and communication between the two portions of the spinal marrow. In such condition, the sympathetic cord may serve as a bridge across the breach. The plexus which is formed by converging trunks from separate points of the cord, and which distributes diverging branches, becomes a medium for the restoration of innervation through indirect routes: and through such by-path the nervous influence may find transit for itself. And, again, at the peripheral ending of nerves there may be intercommunication between filaments which arise from separate sections of the cord. And, finally, sensation may survive in the surface through some

special ganglion-like formation at the end of the peripheral filament.

As the limits of this work exclude a special consideration of the parts of the body below the neck, the remainder of this article will be confined to a short consideration of spinal fracture occurring in the cervical region.

Fracture in the upper part of the vertebral column occurs most frequently between the fifth cervical and first dorsal vertebræ, yet it may take place at any other point: and the most common causal agency is from forcible anterior flexion. The spinal marrow rarely escapes injury: yet the large caliber of the spinal canal, especially as one approaches the occiput, may screen the cord from injury, provided the displacement is slight or absent. In case the fracture originate from super-flexion, if there be displacement, this will consist of the upper segment of the column being carried forwards, beyond the one below; and thence must arise compression, laceration, or complete division of the spinal marrow.

The consequence of such injury will be different according to the amount of lesion of the cord: if the division of the latter be incomplete, the palsy arising will also be incomplete. The brachial plexus is formed by the commingling of the four lower cervical and first dorsal nerves: and should the origin of one or more of these nerves escape injury, then the tract to which the same is distributed, will escape paralysis. And according to Thorburn, who has studied this subject, such palsy may be in the scapular muscles of the upper arm, lower arm or hand, according as the injury is limited to the fourth, fifth, sixth, seventh, eighth or ninth nerve. And, hence, as examples of isolated injury of the motor and sensory endowment of the upper extremity, the following may be mentioned. Rupture of the cord between the fourth and sixth vertebræ will affect the power of elevation, flexion, abduction and supination of the upper arm and elbow; rupture above and near the sixth vertebra will interfere with the extension of the elbow: that is, it will palsy the triceps extensor cubiti. Rupture at the seventh vertebra will paralyze the extensors of the wrist; and if the injury be a little lower, the flexion of the wrist will be lost.

In consequence of the cilio-spinal center or nucleus of the innervation of the iris being located in the lower part of the cervical portion of the cord, injury of that part may disturb the normal movements of the pupil.

By far the most important nerve which originates from the cervical section of the spinal cord is the phrenic: its origin is from the fourth and fifth cervical nerves; and this corresponds approximately to the fourth cervical vertebra. A fracture below this point permits the continuance of life for at least a few days; but if the cord be broken above this, death is instantaneous. Hence the movement of the diaphragm, in case of spinal fracture in the cervical region, if unimpaired, denotes fracture below the fifth vertebra: if incomplete, it signifies probably fracture through the fifth vertebra. Many years ago, Marshal Hall visited a hospital to which the writer was attached; the learned neurologist was shown a patient who had recently fractured his spine in the cervical region: the physician, as the first step in the examination, passed his hand beneath the covering of the patient, and finding that there was free movement of the diaphragm, he remarked that the fracture was below the origin of the phrenic nerve; and the diagnostic acumen displayed, great for that period, awakened admiration among the young medical men who were present.

If the lesion should be in the thoracic region of the spine, besides the phrenic nerve, some of the intercostal nerves might be spared: and then, in breathing, besides the movement of the diaphragm by which the inspiratory act is normally accomplished, the movement of expiration might be aided by the intercostal muscles.

If the injury be so high that only the phrenic nerve escapes, then the normal inspiratory movement will be rhythmically made: the diaphragm descending, the lungs will be filled with air: but in this, the work of respiration is but half done; an equally important part remains to be accomplished, viz., the expulsion of the air: this is but imperfectly effected by the resilient movement of the compressed abdominal viscera forcing the diaphragm upwards; also by the elastic force inherent in the pulmonary structure, due to the muscular tissue which Moleschott finds that the lungs possess; and, lastly, there is some expulsive force exerted by the recoil of the uplifted walls of the chest. By these united forces, which are all of a passive character, the inspired air is only incompletely expelled. And, further, those acts of the body which require expiratory effort, cannot be performed. For example, the subject of such injury cannot cough; an attempt to do so is of a spasmodic character, similar to sneezing.

In case of fracture below the origin of the phrenic nerve,

besides the respiratory disturbance mentioned, there arise other serious troubles, which require description. In a few cases observed, the temperature was lowered; sometimes much below the normal standard; but, as a rule, the temperature rose, and has been known to reach one hundred and nine degrees Fahrenheit; and even an elevation of heat to one hundred and twenty-two degrees was seen by Teale; but probably there was an error in this observation, or its record.

The pulse may not vary much from normal in the early stage of the injury; but in the more advanced stage the pulse becomes accelerated.

The secretion of urine may be normal for a time: yet frequently, it is lessened in amount. Sometimes, from passive congestion of the coats of the bladder, blood escapes from the turgid vessels, and hæmaturia is present. In composition the urine remains normal for a period; later, it becomes alkaline.

As the bladder is palsied, it retains the urine and soon becomes excessively distended; and as a result, there is an increased excretion of mucus, that alters the constitution of the urine, which, in turn, reacts ill on the vesical wall. And these morbid agencies are soon reënforced by the appearance on the scene of rapidly multiplying bacteria. The power of voiding the bladder is entirely lost; and the urine continues to augment until the neck is forcibly dilated, and then the urine, from time to time, trickles away. And should such escape not occur, then the bladder slowly expands and rising into the abdominal cavity, resembles an immense cyst-like tumor. Though the timely use of the catheter may prevent such accumulation, still the urine usually becomes laden with mucus charged with ammonia, and is otherwise abnormal in composition; and then the walls of the bladder become the seat of changes similar to those of chronic cystitis. Inasmuch as the trunk is paralyzed, the patient is quite insensible to these conditions of the bladder, which in the non-palsied subject would be the source of indescribable torment.

These conditions of the bladder cannot continue without finally implicating the kidneys: the latter are impaired in function, and become trammeled in their work of depuration. The blood being imperfectly oxygenated and depurated is unable to maintain the tissues at their normal standard of vitality: hence the readiness with which parts slough when they are subjected to pressure. In the normal condition of the blood, the pressure though prolonged on the gluteal and dorsal structures, is toler-

ated; for example, in the phthisical patient such pressure will be endured for an indefinitely long time; while in the subject of fracture existing high in the spine, immense sloughing will soon take place. This tendency to sloughing from slight cause may find some explanation in the loss of sensory innervation of the parts: for, as is known, the sensory nerves have some agency in the nutrition of the tissues: verification of this is obtained in vivisective work in animals, or, its counterpart, in surgical work on man. In recent periods, when the surgeon's knife has invaded regions once considered impenetrable, the cranial cavity has been opened and the trifacial nerve has been severed for relief of facial neuralgia: and though the pain was thus extinguished, vision was lost through sloughing of the cornea.

An occasional accompaniment of spinal fracture is priapism; the patient has no consciousness of the condition: this erectile state is by no means a constant one: in nearly all the cases of spinal fracture seen by the writer, it was absent; and when present, the erection was imperfect; and it was rather one of passive congestion of the part, than of active priapism. The erectile condition rarely appears until the bladder has become distended with urine; or until the viscus has been irritated by the introduction of a catheter.

Through the weakened condition of the abdominal wall the normal compression is withheld from the bowels; and as a result of this, they become tympanitic. This tympanites interferes with the movement of the diaphragm, and disturbs the inspiratory movement of respiration; but, on the other hand, it promotes the expulsion from the lungs of the inspired air.

The sphincter muscles of the rectum are wholly palsied; and as result, there is no restraining action exercised by the bowel on its content. The anomalous state of the bowel presents itself, in which constipation and diarrhœa succeed each other, alternately. The fæcal content collects in the colon until the mass is so great that it descends by its weight; and when the hardened portion has passed out, the succeeding liquid material continues to escape for some time, similarly to what occurs in diarrhœa. The bowels unaided will move once or twice a week. And though sensation is absent in the parts, yet the patient is conscious of the accumulation of fæces through flushed face and headache.

As stated, cervical fracture above the fourth vertebra is quickly fatal, but in the region of the fifth, sixth, seventh or

eighth vertebra, death is not so immediate: but in such patients life is rarely prolonged beyond the fourth or fifth day. Hence vertebral fracture in the cervical region of the spine is an exceedingly grave injury, in fact, one of the most perilous that can befall the human body.

Though the injury be grave, its gravity may be increased if the patient be incautiously lifted or carelessly carried: for through such negligence, the incompletely ruptured cord may be entirely severed. Hence the subject of this accident should be lifted and placed on a stretcher or carrying appliance, which should be solid or unyielding. A broad plank seven feet long laid on two cross-bars will answer for such carriage. To place the patient on this, four assistants are necessary: viz., one to lift the lower extremities, two the trunk, and one to support the head. By such assistance, the patient is so lifted, that the spinal column is safely cared for, and no sliding nor displacement of the broken part can take place. If the plank mentioned be used for transporting the patient, the head should be somewhat supported by a pillow laid beneath it; and this support can be formed of the patient's coat, properly folded. The patient should be carried feet foremost: in the same manner as the wounded soldier is borne from the field. And thus carried, the subject of spinal fracture can have additional care from an assistant, who, following, places his hands on each side of the patient's head, and protects it from jostling. With these precautions, the patient is to be borne to the room where he is to remain during treatment. The next thing demanding careful attention is to prepare a proper bed for the patient. For this purpose, the bed used for the treatment of the fractured femur may be used: viz., the so-called fracture bed; but in place of the hair or straw mattress, the bed must have an air or water sack, upon which the patient will lie. This sack is made of India-rubber cloth, and is provided with an opening at one of its corners, through which air or water can be introduced, and retained there by a stop-screw. In case the injured patient can yet move himself, the air-couch is preferable to that of water; since in moving laterally on the latter, the fluctuating water may roll the patient out of bed. The writer knew of such an accident, in which the subject of spinal lesion was thus cast from the bed, and injuries received that finally ended life. It should be remarked that such ejection from the bed could more readily occur from a narrow, than from a wide one. And in the construction of the bed, provision should be made for lowering a

portion of it, so that a vessel for receiving excrement may be used as occasion requires. The bed may have other appliance or attachment, according to the plan of treatment which is pursued.

The bed being arranged, the patient must be removed from the stretcher to the bed: and the shifting from the carrying stretcher must be carefully done, the same assistants are needed, and the same precautions must be observed, as were used in placing the patient on the stretcher; one aid should lift and maintain the head at rest; two should support the trunk, and one should carry the lower extremities. The patient, being lifted by these assistants from the stretcher, is to be carefully laid on the permanent bed that has been made ready for him.

The prognosis of spinal fracture in the cervical region is inauspicious in the extreme: in fact, is fatal if the cord has been wholly divided; yet, as the extent of the wound is often indeterminable, no effort looking towards reparation of the injury should be neglected. The treatment may be classified under three headings, that of simple rest, mechanical, and operative.

The method of rest is to reduce the broken parts to normal position, and then to maintain the body as nearly motionless, as possible.

Should the lesion of the cord be a slight one, and the functional impairment arise from clotted blood which has been effused, then it is probable that absorption may occur, and the slight breach in the cord be repaired. Such repair will be tedious, since the disposition of the rhachidian vessels is far from favorable for restitution to integrity. And the dorsal position of the patient, disposing as it does, to hypostatic plethora of the injured part, is an agency which opposes recovery: in fact, renders complete repair scarcely possible.

This stasis of blood about the injury from dorsal recumbence has, probably, not been taken sufficiently into account; and the query arises, Would it be possible to avoid this by placing the patient in a prone, or nearly prone, position? There would certainly be many difficulties which would antagonize an attempt to pursue treatment in such position, yet the advantages which it would give in preventing congestion commend a trial of it. That such position can be tolerated is shown by the observation of Blandin, who announced, as early as 1845, that patients suffering from spinal disease can be treated in the prone posture, and though the position is uncomfortable at first, yet the patient soon learns to tolerate it.

One of the grave complications of spinal fracture is the supervention of sloughing of the parts subjected to pressure; attention should be given to this, and an attempt made to avoid it as far as is possible. For this purpose, continuous pressure of a part should be avoided by supports which will distribute the pressure, or take it from prominences which rest on the mattress. Besides this, the parts acted on may be given some resistance by washing them with alcohol, or with a weak solution of corrosive sublimate: viz., one part in one thousand. The part may be hardened by occasionally sponging it with Tinctura Gallæ; and it may be given a protective coating with the compound tincture of benzoin.

The evacuation of the patient's bladder is a matter which demands unremitting attention: the urine should be removed with a soft aseptic catheter three times in twenty-four hours. The removal of the urine in this way will prevent its decomposition, which otherwise would ensue. Despite these precautions, should the urine undergo alkaline putrefaction, then, beside the evacuation of the urine, there is the need of using means to purify the vesical cavity, and for this purpose a solution of boracic acid may be injected. For this purpose, one may also use simple boiled water, which has been slightly acidified with nitric or hydrochloric acid.

The bowels should be evacuated once in forty-eight hours; and this is best done by means of a stimulating enema; and for this purpose, the following mixture may be employed:—

℞. Ex. Sennæ Fl.
Glycerini ....aa ℥ss
Ol. Tiglii .. .. .gtt i
Misce.

And should this finally fail to act, the croton oil should be increased to two or three drops, in each injection.

The attentions to the skin, bladder and bowels which have been described, are applicable to, and demanded in, all cases, whether the patient be treated by simple rest, mechanically, or operatively.

In 1844, Hecker, from a study of the means then in use in the treatment of fractured spine, and the unsatisfactory results obtained, urged that some other method should be resorted to; and thus avoid the slow and agonizing death, in which such accident usually terminates. Hecker has some hope of a better

ending by the use of extension, which had been advised and practiced by Crawfoot. In the treatment of a few cases, Crawfoot obtained excellent results by fastening the patient's trunk to a bed, and then making traction on the feet. Hecker thinks such extension should be tried in all cases of spinal fracture: and this failing, he would trephine the spinal column at the site of injury.

The object of extension being to restore the broken column to normal line, the traction should be continued for some time in order to be effective: at least for two months, which is the average time required for the union of a broken bone. The work may be done on the water or air bed by means of weights and pulleys, with attachment at the feet. Before these retentive weights are applied, an attempt should be made to reduce the broken vertebræ to normal situation: and this can be accomplished by firmly holding and fixing the head, while traction is being made on the feet; or the traction might be made on both the head and the feet; and while such extension is being made, the surgeon may coöperate and control the adjustment of the displaced parts by pressing against the portion of the spine which projects and deviates from the normal line. This controlling work of reduction must not be overdone, lest the lesion of the cord may be increased.

Inasmuch as the paralyzed parts of the body will not tolerate compression without sloughing, there is a serious objection to attaching the appliance of traction to the palsied inferior extremities; therefore, it is better to do the work otherwise. For this purpose let the bed be converted into an inclined plane, sloping toward the feet; and then include the head in a fenestrated, halter-like helmet, which can be fastened to the head of the bed: or a cord attached to the head-gear can be passed over a pulley, and by means of weights, any degree of traction needed can be made. The head-gear here used is similar to that employed by the orthopedist for suspension of the body in cases of spinal curvature.

When the patient is treated in this manner, the body, tending to slide down the inclined bed, acts as an extending force, and maintains the broken parts in corrected position.

Another plan of treatment which has its advocates is to suspend the patient in the suspending appliance of the orthopedist, and having reduced the broken spine to integrity of outline and form, to enclose the upper part of the trunk in a gypsum

casement. In the application of the gypsum, care must be used not to compress the thorax: for it must be recollected, that in the high spinal fracture here under consideration, the ribs do not move actively, since the breathing is done by the diaphragm. A tightly-fitting gypsum casement would interfere with the action of the diaphragm, and render the breathing more laborious: in fact, the patient's life might be destroyed. Even in the healthy subject, it is perilous to encase the thorax tightly in plaster of Paris.

This was illustrated, a few years ago, in the application of gypsum to the trunk of a man for the purpose of making his bust. The man's trunk was incased in the plaster and he was left alone, for some time. The material hardened, and the case became smaller, so that the man could hardly breathe when found, and with difficulty he was rescued from his perilous position.

The subject of spinal fracture is so rarely cured by the methods which have been described, that from time to time, in the history of the injury, surgeons have sought to get relief through operative means: viz., to open down on the fractured spine, and thus uplift or remove the portion of the vertebra which compressed the cord. The early essays in this section of surgery, as a rule, resulted so unsatisfactorily, that such operations were rarely done; and, in fact, some recent authorities, discouraged by the frequent failure to cure by operating, do not advise it; for example, Burrell, of Boston, in 1887, discarding knife and trephine, advises to suspend the patient, and having thus rectified the displacement, he applies a gypsum cast. But in recent years, better results have been obtained, so that rachitomy, as the operation may be denominated, may now be said to have an accredited position among surgical operations; and this is justified by the statistics of White, who finds the results of twenty-seven operations to be the following: six entire recoveries, six incomplete recoveries, eleven cases in which there was no benefit from the operation, and fourteen patients who died soon after the operation: the result being a death-rate of thirty-eight per cent. Though the number of observations was too small to generalize from, yet the facts speak in favor of interference.

Among the early operators for spinal fracture was Potter, an American surgeon, who, in 1863, in a case of fracture in the cervical region, in which there was palsy of the upper and lower extremities, trephined and removed the arch of the fifth vertebra,

and the spinous process of the sixth one. The result was that the wound healed readily, and there was a slight return of motor function on the left side, especially in the left hand. The patient remaining in a helpless condition, three years afterwards, Potter operated again, and claims to have removed the fourth, fifth and sixth vertebræ. This operation afforded no relief, and it was discovered by it, that the ruptured cord had not healed. He operated in other cases of similar character, and obtained in one case, a complete recovery. He states that after the operation, the patients emaciated for some time, and remained thus temporarily; and later they regained and retained their flesh. The report of Potter's operative work is less extended than could be wished; yet enough was learned to justify further effort of the kind in a class of patients, who, otherwise, would remain hopelessly palsied.

In the case of fracture due to a blow or body striking the spine, that is, to direct violence, the indications for operating are more positive and imperative, since the causal agency, acting from behind on one or more vertebræ, would probably be limited to the spinous processes, or vertebral arches. In injury thus arising, the patient being placed in a prone position, and a longitudinal incision being made in the median line, the spinous processes can be reached, and, by means of a chisel or blunt dissector, separated from their periosteal and ligamentous investment; and if the injury be found to be limited to one or more spines which are broken and pressed into the spinal canal, then the operation could be completed by the simple removal of the loose spine or spines. If the fracture be more extensive, and involve the laminated wall of the canal at its side or pedicle, then a detached fragment may be removed, and the remaining part of the wall be uplifted and restored to proper site. A careful search for spiculæ should be made, and, if found, they must be removed. This work having been done aseptically, the wound may be closed by sutures, and dressed with lint saturated with a twenty-five per cent solution of alcohol. In injuries of the limited kind mentioned, healing of the wound will be obtained in a few weeks; but if the cord be injured to any extent, the patient may require a long time to recover from the motor and sensory disturbance which has arisen from the injury

In case the fracture has arisen from violent torsion, flexion or extension of the spinal column, then the injury is commonly more extensive than that which has just been considered; since,

besides fracture of the arch, the vertebral body may be broken; and, with the fracture, there may be displacement. In such injury two or more vertebræ may be implicated in the fracture.

The treatment, here, should commence with an attempt to restore the broken column to proper position by traction and counter-traction: in fact, the work to be done is analogous to that resorted to, to restore to position the fractured parts of a broken bone of the arm or leg; while traction is being done, the hands of the surgeon should be applied to the injured part, and coaptation accomplished as far as possible. When this work has been done, if the cord has merely been compressed, it is probable that the motor and sensory disturbance will disappear. Should such fortunate result follow the work of traction and coaptation, the remaining treatment will consist in retaining the patient in recumbence for a number of weeks; and, in this, the prone is better than the supine position.

The attempt to restore the broken vertebral column to normal form, will, owing to the conditions present, rarely bring relief; yet to passively fold the hands, and to commit the case to nature already overburdened, is most unsatisfactory. To make an effort, even though nothing is hoped from the attempt, is more satisfactory to the victim than idle abandonment of him. And there is the chance that by the exposure of the spinal column and exsection of a portion of one or more vertebræ, the work of traction and counter-traction may effect restoration to normal anatomical form.

In the operation here proposed, the patient should lie prone, and provision be made for traction and counter-traction, when the excision has been done. A longitudinal cut should be made to the spinous processes corresponding to the site of injury; the soft parts are then to be reflected laterally; and in this separation of these parts from the bones, the periosteum, as far as possible, should also be included and reflected laterally. By such preparatory incision, which should be ample in dimensions, the field is opened in which the broken vertebræ can be seen, and any work done on the latter which the character of their injury may indicate. For example, a lateral opening may be made with a trephine at one or more points, and the cord examined. And then with cutting forceps, enough of the wall may be removed to liberate the cord from all pressure. And should there be displacement of one or more of the vertebral bodies, it may be possible, by extending and counter-extending, to restore the displaced parts to normal position. The excision, as reported done

by some surgeons, seems to have included a large portion of one or more vertebræ: and such removal appears to have been readily tolerated.

In the reports of operative work done for relief in such injury, the dura mater was opened for the purpose of removing a clot of blood, or of restoring the continuity of the ruptured cord. After this has been done, the dura mater must be closed by means of fine catgut suture.

The work of rhachitomy being completed, the wound is to be closed, with or without drainage, as the conditions may demand. And should there be danger of displacement of the rectified spine, then immobilization may be done by means of a gypsum casement comprising the neck and the upper part of the trunk.

Instead of operating thus in the median line, the plan of a lateral incision suggests itself to the author in which an incision might be made to the spine between the transverse and spinous processes, and the canal being opened by the aid of a chisel, the spinous segment of the canal could be reflected towards the other side, and the cord having been liberated from pressure, the wound could be closed. The advantage of this procedure is that no bony structure would be sacrificed. For, despite the asseverations of surgeons that no ill consequence results from removing sections of one or more vertebræ, the avoidance of such sacrifice would evidently be one improvement on the usual method of rhachitomy.

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