It is collected in the northern part of Scio, whose political fate for centuries depended upon its importance, from cultivated (male) trees planted for the purpose, by making light incisions in the bark, through which it flows in little rounded tears, and on which it slowly hardens in the same shape. Two or three weeks after the tapping, the collectors revisit the trees and collect the little tears from the bark, and from the ground, to which some of them have fallen. This product is afterward sorted, according to whiteness, cleanness, and shape, into several grades, and so sold. The best of that which reaches us is in lemon-yellow tears, of the size of a large pea and smaller. The surface is smooth and free from dust, by which it is distinguished from the dusty tears of sandarac, and the fracture is clear and glassy. Odor and taste pleasantly terebinthinous; texture brittle, but softening in the mouth. Mastic contains one to two per cent. of *essential oil*, about ninety per cent. of *resin*, soluble in alcohol, and ten of another *resin* soluble in ether, but not in alcohol. Mastic is superior when fresh, and this is determined by its degree of plasticity when chewed and by its higher solubility (up to ninety per cent.) in benzol.

The medicinal action of mastic is exactly that of other turpentines, although, perhaps, on a sightly milder scale than the most active of them; that is, it is a local and renal stimulant. It has been, and still is, in the East, employed as a sort of dentifrice, and as a temporary filling for carious and aching teeth. Out of respect to old tradition it is still used in the *Pilulæ Aloës et Masticheś* of the Pharmacopœia, which are one-sixth mastic. It is claimed that the addition of the mastic increases the certainty and promptness of action of the aloes, as of other cathartics.

Oil of mastic, of a clear yellow color, having a specific gravity of 0.858 and the characteristic odor of mastic, is an article of commerce.

Allied Product.—*Pistache* or *Pistacia Nuts* are the seeds of *Pistacia vera* L., obtained chiefly from trees cultivated in the Mediterranean region. This product has no medicinal properties, but is extensively used as an article of food or flavoring by confectioners, in *bonbons* and ices. An emulsion may be made by pounding the seeds with sugar and water, after the manner employed with almonds. This can be used as a pleasant vehicle for more active substances. *Henry H. Rusby.*

MASTICATION.—In order that the digestive juices may act rapidly and efficiently upon the solid food, it is necessary that a large surface should be exposed to their action; otherwise the time of digestion is lengthened and the large lumps of solid matter disturb digestion both by undergoing decomposition and by acting as mechanical irritants to the mucous surface which lines the alimentary canal. The necessary comminution is brought about in the process of mastication by the action of the jaws armed with their various types of teeth, and assisted by the muscular action of the buccinators and tongue.

In addition to being thoroughly subdivided by mastication, the food is intimately admixed with the saliva which is poured out upon it during the process, and so is converted into soft semi-fluid mass which can easily be swallowed. It has also been recently shown by Pawlow, that efficient mastication, in some reflex fashion, greatly promotes the secretion of gastric juice and so favors peptic digestion. For the quantity of gastric juice secreted is not nearly so great when food is introduced into the stomach through a gastric fistula as when in the same animal it is chewed and swallowed in the natural fashion. Further, in an animal with both an œsophageal and a gastric fistula, in which the food drops out at the œsophagus, after being masticated and swallowed, so that none reaches the stomach, it is found that mastication produces a copious flow of gastric juice.

For these reasonsit is obvious that efficient mastication is a great adjunct to the process of digestion, and, although for a time the digestive juices may be able to digest the solid food, even when mastication is defective and the food is swallowed in lumps, yet such a defect in the preparation of the food handicaps the forces of digestion and paves the way for commencing a vicious condition of affairs which may go from bad to worse unless the mastication of the food be improved.

The mouth and not the stomach is, therefore, the first ground which ought to be examined in cases of indigestion, and after that has been, from the mechanical point of view, set in as good order as under the existing circumstances is possible, then the habits of mastication ought to be investigated, and the vicious practice of eating in a hurry and bolting the food in a semi-masticated condition should be eradicated.

It is interesting to observe, as was first pointed out by Cuvier, that a constant relationship exists in different classes of animals between the nature of the food, the form of the teeth, and the articulation of the jaw. Thus, in typical carnivora the teeth are adapted for seizing and lacerating the food, there are no true grinding teeth, and accordingly there are no grinding movements of the lower jaw, which articulates by a simple hinge joint. In herbivora, on the other hand, the nature of the food is such that extensive pounding and grinding are required, and hence the lower jaw is so articulated as to allow of extensive sliding movements from side to side. In this connection, it may be stated that the articulation of the lower jaw in man, not less than his dental series and intermediate length of alimentary canal, demonstrates that he has developed as a mixed feeder capable of masticating both vegetable and animal food, and that a mixture of such foods is his natural provender.

The act of mastication is usually described as a voluntary one, but while this is true in the sense that our eating is under the control of our will, and that we can initiate and arrest the process by acts of volition, still it is well to point out that, like all complex co-ordinated muscular acts, the process is largely a reflex one guided from lower centres, chiefly by an adjusted co-operation of afferent and efferent nerves. Complicated co-ordinated actions of such a type are learned and laid down in the central nervous system in early infancy, and at a conscious age all their details are practically out of the control of the will, so that we walk, talk, and eat without consciously exerting the will over the details of these processes. This has a very practical bearing in regard to mastication, as it gives an explanation of the difficulty attending a reform of the acquired habit of hasty mastication. It is a simple thing to tell a patient who complains of indigestion not to bolt his food, but to eat it slowly, carefully masticating each mouthful, and, if necessary, counting so many before swallowing. But the process has become almost a reflex, and the patient finds the advice, even with all artificial aids, most difficult to carry out; he has to keep his thoughts chained upon the problem all the time he is eating, which to many persons is an impossible task, and so at intervals he unconsciously lapses into bolting his food. Again, when some relief has been obtained and urgency has hence been removed, he no longer can keep his mind at work regulating his eating, and once more the old habit or old reflex becomes established. The problem, in fact, is nearly as difficult as that of breathing at an artificial rate, or altering the depth of the respiratory movements.

The afferent nerve chiefly involved in mastication is the fifth, while the efferent or motor impulses travel by the motor root of the fifth to the elevators of the jaw and the mylohyoid, by the facial to the digastric and the muscles of the lips and cheek, and by the hypoglossal to the muscles of the tongue.

In considering the mechanism of the process of mastication, it must be remembered that the action of the cheek muscles and tongue in replacing the food between the teeth after each movement of the lower jaw is quite as essential as the jaw movements themselves, since otherwise the jaw movements would be entirely useless. This is demonstrated by the fact that in bilateral paralysis of the tongue, of either sensory or motor type, mastication becomes almost impossible, and also in paralysis of the buccinator muscle, accompanying facial paralysis, the

food accumulates in a pouch on the side of the flaccid buccinator, from which it must be removed from time to time by the pressure of the hand applied to the cheek.

The mechanism of action of the tongue and cheek muscles in mastication is carried out in the following manner: By each chewing action of the lower jaw, whether it be an upward movement closing the jaws or a grinding lateral movement, the food is subjected to pressure by the teeth from above downward and to muscular pressure produced on the inner margin by the tongue and on the outer margin by the buccinators. The jaw pressure is the more powerful of the two, and hence the portions of food lying immediately between the teeth, after being bruised, crushed, or divided, are thrust on each side into the regions of less pressure, that is to say, either between the tongue and palate or into the pouches of the cheeks. Then the lower jaw is dropped, and by the contraction of the buccinators on the one hand, and the pressure of the tongue toward the hard palate on the other, the food is restored again to its position between the teeth, in readiness for the next action of the teeth upon it.

The tongue is moved forward by the genioglossus and its transverse intrinsic fibres, and retracted by the hyo-, palato-, and styloglossi. Lateral movement is aided by contraction of the intrinsic longitudinal fibres.

The movements of the lower jaw may conveniently be described as consisting of two types, although any given movement of mastication usually is a complex of the two types, co-ordinated or combined with each other in varying proportion. Movement at the condyles may either be effected as at a simple hinge joint, giving as a result merely an up-and-down movement of the lower jaw such as occurs in speaking; or the condyles may be moved backward or forward on the interarticular cartilages, so causing a gliding movement of the lower jaw. Moreover, in the second type of movement, the extent of movement may be different at each condyle or even performed in an opposite direction, namely, forward at one condyle and backward at the other, so giving rise not to simple backward or forward gliding movements but to combinations of these with lateral gliding movements. It is this kind of movement by which the grinding action of the molar teeth is brought about, and it is hence seen typically in ruminants; while the simple up-and-down action is seen in the "biting off" action of the incisors, and piercing action of the canines; this is hence the typical action of the carnivorous jaw.

The share taken by the various muscles in bringing about these movements may be apportioned in the following manner; but it must always be remembered that any movement is in most cases a resultant of the action of nearly all these muscles called forth in varying degree, in some cases in the direction of increased tonicity or contraction, and in other cases of diminished tonicity or relaxation: The lower jaw is raised by the action of the temporal, masseter, and internal pterygoid muscles; it is lowered, chiefly passively, by the action of gravity, but this is probably normally aided by the contraction of the anterior belly of the digastric, and in forced depression also by the mylo- and geniohyoid muscles. Forward movements are effected most powerfully by both pterygoids acting in concert, while if these muscles act on one side only, that side is drawn forward round the opposite condyle as an axis, thus causing lateral movement toward the opposite side. The *external* pterygoid possesses only this lateral action, and acting alone can, from the direction of its fibres, neither raise nor lower the jaw; but, as stated above, a certain component of the force of the *internal* pterygoid acts as an elevator of the jaw.

The posterior position of the jaws, in which the lower incisors lie behind the upper, and the condyle of the jaw rests in the glenoid cavity, is the natural one of stable equilibrium toward which it returns on account of the elasticity of its attachments when the pterygoids cease to pull upon it; but the posterior fibres of the temporal and masseter muscles tend to draw it backward. The anterior fibres of the masseters, in addition to their main action of elevating the jaw, have also a small forward component. *Benjamin Moore.*

MASTOID OPERATIONS.—Indications for Opening the Mastoid Cells.—There is no single symptom, local or general, which, considered by itself, will lead the surgeon to say positively that the mastoid cells ought to be subjected to a direct investigation. The decision to take this step will have to be reached by a careful consideration not only of the history of the case and of the actual conditions revealed by the ordinary examination of the ear and its surroundings, but also of the kinds of micro-organisms found by the bacteriologist in the discharge that escapes from the middle ear. If the services of the latter were more often called into requisition by the surgeon, to aid him in determining whether or not he should open into the mastoid process, it is highly probable that operative interference would be resorted to earlier and with greater confidence, as well as in a much larger number of instances, than is now the case. In corroboration of this statement I have only to say that the knowledge that the specially virulent streptococcus, and not the staphylococcus or the pneumococcus, is the infective agent, in any given case of suspected mastoid involvement, will remove from the minds of most surgeons any remaining doubts in regard to the wisdom of resorting to an operation. The most constant and the most indicative symptom of the purulent involvement of the mastoid process is a *very profuse and creamy discharge of pus* from the middle ear associated with a *prolapse of the posterior and superior cutaneous wall of the external auditory canal near the drum membrane.* But there may be serious involvement of the mastoid cells even when these associated symptoms are entirely absent. Thus, for example, I have seen at least two cases in each of which the discharge had stopped for a period of between two and three weeks, the perforation had healed, and the drum membrane presented a practically normal appearance; and yet in each of these cases the mastoid portion of the temporal bone was found to be extensively diseased In one of the patients there was neither pain in the region of the ear nor tenderness on pressure over the mastoid process. Nevertheless, pus had accumulated beneath the mastoid periosteum, the pulse was increased in frequency, and there were occasional elevations of temperature. In the second case referred to above, marked mastoid tenderness was present. An operation was performed in both instances and it was found that in each case the mastoid cells were filled with pus, and that, in addition, large extradural abscesses were present—the abscess, in one case, extending beyond the occipito-mastoid suture.

A very frequent and very prominent symptom is *tenderness on pressure* over a whole or a part of the mastoid process. The tip is the most frequent site of this tenderness and the area over the antrum comes next. When the tenderness is most marked back of the mastoid tip it is very likely that we are dealing with a case of perisinous abscess. Another point where mastoid tenderness is to be detected is upon the posterior surface of the wall of the external auditory canal. If the case is a recent one this tenderness on pressure may not be very significant; but if it persists, especially after the use of the ice coil for thirty-six hours, then it is time for the surgeon to invade the mastoid cells. The difficulty is, that this symptom is frequently absent even in a case of well-marked mastoiditis. A differentiation will have to be made between tenderness on pressure due to mastoiditis and tenderness due to a furunculosis of the external auditory canal. The history of the case will be of service in reaching a conclusion. If mastoiditis is present, there will generally be a history of pain followed by a discharge; the active pain then ceasing. Then besides, as the canal is generally found to be sufficiently open for the observer to obtain a view of the drum membrane, he will be able to see the pus oozing through a perforation. On the other hand, in a case of furunculosis of the external auditory canal the pain does not diminish but rather

increases, the canal is stenosed, there is little or no discharge, and, with the aid of a probe, a localized area of tenderness may be detected at some point on the wall of the external auditory canal.

In using pressure as a means of detecting mastoid tenderness it is important that this pressure should be firm and steady. It is also advisable to test

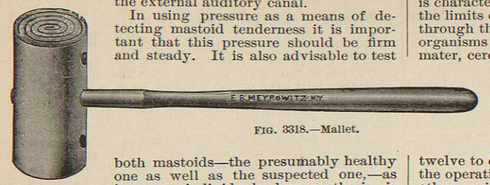

FIG. 3318.—Mallet.

both mastoids—the presumably healthy one as well as the suspected one,—as in some individuals hyperæsthesia is marked, and one may find as much tenderness on pressure over the healthy mastoid as over that which appears to be involved.

Pain which is located in the mastoid process or its vicinity, and which persists despite free drainage, is another diagnostic symptom of mastoiditis. Still another is to be found in *hyperæmia and œdema of the skin covering the mastoid process*. When this is found in a case in which furuncular inflammation of the external auditory canal is not present, it is time, in the vast majority of instances, to operate. The only exception is in those cases in which this symptom manifests itself very early in the disease (the second or the third day). As a rule, however, hyperæmia and œdema develop at a relatively late stage of the disease, and when they are present the signification generally is that the case has progressed very rapidly, or that the mastoid cortex is quite thin, or that the operation has been delayed beyond the period of safety. Extension of the inflammation into the soft parts of the neck generally means that a perforation through the inner table has taken

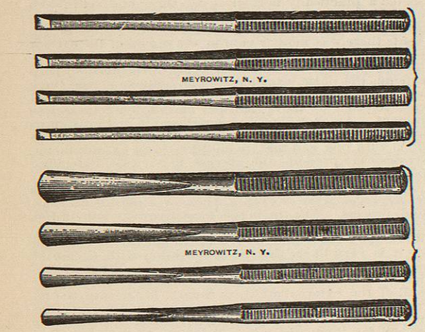

FIG. 3319.—Mastoid Chisels and Gouges.

place. It may also signify a similar perforation through an unusually thin bony wall of one of the large cells at the tip of the mastoid process.

If the *temperature* remains high or is of a septic type, the operation ought not to be delayed.

Finally, it must be remembered that there are cases of well-marked mastoiditis in which all of the symptoms mentioned above may be absent.

A good rule to follow, in all cases of mastoiditis, is—"when in doubt operate"; never wait for redness and swelling over the mastoid. While the operation is one that requires skill and is not to be lightly undertaken, yet it is also one that if properly performed is practically devoid of danger. On the other hand, the disease itself is characterized by a decided tendency to spread beyond the limits of the mastoid process. It may force its way through the inner table of the skull, and the pyogenic organisms may reach the sigmoid sinus, dura mater, pia mater, cerebrum, or cerebellum, there to set up a septic sinus thrombosis, a pachymeningitis, an extradural abscess, a leptomeningitis, a cerebral or a cerebellar abscess. A disease which carries such deadly possibilities within itself is a disease not to be trifled with.

PREPARATION OF THE PATIENT.—If the exigencies of the situation are such that from twelve to eighteen hours may be allowed to elapse before the operation, the patient should be prepared as for any other major operation. The bowels should be thoroughly evacuated, the healthfulness of heart, lungs, and kidneys ascertained, and the patient should be without any food in the stomach for a period of, at least, six hours before the administration of the anæsthetic.

The hair, for a considerable extent in the vicinity of the mastoid process, should be shaved and the underlying skin surface, as also the auricle, rendered aseptic by cleansing with tincture of green soap and warm water, alcohol, and a 1 to 1,000 bichloride-of-mercury solution, and then covered with a moist bichloride of mercury (1 to 3,000) dressing.

The external auditory canal, which is, as a rule, serving as a drain for the pus flowing from the tympanic cavity, should be irrigated with a bichloride-of-mercury solution (1 to 3,000) sufficiently often, during the interval between the application of the moist dressing and the time of operation, to keep it fairly free of pus. After each irrigation a wick of sterile gauze should be inserted into the canal and a fresh external dressing applied.

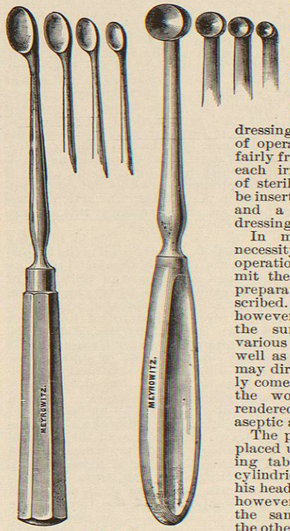

FIG. 3320.—Curettes.

In many cases the necessity for immediate operation will not permit the making of the preparations just described. In all cases, however, the patient, the surgeon, and his various assistants, as well as everything that may directly or indirectly come in contact with the wound, should be rendered as thoroughly aseptic as possible.

The patient should be placed upon the operating table with a hard cylindrical pillow under his head. (This pillow, however, should be of the same thickness as the other cushions which cover the table, as it is not desirable that the head should be elevated above the level of the shoulders.) A piece of india-rubber sheeting, large enough to extend well over the shoulders and chest of the patient and below the cushions of the table, should be

securely fastened about his neck. This sheeting should be covered with towels which have either been wrung out in a bichloride-of-mercury solution or have been subjected to dry sterilization. The unshaved portion of the head should be carefully wrapped in a moist bichloride-of-mercury towel.

It matters not how simple the case of mastoiditis about to be operated upon may appear, the surgeon should at

FIG. 3321.—Retractor.

all times be prepared, if such a step should be found necessary, to open the sinus and excise the jugular vein for a sinus thrombosis, or to trephine the skull and explore the brain for a cerebral or a cerebellar abscess. He should have for the operation a scalpel, a rawhide or lead mallet (Fig. 3318), chisels and gouges (Fig. 3319), scissors curved and flat, a periosteal elevator (Fig. 3326), curettes (Fig. 3320), retractors (Fig. 3321), rongeur forceps (Figs. 3322, 3323, 3324, and 3325), artery forceps, dressing forceps, silver probes, aneurism needle, a trephine, an infusion apparatus, an irrigation bottle, needles, catgut for ligatures, silkworm gut for sutures, iodoform gauze in bulk and also in strips one-half inch and one inch wide (Nu gauze, with selvedge edge, as prepared by Johnson & Johnson, has the advantage of not unravelling), dry sterile gauze handkerchiefs and sterile cotton for dressings, bandages two inches wide, also dry sterile gauze sponges.

THE SIMPLE MASTOID OPERATION.

Each surgeon will have his own preferences as to minor operative details. I prefer to stand at the head of the table, near its right-hand or left-hand side, according to whether it is the right or the left ear which is involved. The anæsthetist stands in front of the patient's everted face; the second assistant, who manages the retractors and holds the artery forceps out of the way, stands between the anæsthetist and myself; while the first assistant, who sponges and seizes bleeding vessels, stands on my other side. The instrument table with the attendant nurse is within my convenient reach.

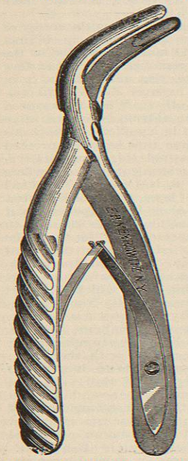

FIG. 3322.—Whiting's Rongeur Forceps.

Narcosis.—My preference is for nitrous oxide gas followed by ether, as used by Dr. Bennett, of this city (see Vol. III., p. 9). In cases of suspected brain abscess in very young children, in kidney complications, or when œdema of the lungs is to be feared, chloroform is to be preferred. Schiebe reports six cases in which local anæsthesia (ethyl chloride) was employed, in five of which cases it gave good satisfaction. Berens, of New York, operated successfully in one case with orthoform anæsthesia.

As a preliminary step to the operation the drum membrane should be incised, if a free opening does not already exist in it, and a strip of iodoform, or of plain sterile gauze, should again be inserted into the auditory canal.

The first incision is made by inserting the point of the knife, held vertically to the tissues, over the tip of the mastoid process and carrying it through the periosteum to the bone; the handle should then be lowered so that the curved edge of the blade does the cutting; and the incision itself should be carried, in a direction parallel to the insertion of the auricle and about 5 mm. from it, to a point directly above the external auditory canal (see Fig. 3327, *A D B*). In adults the scalpel should cut through the periosteum with the first incision, but in the case of children it is not safe to do this, for the reason that in them the cortex of the mastoid process is so thin that the knife might easily pass through it and so wound the underlying sigmoid sinus or the dura mater. In cases in which the mastoid process is large, it will be necessary to make a second incision (Fig. 3327, *D E*), extending horizontally backward on a level with the external auditory canal and at right angles to the first one. In still another group of cases it may be necessary to extend the first incision horizontally forward (Fig. 3327, *B C*), a short distance in front of the anterior insertion of the auricle.

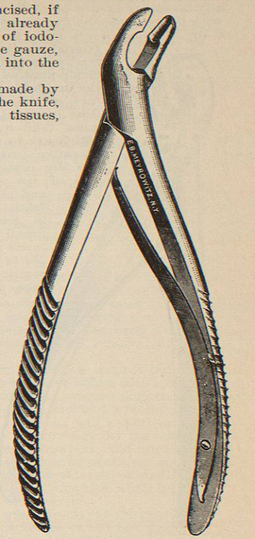

FIG. 3323.—Bacon's Rongeur Forceps.

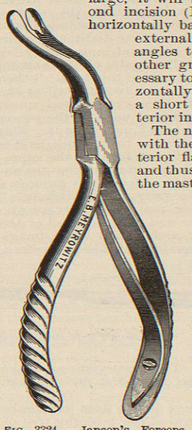

FIG. 3324.—Jansen's Forceps for Removing Posterior Canal Wall.

The next step is to push backward, with the periosteal elevator, the posterior flap including its periosteum, and thus expose the greater portion of the mastoid process. In a similar manner the anterior flap and its periosteum are to be pushed forward for the purpose of exposing the posterior and superior borders of the external auditory canal and the root of the zygomatic process. In separating the periosteum from the bone, great care should be taken to avoid wounding the former.

Our next procedure is to control all bleeding by means of artery forceps. After this has been accomplished a retractor is placed in position so as to hold forward the anterior flap, and another is placed to hold backward the posterior flap. It is gener-

ally necessary at this point in the operation to extend, with the scissors, the first incision downward for about 8 or 10 mm. Then with the blunt-pointed scissors, curved on the flat, we separate the tendinous insertion of the sterno-cleido-mastoid muscle from the tip of the mastoid process. The bony surface of the mastoid process having thus been fully exposed to view, we must take notice of the landmarks which are to guide us in our further operative procedures. First, we notice the posterior and superior margins of the external auditory canal and at their juncture a little fossa, the *supramastoid fossa*, in front of which is to be found a small spine, *spina supra meatum*, or the *spine of Henle*. The supramastoid fossa presents a sieve-like appearance, due to the presence of several vascular foramina—the *vascular zone*, or, as it is called by some authors, the *spongy spot*. At times these vascular foramina dip down into the underlying cells, the lining mucous membrane of which comes almost in contact with the external periosteum, and so renders the passage of pus from these cells to the surface of the mastoid easy. This fossa is situated exactly at the level of the mastoid antrum. From infancy to adult life its position changes. In infancy it is above the meatus, from which point it gradually moves downward and backward in a circle concentric to the auditory meatus until, in adult life, it is to be found immediately behind the suprameatal spine. The centre of the antrum in infancy is slightly above and behind this fossa; it then gradually passes downward and backward until at the age of ten it is directly back of the suprameatal spine, from which point it passes backward until, in the young adult, it reaches a distance of about 7 mm. from it. This fossa is our most important guide to the antrum, as it is always present, whereas this is not true of the suprameatal spine, which changes its position, as does the antrum, from infancy to adult life. Macewen's guide is a triangle, which he terms the "supramеatal triangle," formed above by the posterior root of the zygomatic process, below by the superior and posterior wall of the bony external auditory canal, and behind by an imaginary line connecting the extremities of these two lines.

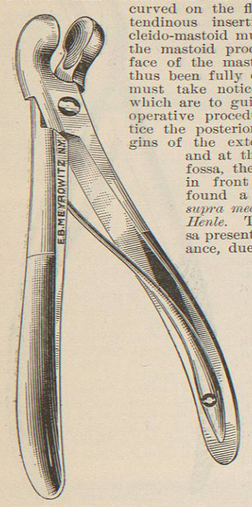

Fig. 3325.—Mathieu's Rongeur Forceps.

Fig. 3326.—Langenbeck's Periosteal Elevator.

In early life the non-existence of the posterior root of the zygomatic process renders this guide less positive than the one mentioned above.

The next landmark to observe is the linea temporalis which is the extension backward of the posterior root of the zygomatic process. This is an important guide, as it fairly accurately indicates the level of the floor of the middle fossa, the latter being more often a little below, instead of a little above, this line. Before beginning the operation it is well to call to mind the anatomical structures which are to be avoided. The floor of the middle cranial fossa is, as I have stated above, fairly easily avoided by not removing any bone above the line of the temporal ridge. Another very important structure which should be borne in mind is the lateral sinus. This structure is very variable in its relation to the mastoid antrum, its position varying, according to Lake (*Journal of Laryngology, Rhinology, and Otology*, vol. xiii., p. 231), from 0.2 inch (5 mm.) to 0.7 inch (about 17 mm.). On an average it is situated at a distance of 0.48 inch (12 mm.) from this cavity. The sinus is more superficially situated than the antrum; on the right side it extends, as a rule, more forward than does that on the left side.

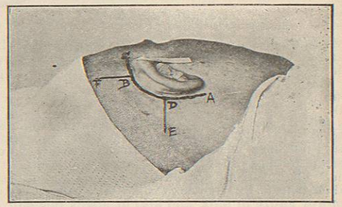

Fig. 3327.—Shows the Patient Prepared for Operation and the Various Incisions. *A D B*, Line of incision close to auricular fold—the only incision necessary in most cases of simple mastoiditis; *D E*, the posterior incision necessary in cases with a large mastoid process, in sigmoid sinus thrombosis and in intracranial complications situated in the posterior fossa; *B C*, extension of first incision necessary in the radical operation, the Stacke operation, and in intracranial complications in the middle fossa; *B F*, additional vertical incision necessary in cases of intracranial complications in the middle fossa. (The strip of adhesive plaster is used merely to hold the auricle forward so as to show the line of incision.)

In infancy the depth of the antrum from the cortex of the mastoid process varies from 2 to 4 mm.; in children it has been found as deep as 11 mm. In adults, on the other hand, it is much farther removed from the surface of the bone. Thus, Broca states that he has found it, in two very old subjects, at the extreme depth of 25 mm. in one case, and 29 mm. in the other. When the surgeon encounters a case in which the antrum is located at an unusual depth, he must persist in his efforts to reach his objective point, but at the same time he must proceed with caution. In pneumatic mastoids this is comparatively an easy thing to do, but in chronic conditions, where sclerosis has taken place and it is necessary to chisel through a hard compact mass of bone, to proceed requires the determination which comes alone from experience and from the knowledge that the antrum does exist and is to be found. The antrum is connected with the tympanic cavity by a canal—the *aditus ad antrum*; this canal is from 3 to 5 mm. long, 3 mm. high, and 3 or 4 mm. deep. Its upper wall, the *tegmen tympani*, forms part of the thin plate which separates the tympanic cavity from the cranial cavity; at times it is wanting. The mucous membrane and endosteum lining the tympanum are in close contact with the underlying bone, and hence in purulent inflammations of the tympanum caries and necrosis readily occur. In view of the fact that the tegmen tympani and the tegmen antri are very thin, or may even be wanting, it is a source of wonder that abscess of the middle or of the posterior portion of the temporo-sphenoidal lobe does not more often occur.

Two very important structures, it must be remembered, are in close relation to the aditus ad antrum,

namely, the *facial nerve*, and the *horizontal semicircular canal*. The facial nerve is the most important structure to be avoided in all mastoid operations. There are two places in its course where it is most likely to be exposed to injury in operative procedures around the mastoid. The first point is situated in the horizontal portion and elbow of the facial canal, where it passes under the aditus ad antrum. When the nerve is wounded here it is generally due to the careless use of the curette when employed for removing granulations from the epitympanic space. The second point where the nerve is liable to injury is near its exit from the stylo-mastoid foramen. It is apt to become involved at this point in those cases which are spoken of as instances of Bezold's perforation—cases in which perforation of the inner table or anterior surface of the mastoid process takes place. The nerve is also apt to receive damage at this point in infancy, because the undeveloped condition of the mastoid process leaves the stylo-mastoid foramen more exposed upon the lateral surface of the bone than is the case in adult life.

The only part of the internal ear which is apt to be encountered in operative work is the horizontal semicircular canal. This canal, which is surrounded by an eburnated sheet of bone and is situated just behind the inner wall of the aditus ad antrum, is rarely injured. In order to avoid injuring it, one needs only to be careful not to curette the inner wall of the aditus ad antrum.

The short process of the incus is another part which bears some relation to the aditus ad antrum; it rests upon the floor of this canal at its tympanic end.

The surgeon having recalled to memory the various landmarks and the relations between the structures which he expects to invade and those which he must avoid, is now ready to proceed with the bone operation. As the first step, he should remove, with the chisel, a square of bone, the sides of which should each measure about 7 or 8 mm. in length. The anterior superior angle of the shallow excavation (2 or 3 mm. in depth) thus made should include the supramеatal fossa. When in use the chisel should be held at an acute angle to the bone surface and it should be so firmly grasped that, should the cortex of the bone prove thin, the chisel will not plunge too deeply into the underlying structures. If the mastoid is of the pneumatic type, the removal of this square of bone will probably bring into view its cellular structure. As soon as this has been effected, I prefer, as the next step,—instead of continuing to work a passage down into the antrum,—to remove the cortex along the anterior border of the mastoid process as far down as its tip. From the vertical groove thus established I proceed, with chisel and rongeur forceps (chiefly the latter), to remove the remaining cortex of the mastoid process. The chisel is then set aside, and, with curette and forceps, I remove each dividing cell wall of the whole mastoid structure until the cells are entirely obliterated and the inner plate of the mastoid process is reached. This thin plate of bone, as will be remembered, is the only structure which separates the sinus and the dura of the posterior and middle cerebral fossæ from the pit made by the removal of the mastoid cells. If, upon careful examination, it shows evidences of being diseased, or if, though it should appear to be healthy, the history of the case should warrant the suspicion that pathological conditions exist in either of these fossæ, or that the lateral sinus is involved, this plate of bone must be removed to permit of a thorough examination.

If it should appear to some that the plan here advocated, of removing all the mastoid cells, is unnecessarily thorough, I will call their attention to the fact that unless these structures are completely eradicated, some remote cell with its nidus of infection may be left behind, and then, weeks later, when the wound is still open, although apparently well on its way toward healing, we are forced to conclude, from the unsatisfactory manner in which the case is progressing, that we did not do our work thoroughly, and that the operation, with all its attendant dangers and worries, must be performed a second time. It is surprising to note how often, in the course of a mastoid operation, one encounters—at some point quite remote from the antrum and separated from it by other cells which to the unaided eye appear to be fairly normal, or at all events free from the presence of anything like purulent material—a single cell filled with pus. Such a discovery is apt to be made among the cells situated in the posterior portion of the tip of the mastoid process, and occasionally also among those located in its upper and posterior portion.

As even the complete destruction of the distinctive mastoid (*i.e.*, pneumatic) cells cannot be trusted to eradicate all the sources of infection, it is advisable, in addition, to obliterate all the cellular structure located above the external auditory canal and at the root of the zygomatic process, as well as that which lies partly between the antrum and the knee of the lateral sinus, and partly at a still greater depth (*i.e.*, nearer the centre of the skull).

Finally, it will generally be found best to remove the entire tip of the mastoid process, instead of leaving, as is often done, its inner surface, which serves no useful purpose. In course of time the sterno-cleido-mastoid muscle forms new attachments, and I have never seen a case in which the muscular movements of the head were at all interfered with as the result of the removal of this plate.

In carrying out the operation in the manner here described, the surgeon will always have before him a broad and open field in which there are no obscure pockets. If he chance to wound the sinus—an accident which is generally the result of undue haste—he will experience no difficulty in controlling the hemorrhage by the simple application of an iodoform gauze tampon; and afterward he may proceed with the operation by working around this tampon—a procedure which could not so readily be carried out if the sinus had been wounded while he was working at the bottom of a deep cavity.

It is important to use the probe freely, as the operation proceeds, so as to ascertain whether or not the granulations are lining a bony cavity or are springing from the dura mater or sinus and protruding into the mastoid cells through an opening in the inner table. Unless this precaution is taken, it is easy, while using the curette, to wound the exposed dura mater or to plunge into the sinus. The probe should also be used for the purpose of searching most carefully for the existence of any possible sinus, which may lead through the inner table into either the middle or the posterior fossa. If such a sinus is found to exist, it should be enlarged sufficiently to permit of the easy examination of the underlying tissues. This careful investigation is absolutely necessary, for it is by means of such a thorough probing that many a case of unsuspected perisinous abscess, or of extradural abscess, has been discovered.

In cases of perforation through the posterior wall of the external auditory canal this bony partition will have to be removed to a limited extent and the adjacent soft tissues carefully curetted. It is rarely necessary, in acute cases, to remove that portion of the posterior wall which includes the tympanic ring.

If the mastoid process is one that contains few pneumatic cells, the surgeon, in performing the operation, must adopt a course somewhat different from that which I have advocated above; he must first search for and find the antrum, and then from this point he should work toward the tip and posterior portion of the mastoid process until this process has been fully excavated. Such thorough excavation is as necessary in these cases of sclerosis as it is in those first described, for in this type of mastoid a large cell is often found remotely situated from the antrum, and yet filled with pus. In fact, I have operated upon cases in which, while the antrum and adjacent cells were apparently free from purulent matter, a cell located posteriorly and near the tip has been found to be full of pus.

In cases in which a perforation has already taken place spontaneously in the cortex of the mastoid, the use of the chisel is unnecessary; the surgeon may begin at once with