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DISEASES OF THE EAR, NOSE AND PHARYNX.

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A TEXT BOOK

OF THE

DISEASES OF THE EAR NOSE AND PHARYNX

BY

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PREFACE.

THIS text-book is intended to assist practitioners and students of medicine to study and treat diseases of the ear. Inasmuch as a large proportion of the affections of this organ, are secondary to or coincidental with those in the naso-pharyngeal region, the diseases of the nose and pharynx, which may cause aural disease, are included in our work and very carefully described. We have also endeavored to give due relative importance to the varied conditions in which an ear may be said to be diseased, whether this causes danger to the hearing only, or to the life as well. An immense advance has lately been made in the recognition and thorough treatment of acute and dangerous affections of the middle ear, requiring operative treatment. But there has not always been, according to our views, proper stress laid upon the simpler affections which usher in the operative cases, and which are, in a very large proportion, susceptible of relief and cure, before the danger-line of serious disease is reached.

While the authors are warm advocates of thorough treatment, in all cases, according to the necessities of the moment, this book is conservative, to the extent of endeavoring to teach not only how to perform the surgical operations necessary for certain forms of acute aural diseases, but also how to treat acute affections, in the early stages so as to avoid an operation when possible.

This work is essentially a new one, but the senior author has not hesitated to repeat some of his former writings, now not accessible, except in libraries, and to incorporate them in this volume. The progress of aural science has allowed of very many omissions of what was formerly necessary in text-books on the ear, because the general knowledge of the profession in aural diagnosis and therapeutics, has so increased, that many subjects no longer require that detailed discussion, with the history of cases, which was necessary when Otology was in its infancy. The recent proper estimate of the relation between the nose and the ear, has led us to endeavor, not merely to place these subjects in one volume, but to weave them together as one subject, thus emphasizing their common dependence.

We desire to express our obligations to the Messrs William Wood & Co, and to Mr. E. B. Meyrowitz for numerous illustrations furnished to us.

D. B. St. JOHN ROOSA.
BEAMAN DOUGLASS.

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DISEASES OF THE EAR, NOSE AND PHARYNX.

DISEASES OF THE EAR, NOSE AND PHARYNX.

CHAPTER I.

THE EXAMINATION OF AURAL PATIENTS.

FOR the thorough examination of an aural patient, it is indispensable that a history be kept. Besides the statement of the name, age and occupation, this history should include a clear statement of the general condition, the diseases from which the patient has suffered, the frequency of earache, the medication to which he has been subjected, and so on. Such a history is necessary if the practitioner ever means to give the profession the benefit of his experience, and it is also important for the proper study of the case in hand. As the years go on, the practitioner will, of course, make his descriptions rather more succinct than when he began. In chronic cases it is sometimes difficult to obtain a correct answer to the question, "When were the aural symptoms first observed?" The first reply will sometimes be, "A few months ago," or "A year or two," but if this response be quickly followed up by the inquiry,—"Before that time your hearing was absolutely good?" and "Were your ears perfectly well?" in many instances, the patient will confess to a dullness of hearing on one side for a long time, or that he once had a little discharge from his ear. But all this is not different from what it is in medicine and surgery in general.

TESTS OF HEARING.

The tests of hearing that are essential are, 1st, ordinary conversation; 2d, the tuning-fork; 3d, the tick of a watch or similar instrument. Politzer's acoumeter is one of the instruments used as a substitute for a watch. The tone is produced by the striking of a hammer upon a steel cylinder which is connected by a screw with a perpendicular vulcanite column. It has no particular advantage over a watch. It is very difficult to test the power of the patient's hearing conversation by the voice, and yet, that is the very best test. If a person has a capability for hearing what is said in social intercourse, as at the table, in the drawing-room, and can hear a lecture or a play without difficulty, his hearing cannot be said to be sensibly impaired, on one side at least. But it is not possible to make an accurate record to express this power of hearing, although attempts have been made by test sentences. Each practitioner will find himself able to come to a reasonable conclusion by carrying on a conversation with his patients. When a watch is used as a test of hearing,—and it is an important means of determining, at least, whether there is any improvement from treatment or if it is becoming more impaired,—it should first be accurately tested with a number of persons who hear well, so that we can get an idea as to how many inches it can be heard. Supposing a watch is heard distinctly 48 inches. The power of hearing can be expressed by a series of fractions, as suggested by Dr. Prout. If the watch be heard only when laid upon the patient's ear, it may be said to be heard $\frac{L}{48}$. If, when pressed upon the ear, $\frac{P}{48}$. If four inches from the ear, then $\frac{4}{48}$ and so on. In testing with the watch, it should first be placed at a distance at which its ticking cannot be heard by the patient, and then gradually approached to a point where the ticks can be accurately counted. Inaccuracies are furnished if the watch is placed at first where it can be heard, and then withdrawn. For if the sound is once perceived, it is easy for a defective ear to follow it until it reaches a distance far beyond its normal range. The ear which is not being tested should be closed by the hand, or better, a towel or the like, firmly pressed upon it, during the examination.

In diseases of the nerve of the ear, there is a great discrepancy between the power of hearing the watch and conversation which will hereafter be spoken of more at length. It is simply necessary to state here that persons with disease of the auditory nerve, hear the tick of a watch relatively badly. Watches are heard better immediately after they are wound. The intensity of their sound is increased by holding them so that the hand covers the back, or when they are held by the patient's own hand. The chief object in testing with the watch is to observe whether, under treatment, any improvement has occurred. But, as a means of testing the actual hearing power, since there are so many disproportions between the capacity to hear the watch and the human voice, it is a very poor instrument. People over middle life, those who have *presbykousis*, those who have disease of the labyrinth or auditory nerve hear conversation relatively much better than they do a watch.

The senior author of this volume published a table[1] showing the disproportion between the power of hearing the tick of the watch and the human voice, which confirms the point just made. The tick of a watch is produced by the striking of a hammer upon the apex or side of the tooth of a ratchet-wheel. It is a simple unvarying tone, modified as to quality, in different watches. The sounds produced by the vocal chords, reënforced by the resonating cavities of the nose and mouth, may pass through a range of musical notes which may compass three full octaves.

All tests of hearing with a watch or acoumeter are inadequate, but, it is easy, in cases in which any considerable improvement or recovery results from the treatment, to demonstrate it by them.

A healthy ear can appreciate from seven to eleven octaves. The tones of the larynx reaching three octaves, cannot, of course, form a sufficient test of the hearing power. As will be shown in a subsequent chapter, a large class of persons with diseases of the ears, hear better in a noise, while another class hear better in quiet places. It is to be seen, therefore, that a great deal has to be taken into consideration in testing the hearing power, lest incorrect conclusions be reached.

THE TUNING-FORK.

Although there is a very large quantity of literature on the tuning-fork, its actual value in testing the hearing power is chiefly with one tuning-fork, C^2. It is used to determine whether a given disease is in the middle or internal ear. If we close our ears and speak,

[1] *American Journal of the Medical Sciences,* vol. lxxiii, p. 50.

the sound of the voice seems to be confined to the head, the reflection being somewhat prevented by the closure of the auditory canal. If the auditory nerve be sound, and there be hardened wax in one canal, or a thickening of the membrane lining the tympanic cavity, the state of things will be similar in its physical effect, to that when the external meatus of a healthy ear is closed by the finger, or in a similar way, the vibration of the tuning-fork C^2, placed upon the bones of the head, will be heard more distinctly by the ear thus affected, than by the sound one. If the ears are equally affected, this will be more difficult. But if the nerve be seriously

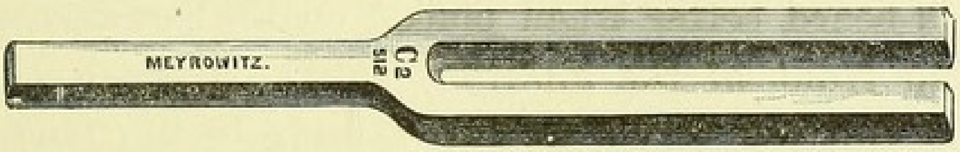

Fig. 1.

impaired, no such marked difference will be observed when the external canal is closed. Again, in persons hard of hearing from disease of the middle ear, while the auditory nerve is not injured, the tuning-fork will be distinctly heard when the handle is placed on the teeth, forehead or mastoid process, but if the nerve be the seat of serious lesion, so that deafness exists, the vibrations of the tuning-fork will not be perceived in the head. Deaf-mutes, with disease of the central apparatus, feel the sound of the tuning-fork passing to the region of the diaphragm or stomach. They involuntarily place their hands there when the vibration begins, as can be seen in examinations of such subjects. So-called deaf-mutes, in all classes,—some deaf from disease of the middle ear, some from that of the nerve, or both, are often collected together by the sound of a drum, and they state that they *feel* the sound.

But the value of the tuning-fork is chiefly in determining, not which ear is mostly affected, but which of the two parts of the ear, middle or external, and here is formed a most reliable test. The tuning-fork C^2 is heard the more distinctly and for a longer time, if there be disease of the middle ear when its vibrations are conducted through the bones of the head. Just the opposite condition obtains when disease of the nerve occurs. It is a very easy matter for any person, even if not very intelligent, to determine whether or not—if there be any considerable disease of the ear—a tuning-fork is heard better when placed on the bone or when held in front of the auditory canal. Even a stupid person can tell which of two sounds is the louder if there be any appreciable difference between them. A tuning-fork C^2, which, according to Helmholtz, equals 512 vibrations, is heard better by persons with normal hearing if held while vibrating in front of the external meatus, that is, it is heard louder and is heard longer. In diseases of the external or middle ear, the intensity with which the tuning-fork is heard through the bones is increased. The natural relations between conduction through the air and bones is disturbed.

The tuning-fork is placed in vibration by being struck on any adjacent piece of furniture which is upholstered or, as is very convenient, on the knee of the examiner. A stop watch is necessary to test the duration of the aërial or bone conduction. The patient may indicate the moment he ceases to hear the vibrations by lifting the hand.

MALINGERING.

There are often found malingerers, who claim to be dull of hearing in one or both ears. Then some malingerers claim that there is an absolute deafness of one ear only. A false assertion of absolute deafness in both ears is so difficult to maintain that it is seldom attempted.

Coggin's test[1] is simple and valuable. He uses a Camman's binaural stethoscope. He plugs the right metal socket with a wooden stopper if the patient claims to be deaf of the left ear. On using the stethoscope in this manner for hearing speech, a person with good hearing power will find that he cannot distinguish it with the right ear. The person who claimed to be deaf of the left ear, was first tested while the tube of the right arm was plugged, and it was found that he could hear a whisper in the thoracic cup which served as a mouth-piece. The tube containing the plug was then removed and the tragus was firmly pressed against the meatus, so as to completely close it. Then the tube was applied to the left ear, as before; the patient positively denied that he could hear what Dr. Coggin said to him. He knew that the tube through which he *supposed* he heard before was no longer in the right ear. As has been said, simulation of impairment of hearing on both sides is very difficult to detect. Such a person should be kept under observation for some few days, and repeated examinations made as the ingenuity of the surgeon may suggest them.

[1] *Archives of Otology*, vol. viii, p. 177.

EXAMINATION OF AUDITORY CANAL AND MEMBRANA TYMPANI.

After noting the hearing power, the auditory canal and the membrana tympani should be examined. Three instruments are necessary for this purpose. A pair of angular forceps, an aural speculum and a concave mirror. Specula of various shapes are used, but the specula of Wilde, Tröltsch, or Gruber are all useful. The material should be of German silver or the like.

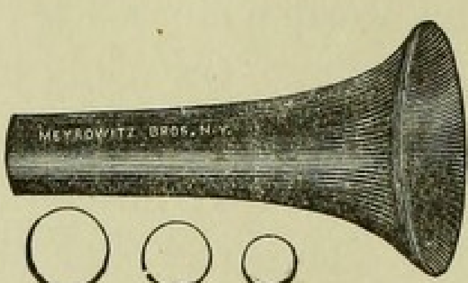

Fig. 2.—Politzer's Speculum.

Politzer prefers rubber specula. For the purpose of employing acids or caustics, one of hard rubber, porcelain or glass, is to be preferred. The instrument, both the hand and the instrument being absolutely clean, should be inserted gently and slowly into the meatus

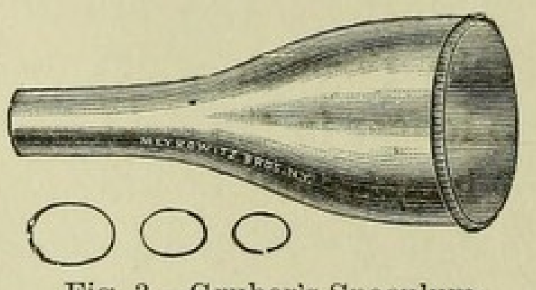

Fig. 3.—Gruber's Speculum.

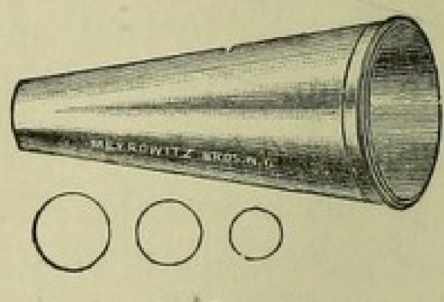

Fig. 4.—Wilde's Speculum.

with the right hand, the auricle being lifted with the left and the speculum held in position by the thumb and index finger of the same hand. It can thus be kept under complete control, and turned so as to successively view the different parts of the whole surface of the membrana tympani. A considerable experience is necessary before this instrument can be introduced so as to secure the best view and not hurt the patient.

The light is then thrown into the ear (Fig. 7) by means of the otoscope, invented by Tröltsch. For

Fig. 5.—Method of Holding Speculum in the Ear.

young examiners, ordinary daylight, when it is of a good quality, is one of the best sources of illumination for the mirror, but on dark days or in presbyopic persons, the light from a good lamp, gas-light, such as the Kern incandescent, an ordinary Argand burner, electric light, or even the light of a candle, is better. There are also excellent apparatus by which electric light is made a means of illuminating the drumhead. A mirror with a forehead band is necessary for operations and in making

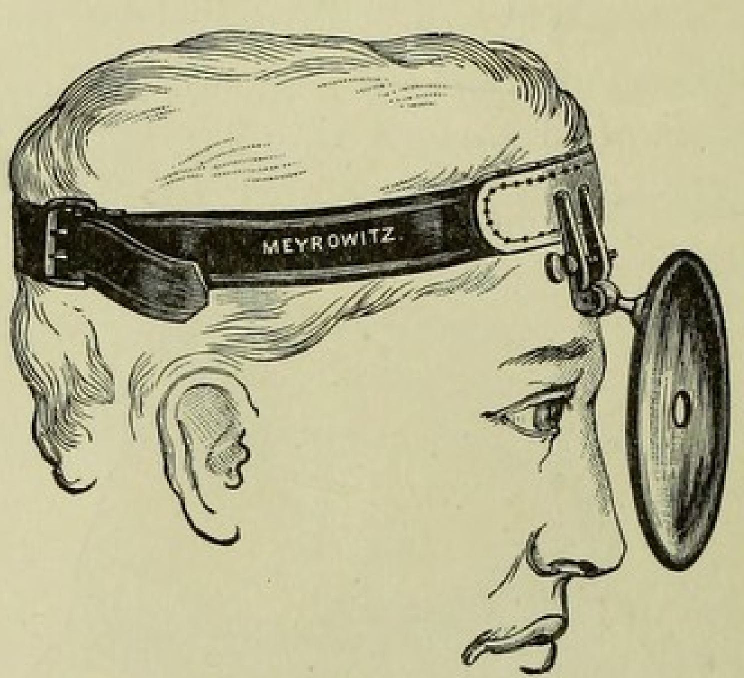

Fig. 6.—Forehead Band with Otoscope.

applications. The observer does not look through the opening in the mirror but rather over the rim of it.

Fig. 7.—Examination of the Ear with Tröltsch's Otoscope.

The adoption of this simple method of examination has done more for the scientific and practical study of aural disease than any previous suggestion in this department. It has placed within the hands of every practitioner a method by which he may, in a few min-

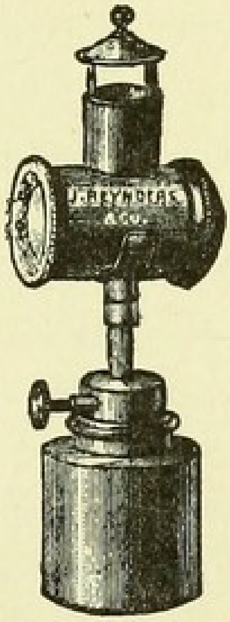

Fig. 8.—Collin's Lamp used with a Candle.

utes, learn to examine a membrane which not a few physicians have never seen on the living subject.

EXAMINATION OF THE NOSE, NASO-PHARYNX, PHARYNX, AND EUSTACHIAN TUBES.

GENERAL REMARKS:

The nose is the starting point of many of the common lesions of the ear. Perhaps 90 per cent of the more common forms of aural disease are dependent upon pre-existing nasal conditions. There seems to be no doubt but that atrophic catarrh of the middle ear, chronic hypertrophic catarrh of the middle ear, acute and chronic suppuration of the middle ear often arise from nasal conditions. It is obvious that these aural diseases cannot be successfully treated unless at the same time proper attention is given to the diseased naso-pharynx. When the upper respiratory tract is diseased, the catarrhal or infective discharge may directly involve the area, or the disease may extend from these parts to the opening of the Eustachian tube, and from this to the tympanum and mastoid.

Notable examples of such extension of inflammation are seen in the ordinary influenza type of aural infection, as well as in the aural diseases resulting from measles and scarlet fever. It has only been within the last three decades that the dependence of aural disease upon the presence of adenoids has been recognized. As the result of this recognition and the institution of proper treatment the children of the present generation will enjoy immunity from much of the impairment of hearing which is now so commonly seen.

CONDITIONS OF THE UPPER RESPIRATORY TRACT WHICH PRODUCE AURAL DISEASE.

1. Infective material may be carried directly into the ear from the upper respiratory tract by blowing the nose, by prolonged sneezing, by the use of the nasal douche and so forth.

2. Inflammation may spread slowly from the nose into the naso-pharynx and thence into the ear by simple extension of a chronic hypertrophic catarrhal lesion. In such cases there is no question of infection, but the disease is one of slow extension.

3. Inflammation may spread quickly from the upper respiratory tract into the ear as the result of nasal infection. In this case the aural lesion may develop very rapidly and is sometimes fully established within twenty-four hours. The conditions which produce these aural complications may be mild nasal sepsis resulting from an operation, influenza rhinitis, extension of a

purulent disease of the nose, reaction from cauterization of the faucial tonsils, and so forth.

4. Congestion of the tube and the tympanum is produced and maintained by the pressure of hypertrophied pharyngeal adenoids and the enlargement of the faucial tonsils, as well as by a tumor in the naso-pharynx or pharynx, and especially by a chronic congestive enlargement or hypertrophy of the posterior end of the inferior turbinate body.

5. Nasal stenosis frequently produces chronic non-suppurative inflammation of the middle ear, chronic congestion, and narrowing of the Eustachian tube, by inducing chronic congestion of these parts followed by hypertrophy from the inflammation. The direct cause of these aural conditions arising from nasal stenosis is probably interference with the ventilation and the constant production of partial vacuums within the naso-pharynx. The lesions within the nose which are active in producing this condition are posterior hypertrophies of the turbinate bodies, deflections of the nasal septum and chronic thickening of the septal membrane, the presence of spurs, the formation of synechiæ, and chronic congestion or hypertrophy of the turbinate bodies.

6. Atrophic rhinitis acts upon the ear by the extension of the atrophic process from the naso-pharynx to the tympanum through the Eustachian tube. Unless the nasal condition is promptly treated it produces a form of atrophic otitis media.

7. Suppurative diseases of the accessory nasal cavities sometimes, though rarely, produce aural lesions by direct infection with bacteria. In other cases the lesion of the ear is influenced by the chronic congestion

or chronic inflammation which is started by the complications resulting from these sinus lesions. An instance of this is the aural diseases which result from the formations of polypi dependent upon accessory sinus diseases. In such cases the effect of the affection of sinus upon the disease is secondary. The direct causes of the aural lesion are either sepsis, or interference with physiological aeration, or stenosis.

8. Other lesions of the naso-pharynx or pharynx produce aural disease by interference with drainage, extension of inflammation, or by the production of chronic congestion. In this way we account for the rôle played by adenoids in the production of aural disease, as well as for the chronic congestion produced by the faucial tonsils and by the presence of follicular enlargement of the mucous glands of the pharynx.

9. Certain medicaments or other foreign matter may produce aural diseases, either directly from being forced into the ear, or by setting up an inflammation in the Eustachian tube which afterwards spreads to the middle ear. One need only recall the effect of peroxide of hydrogen, the injection of water by means of the nasal douche, the effect of irritating applications such as iodine, carbolic acid, and cauterizants to the region at the mouth of the tube or the naso-pharynx, and to remember the results which we have all seen from blood being forced into the tube by coughing or sneezing, or the effects of small particles of food forced into the tube during vomiting, as well as involvements of the middle ear following the use of the post nasal plug or other forms of packing, to realize how frequently these agents are active in producing aural lesions.

EXAMINATION OF THE NOSE.

ANTERIOR RHINOSCOPY.

Examination of the external nose.—Any lesions of the external nose are readily discoverable without the use of an examining instrument. They may be located around the opening of the nose upon the alæ, and generally produce some change in the conformation of the nose. Frequently internal lesions of the nose may be detected by external alterations. This is true of deformities of the nasal septum, and occasionally

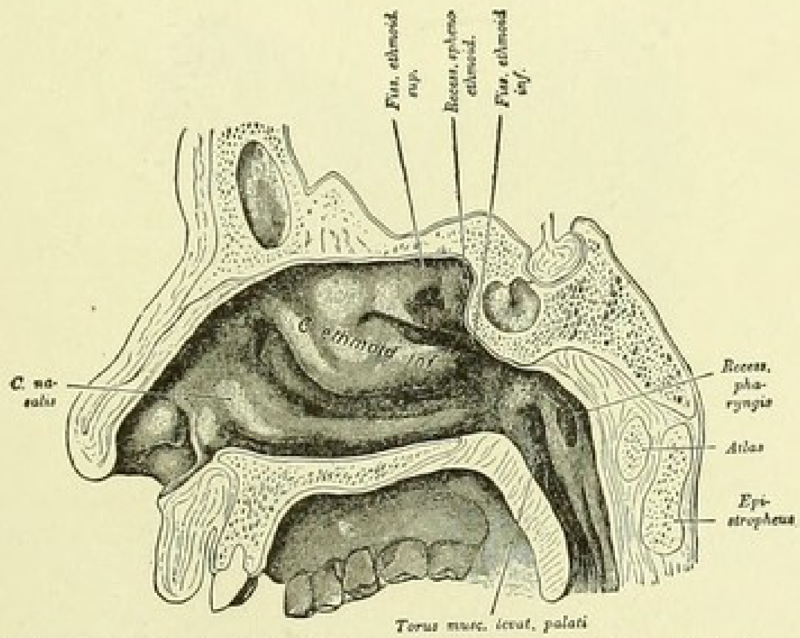

Fig. 9.—External Wall of the Nasal Cavity with the Turbinated Bones (Zuckerkandl's Atlas.)

in the formation of polypi. The conformation of the nose should be studied for alterations from the normal. We can readily detect any deviation from the median line, a twist or a bend of the nasal bones or the triangular cartilage, or any altered position of the tip. When investigating the vestibule of the nose, it is only necessary to raise the tip and spread the sides of the nose with the finger. This will open the nasal orifice and allow inspection of the interior of the vestibule.

It is easy to detect foreign bodies within the nasal chamber if they are lodged anteriorly, as well as crusts, scabs or discharge which may cover an ulceration in that locality. Inspection of the hairs and the hair follicles around the orifice of the vestibule will often reveal the presence of an affection of the skin or show minute follicular abscesses.

Examination of the internal nose.—To make this examination it is necessary to have a head mirror, a

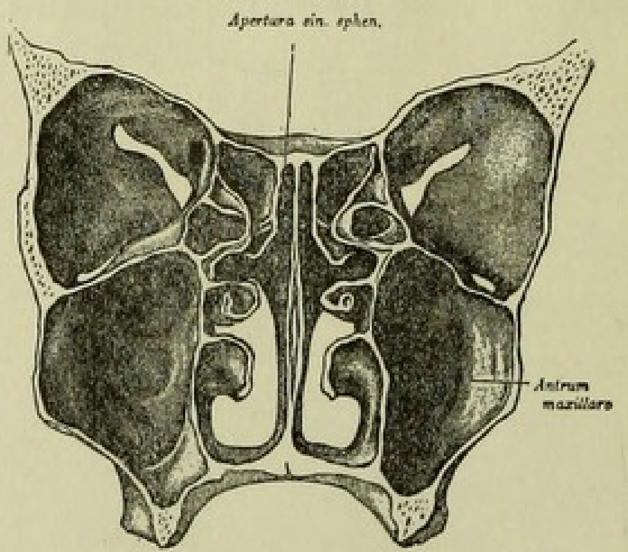

Fig. 10—Frontal Section through the Nasal Cavity (Zuckerkandl's Atlas.)

good light, and a nasal speculum. A probe and a solution of cocaine and adrenalin chloride are also useful. The patient sits by the side of the table with the right elbow resting upon its edge; the illumination should be arranged either from a candle, Argand or Kern burner, or electric bulb, on a level with the patient's ear; the physician sits facing the patient, his left elbow resting on the edge of the table and the head mirror arranged in such a way that it will cover his left eye. The light is reflected by the head mirror upon the patient's nose, and the physician should see the patient's face with the left eye looking through the hole in the centre of the mirror. The nasal speculum is used to dilate the naris. Bosworth's speculum is recommended for examination work, while for operation Lennox Browne's will be found more useful.

Through the opening in the nostril a thorough inspection of the nasal interior may be made. The examination is facilitated by tipping the patient's head alternately up and down and from side to side as the

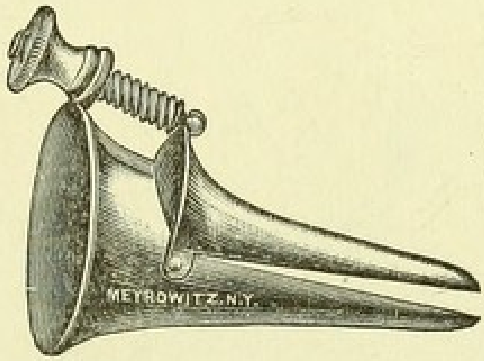

Fig. 11.—Nasal Speculum.

examination proceeds. By this method one is able to examine the entire nasal interior. Occasionally it is possible to see the naso-pharynx. Two-thirds of the nasal interior may always be seen unless there is some pathological obstruction, but often the posterior third is hidden from view.

In making the examination the patient's head should be tipped downward so as to get a view of the floor of the nose; next, the septum should be studied and any irregularity of its surface noted. The roof of the nose is usually out of line of vision, being hidden by the lateral projection of the middle turbinate body, and it can only be examined with a probe.

The turbinate bodies are located in the outer nasal

2

wall. Their anterior ends are always easily visible, and often two-thirds of their lateral surface may be seen. When the turbinate bodies are normal they never touch the nasal septum, nor do they impinge upon each other. Their external surfaces are hidden from view while their median or septal sides may be studied. If the nasal cavity is unusually wide, or if there is an atrophic process present, it is possible to observe not only the whole length of the turbinates but also to study the structures on the outer nasal wall, which are usually

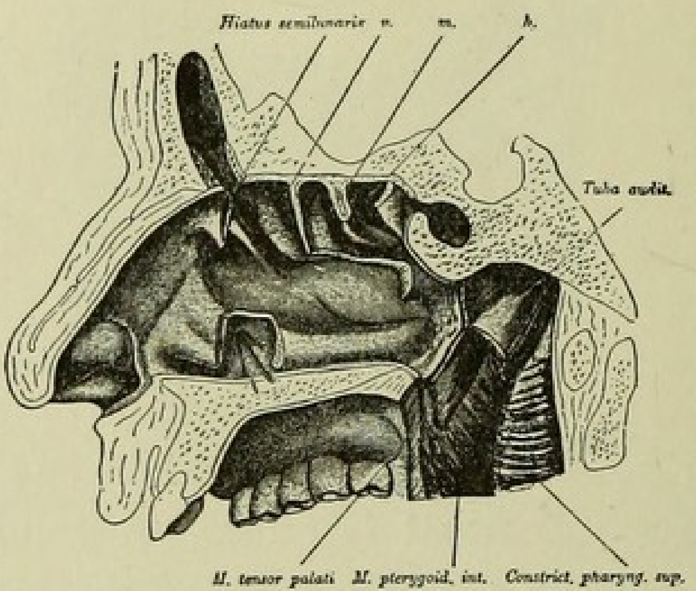

Fig. 12.—External Wall of the Nasal Cavity after removal of Inferior and Middle Turbinate (Zuckerkandl's Atlas).

hidden by the middle turbinate body; and generally it is possible with good illumination to get a view of the naso-pharynx and to observe the pharyngeal opening of the Eustachian tube. The examination is interfered with when the nose is the seat of hypertrophic processes or any obstructive lesion. In such cases it is not possible to see past the obstruction without employing other aids. These are solutions of cocaine and adrenalin. The probe is also employed to complete the examination.

When the nose is the seat of congestive swelling or hypertrophic enlargement the cavity may be enlarged by shrinking the swollen tissue with cocaine and adrenalin solution. For this purpose a four per cent solution of cocaine in a 1 to 10000 solution of adrenalin chloride is either sprayed into the nose or applied on pledgets of cotton. The pledgets soaked should be left in place for four or five minutes, when the full contractile effect of the cocaine and adrenalin will be established, the nasal tissues being shrunken and anæmic, the venous sinuses

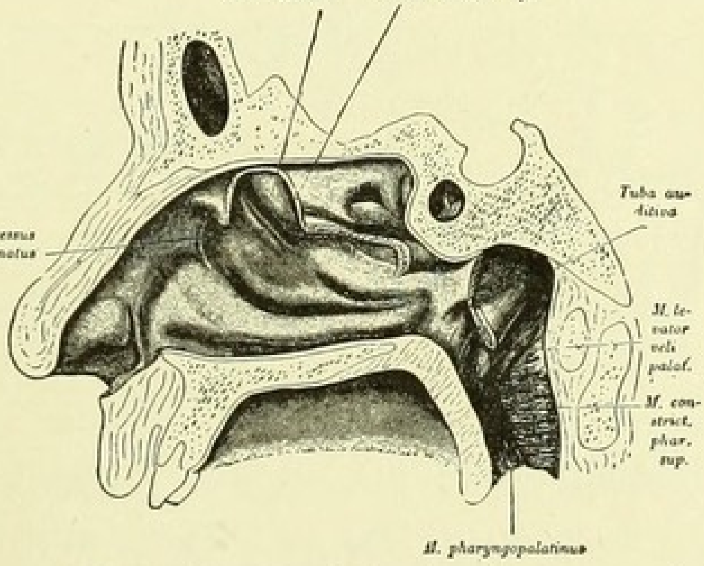

Fig. 13.—External Wall of the Nasal Cavity after removal of part of the Middle Turbinate (Zuckerkandl's Atlas).

emptied, and the air space of the nose increased. This provides a ready means of differentiating between congestion and hypertrophy of the nasal mucosa. The cocaine will also anæsthetize the nasal tissues and allow the use of the probe without causing pain.

Examination by means of the probe should never be neglected, for by it much definite information about the character of the nasal lesion may be obtained. The length of the spurs or the thickness of the nasal septum may be measured; the character of the thickening definitely determined by the resistance which it offers; the consistency of the turbinate tissue may be detected and it can be decided whether a thickening be due to bone or be the result of a hypertrophy of the soft tissue; granulation tissue within the nose is easily discovered and the consistency of any growth revealed; the location of polypi and their point of attachment is ascertained. It is also possible with this instrument to discover areas of bone necrosis which would ordinarily escape detection, and it is invaluable in determining the

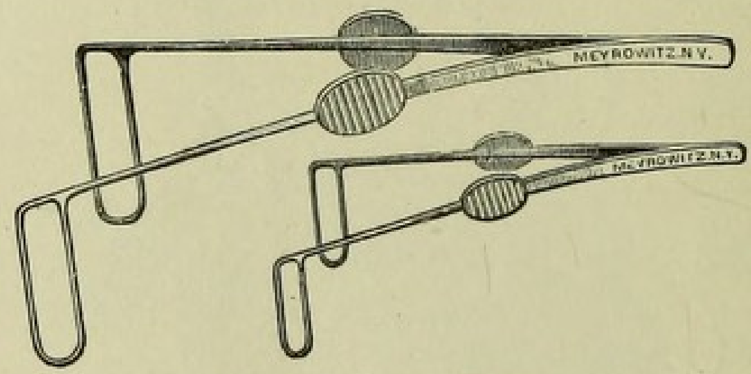

Fig. 14.—Nasal Specula.

existence of diseases of the accessory nasal sinuses, as well as the condition of the soft tissue and bone in the region adjacent to their openings. With it one can also detect hypertrophy of the posterior ends of the turbinate bodies, for during examination the probe is passed under the turbinates toward the pharynx, and reveals the hypertrophy which otherwise could not be discovered except by posterior rhinoscopic examination.

A view of the pharyngeal orifice of the Eustachian tube and of the naso-pharyngeal wall is sometimes obtained by means of anterior rhinoscopy. This is not seen in an absolutely normal nose, but is possible in one where the tissue has been shrunken with cocaine. As a rule it may be said that some atrophy exists when these structures are visible from the nasal orifice during an anterior rhinoscopic examination.

The pharyngeal orifice of the Eustachian tube may be identified by its appearance and movement. It is seen on the lateral pharyngeal wall at the level of the

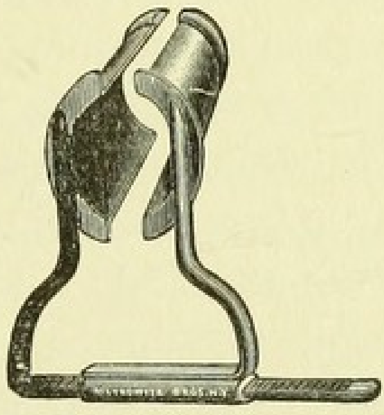

Fig. 15.—Nasal Speculum.

inferior turbinate body. The opening is oval, and its median wall is more prominent than its external one. If the patient is directed to swallow, the movement of the pharyngeal muscles will be observed, and with it the forward and inward movement of the edge of the Eustachian tube.

POSTERIOR RHINOSCOPY.

The instruments required for this examination are a head mirror, tongue depressor and a No. 3 throat mirror. The arrangement of the light, patient, and physician are the same as has been described in anterior rhinoscopy. In this examination delicacy of touch is very important to prevent the spasmodic movement of the soft palate, or even nausea and vomiting. When the light from the head mirror is reflected in the proper way, the patient's mouth is opened and the tongue is gently depressed toward the floor of the mouth. The depressor must be introduced gently and must not rest on the posterior third of the tongue. If the tongue is unruly and tends to rise, thus obstructing the view of the pharynx, constant and gentle pressure will overcome the difficulty. When this organ is well pressed downward a view of the pharynx and soft palate is obtained and if the uvula has dropped away from the pharyngeal wall and the patient is breathing quietly through the nose, a space will be left between the uvula and the posterior wall of the pharynx into which the small throat mirror is introduced. If the mirror is held behind the uvula at an angle of 45 degrees it will reflect the naso-pharynx. If the angle is less than this, only the roof of the nose will be seen in the mirror; if the angle is greater, only the posterior surface of the soft palate will be visible.

One of the difficulties in making a posterior rhinoscopic examination arises from the uvula and soft palate being involuntarily forced upward so as to close the pharyngeal space. This is prevented by having the patient always breathe through the nose. The tendency in all cases is to breathe through the mouth when the tongue is depressed, but nasal breathing may be established and the uvula relaxed by requesting the patient to smell an imaginary flower. This is usually more successful than simply instructing him to use nasal respiration. Another difficulty is experienced if the uvula is at all enlarged. When the view is obstructed in this way, it is better to hold the mirror low in the pharynx with its handle lying firmly on the base of the tongue. If the pressure upon the tongue is gentle and constant, no involuntary movements of the throat will be excited. In order to use the mirror low in the pharynx and behind the uvula, it is necessary that the tongue should lie well depressed toward the floor of the mouth. Sometimes even when all of these precautions are used a view of the naso-pharynx is impossible without the aid of a palate retractor. It is the habit of the writer to always use a palate retractor in making a posterior rhinoscopic examination, for in this way a much more thorough view of the naso-pharynx is obtained, as well as an opportunity to study the posterior third of the nasal interior. The palate retractor should not be stiff or bulky. Before the palate retractor can be readily used, it is generally necessary to cocainize the soft palate and uvula on both the faucial and pharyngeal sides. For this purpose a four per cent cocaine solution is applied to the uvula and soft palate with a cotton-covered applicator. The cocaine is also applied to the posterior surface of the soft palate and to the lateral pharyngeal walls. The cocainization will be complete in four to five minutes, and the curved end of the palate retractor can be introduced behind the uvula. The uvula and soft palate are drawn forward as far as possible and are retained in this position by tightening the screw on the sliding part of the retractor. The instrument is sometimes thrown out of place by spasmodic movements of the uvula, but this can be prevented by instructing the patient how to control the contractions of the soft palate. The use of the palate retractor also excites salivation, and the patient must be instructed to retain the saliva until the floor of the mouth is well covered, and then to allow it to run out by tipping the head forward over a basin.

When the palate retractor has been properly adjusted, there is a wide space between the uvula and the posterior pharyngeal wall into which a large throat mirror may be introduced after the tongue has been depressed, and a thorough examination of the region made.

POSTERIOR RHINOSCOPIC VIEW.

A complete posterior rhinoscopic view is obtained by moving the mirror from side to side within the naso-pharynx. The posterior openings of the nose are clearly visible, and in front may be seen the posterior portion of the nasal cavity. In the median line the thin posterior edge of the septum can be observed throughout its whole length. It is wider above where it joins the sphenoid than below where it is attached to the hard palate. The soft palate is seen just below the septum. Anterior to the nasal septum and external to it on the lateral nasal walls, the rounded posterior ends of the inferior and middle turbinates may be seen; and in the higher part of the nose that portion of the ethmoidal region which is known as the superior turbinate body. The ethmoidal cells may be observed and often the openings of the posterior ethmoidal cells will be in plain view. The posterior part of the roof of the nose is clearly visible, and also the posterior third of the floor. If the face of the mirror be tipped slightly backward the roof of the naso-pharynx may be seen. The shape of this dome-like roof is frequently changed by the presence of adenoids. Exactly in the median line of the roof a slit may be seen in the adenoid tissue. This is the opening of Luschka's crypt. On each side of the naso-pharynx the openings of the Eustachian tubes are plainly visible.

They will be then on a level with the posterior end of the inferior turbinate body, and are distinguished by their oval orifice and projecting posterior border.

EXAMINATION OF THE NASO-PHARYNX.

The naso-pharynx is examined by sight and palpation. The method by sight has been described under posterior rhinoscopy. Palpation is always useful with adults and is frequently the only means of making an examination in children.

Mode of palpation.—The mouth gag should be introduced, or if this is not available the mouth should be opened and the tissue of the cheek pressed between the teeth. This is a useful precaution with children, for it prevents them from biting the examining finger, the mouth of the child opening quickly as the teeth close upon the cheek tissue. If a mouth gag is used in examining a child, its head should be firmly held by an assistant. If no assistant is available the examiner must place the head of the child in the curve of his left arm and force the left cheek between the teeth with his left index finger. This leaves his right hand free for the examination, while the head of the child is firmly held. The right index finger is then passed into the mouth of the child, over the tongue to the tonsils and turned upward toward the median line between the posterior pillar of the fauces and the posterior pharyngeal walls. It finds an easier entrance here than if introduced in the median line behind the uvula. If the head is firmly held the naso-pharynx may be examined at leisure, for there is no obstruction to respiration. The finger can then examine the septum and ascertain the size of the posterior choannæ, touch the posterior ends of the turbinate, feel the Eustachian tubes, and ascertain if adenoids or other growth, or any foreign body be present.

EXAMINATION OF THE PHARYNX.

For this examination the light, patient, and physician should be arranged as described in anterior rhinoscopy. The mouth of the patient is opened, the light thrown into it and the condition of the teeth and tongue are first noted. The character of the coating upon the tongue, the conditions of the alveolar mucous membrane, the color and the appearance of the roof of the mouth can all be observed at a glance. The tongue should be depressed with any convenient form of tongue depressor—the best forms are those having rather narrow blades. It is sometimes difficult to control rebellious tongues which refuse to lie quietly on the floor of the mouth, but much can be done to manage the unruly member by quietly assuring the patient that the examination presents no difficulty and by making very gentle pressure upon the anterior two thirds of the tongue. Sometimes it is necessary to distract the patient's attention by requesting him to take deep respirations, when the tongue will often sink quietly to the floor of the mouth.

When the pharynx is exposed for examination the faucial tonsils should be observed and any attachment to the pillars noted. Sometimes the tonsils which are considerably enlarged will not be in evidence until the patient swallows. This action may be performed while the tongue is depressed, when the hypertrophied part of the tonsil will project into the pharynx. The surface of the tonsils are inspected for evidence of inflammation, exudation, ulceration, or tumor formation, and the tonsillar crypts—if dilated—should be examined with a probe. Any swelling in the region above the tonsil (supra tonsillar fossa) should be examined by careful palpation. For this purpose the index finger or a blunt probe is used. The position and condition of the uvula and the faucial pillars are noted, and when the tongue is pressed well downward and the uvula drawn upward the posterior pharyngeal wall is plainly visible.

In examining children for the presence of adenoids it is often not necessary to introduce the finger into the naso-pharynx, for the evidence of these growths is often found on the posterior pharyngeal wall as hypertrophied masses of lymphoid tissue extending upward into the naso-pharynx and beyond the line of vision. The presence of discharge or scabs on this wall should also be noted.

EXAMINATION OF THE EUSTACHIAN TUBES.

The Eustachian tubes may be examined by 1, Inspection; 2, Compressed Air; 3, The Aural Bougie; 4, The Probe. The probe can only be used through the external auditory canal when the membrana tympani is absent.

1. *Inspection.*—The pharyngeal orifice of the Eustachian tube is the only part that can be examined by inspection. It will be recalled that in describing the anterior rhinoscopic examination, mention was made of the fact that in some cases when the mucosa of the nose has been shrunken by cocaine the pharyngeal orifice of the tube is plainly visible. The orifice may be iden-

tified by its movement forward and toward the median line during the act of deglutition. It may also be inspected during the posterior rhinoscopic examination, the technic of which has been fully described.

Here the appearance of this orifice may be described more fully. The pharyngeal orifice of the Eustachian tubes are located on the lateral walls of the pharynx just behind and on a level with the posterior end of the inferior turbinate body. The angle of the opening with the pharyngeal wall is about 15°, and the axis of the tube points toward the nasal cavity of the same side. Behind the prominent posterior lip of the opening is a marked depression, the fossa of Rosenmüller, the mucous membrane of which is rich in mucous glands and lymphatic tissue. The lips of the orifice form a triangular arch, the apex of which is directed downward, and the posterior or median lip is rounded, well defined and very prominent. The mucous membrane covering this region is slightly paler than the adjacent pharyngeal tissue. The opening of the tube is round, but quickly becomes a deep curved elliptical slit leading into the tube proper. The shape of the orifice changes with the act of deglutition, when it is much wider than in repose.

In an examination of this orifice it is advisable, if it can be seen by anterior rhinoscopic examination, to note the changes in the shape during the act of swallowing. It is not possible to make this examination with the rhinoscopic mirror, but granulation, adhesions, ulcerations, discharges, scabbing, or dryness may be noted with the mirror.

2. *The probe.*—The probe is used to examine the Eustachian tube only when the membrana tympani is

absent. It is then possible, after anæsthetization of the tympanum with a strong solution of cocaine to pass a probe into the anterior and inferior angle of the tympanum, thus reaching its internal opening. This procedure must be performed very carefully, particularly if any necrosed bone is discovered on the floor of the middle ear. Only a thin shell of bone alone separates this end of the Eustachian tube from the carotid artery. If the probe is used over an area of necrosis in this region, it is possible to rupture the artery and produce serious hæmorrhage. If the probe is small it may be passed a varying distance into the Eustachian tube and much valuable information obtained about its patency, the presence of granulations, and the character of the discharge.

3. *Compressed air.*—Much information about the condition of the Eustachian tube may be obtained by means of compressed air, either by Valsalva's or Politzer's method, or by catheterization of the tube. When compressed air is introduced within the tube the walls of the tube, which normally approximate, are forced apart and the tube opens. The sounds produced by the air through the tube and into the middle ear are conducted to the physician's ear by a soft rubber auscultation tube connecting with the patient's external auditory canal. If there is fluid in the Eustachian tube or in the middle ear fine crackles or squeaks only are heard at first, but as the tube opens the force and volume of the injected air increases until the sound of the inrushing air may be distinguished above the continued crackling or squeaking sound of the fluid. If there is considerable fluid under pressure in the ear, bubbling

sounds are heard and the entrance of air may not be distinguished or it may be heard only as a blowing sound. If the tube is tightly closed so that no air enters the middle ear, no sound can be detected through the auscultation tube, but a loud pharyngeal gurgle will be heard with the other ear. If the tube is atrophic and partly closed by a stricture, a faint blowing sound may be heard, or it may be altogether absent. If the air continues to be forced into the tube the sound may reappear. If the tube is simply congested, blowing the air into the tube relieves the congestion and the permeability of the tube is restored, and the sound which at first was faintly blowing becomes fuller and of greater volume as the tube dilates, until it passes with a free blowing sound. If there is an organized stricture of the tube the sound is of a whistling character—the intensity of the whistle diminishing in direct ratio with the degree of stricture.

The greater the degree of stricture or congestion within the tube the higher the note formed by the inrushing air; the freer the calibre the lower the tone, except in cases of absolute closure of the tube, when no sound at all is heard.

There are four methods by which compressed air is forced into the tube and middle ear to obtain information of their condition. These are Valsalva's method, Politzer's method, catheterization, and inflation by a double bulb.

Valsalva's method consists in forcing air into the middle ear under pressure obtained by prolonged and forced expiration, when the mouth and nostrils are tightly closed. The air compressed within the nasal chamber and pharynx during this powerful expiration causes the tube to expand and the air rushes through it to the middle ear with sufficient force to produce a decided movement of the membrana tympani outward, carrying with it the handle of the malleus and disturbing the position of the other ossicles. The movement of the membrana tympani can be observed with the aid

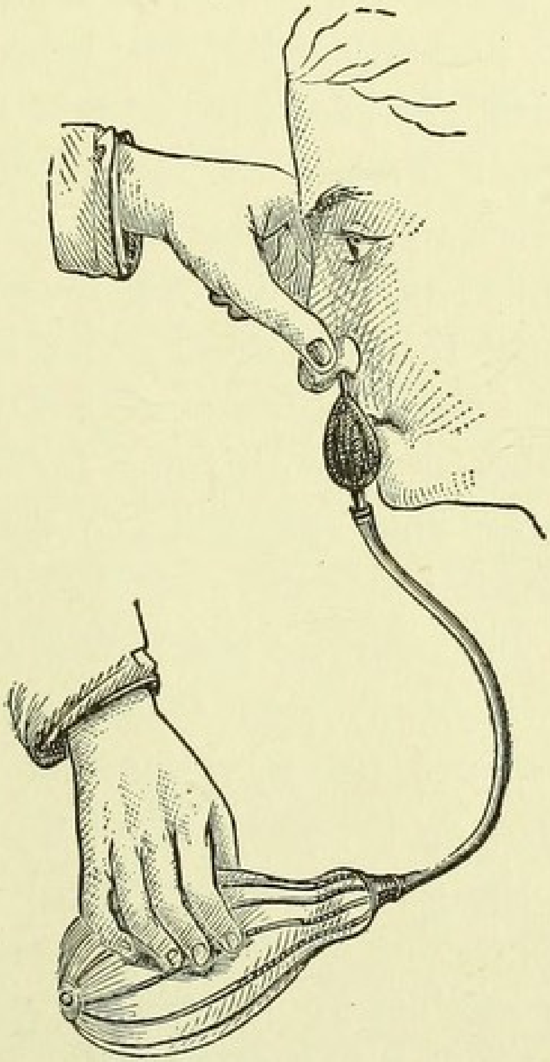

Fig. 16.—Politzer's Method of Inflation with the Roosa Bulb Attachment.

of an aural speculum, or the sound of the inrushing air may be obtained with the auscultation tube.

This method is the least valuable of all the methods of inflating the Eustachian tube and is chiefly useful, and then only sparingly, in aural examinations.

Politzer's method (A. Politzer, Vienna).—Politzer's bag is made of soft rubber with a capacity of 12 ounces or more, and is connected by a soft rubber tube with a hard rubber olive or tube-shaped nose-piece. The nose-piece is introduced into the nasal orifice, while the operator closes the nostrils of the patient over it with the fingers of his left hand. The patient is given a small quantity of water to hold in the mouth until he is told to swallow it. The head of the patient is then tipped slightly backward so that the prominence of the larynx can be seen. When everything is ready for the Politzerization, the patient is instructed to swallow the water, and during this act when the larynx is moved upward to its highest point, the soft rubber bag is quickly and firmly compressed with the right hand. A portion of the air thus forced under compression into the nose, reaches the Eustachian tube, dilates it and rushes into the middle ear, while a larger portion enters the pharynx producing a loud gurgling sound. At the moment when the patient swallows the water the nose and the naso-pharynx are closed off from the pharynx by the elevation of the uvula and soft palate against the posterior pharyngeal wall. The success of the experiment depends upon raising the uvula and soft palate against the pharyngeal wall at the exact moment when the bag is compressed. It is not always necessary for the patient to swallow water to produce this effect. Instead he may be instructed to repeat rapidly the syllable *keck, keck, keck,* or *hock.* In this way the uvula and soft palate are raised as in swallowing. When neither of these means is employed the patient may be instructed to blow away the hand of the operator from before his face by a prolonged expiration, as if blowing out a light.

EXAMINATION BY THE EUSTACHIAN CATHETER.

There can be no thorough examination of the ear without the use of the Eustachian catheter. Its employment with instruments of a proper curve may be said to be without pain. In almost all cases, it is easily tolerated without the preliminary use of a solution of cocaine, a practice which is quite common but which is unnecessary, and sometimes injurious. Where the nasal passages are very narrow or sensitive, if the end of the catheter be dipped in vaseline or glycerine or the like, the painless use of the instrument is facilitated. The material of which the instrument should be made is hard rubber generally; occasionally alloyed silver ones may be employed.

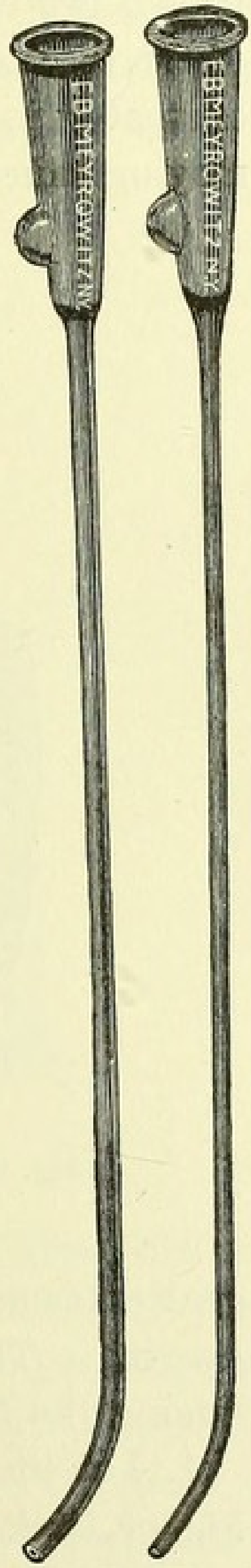

Fig. 17.—Hard Rubber Eustachian Catheter, Actual Size.

In the method of introduction we proceed as did Archibald Cleland, an English surgeon, who, after Guyot, did the most to demonstrate the utility of entering the mouth of the Eustachian tube with an instrument, and we pass the catheter through the nostril. It is very difficult to imagine how the Versailles layman succeeded in introducing an instrument into the tube, through the mouth. He certainly did not use a catheter such as we now employ and which is represented here.

(Page 33.) This instrument is a delicate tube of about six inches in length with a slight curve at its extremity. A long and flexible catheter might, it is true, be passed behind the soft palate into or opposite the mouth of the tube, and this is the operation which Guyot demonstrated to the Paris Academicians and which, by removing mucus from about the trumpet-shaped pharyn-

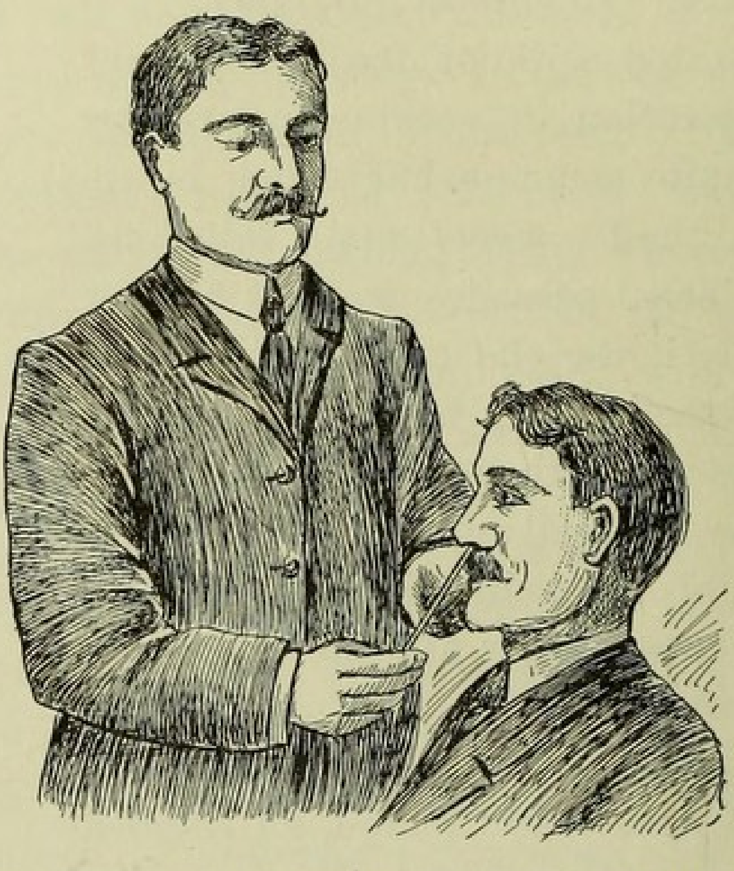

Fig. 18.—Method of Introducing Eustachian Catheter.

geal extremity of the canal, relieved his impairment of hearing. The various steps in the operation of introducing the Eustachian catheter are as follows:

1. Let the patient be seated on a chair, with a little higher back than usual, so that the head may be supported. If the patient is a child or a very timid subject it may be necessary to have its head supported by the

back of an examining chair, or by an adult standing behind. It seldom is important, however, to use the Eustachian catheter in a young child.

2. The nostrils may then be cleansed by a nebulizer and an aseptic solution. The catheter is thoroughly cleaned and air forced through it that it may be seen to be entirely permeable.

3. The surgeon standing a little to one side of the

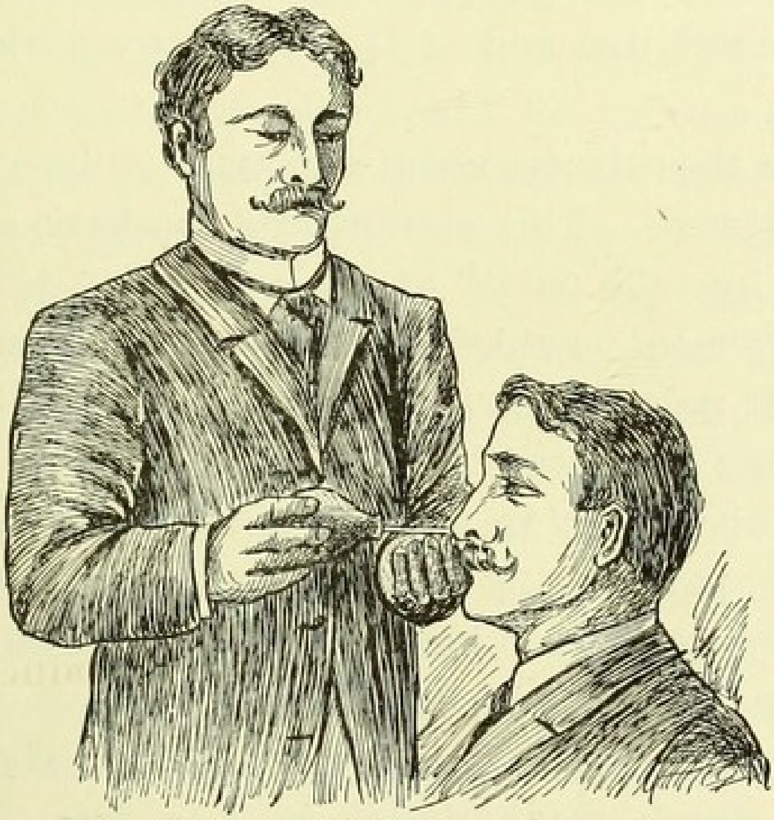

Fig. 19.— Eustachian Catheter in Position.

patient, whose head should have a good rest, draws down the upper lip with the left hand and with the thumb and finger of the right lightly holds the catheter at its funnel-shaped end, nearly in a vertical position so that the quive or projection of the side of the funnel-shaped extremity looks directly downward until the catheter has entered the meatus. It is then quickly turned (Fig. 19.) nearly to a horizontal position, when the beak will rest on the floor of the nasal meatus close to the septum with its convexity upward.

4. The catheter is then to be quickly slid backward, keeping it as close as possible on a line with the floor of the meatus, gradually elevating the handle until the instrument lies in a perfectly horizontal position and the beak touches the posterior pharyngeal wall.

5. At this point the funnel-shaped end of the catheter in the hand of the operator is to be raised a little above the horizontal line and at the same time withdrawn a little.

6. Turn the catheter about a quarter on its axis, from within outward. This motion lifts the beak of the instrument into the mouth of the Eustachian tube. This latter movement is aided somewhat by the constriction of the soft palate, which performs a swallowing movement, raises itself and lifts the beak of the instrument into the tube. Once in position the catheter should not cause the patient any inconvenience in speaking or swallowing, and the guide will lie at about an angle of twenty-five degrees with the tragus.

The difficulties that are found in introducing the catheter, simple manipulation as it is, arise from two causes:

First, the surgeon does not always hold the instrument in a vertical position until he has got the beak well in the meatus. A failure to do this will often cause the instrument to pass between the inferior and middle turbinated bones, instead of along the floor of the meatus, which must be *hugged* in order that the instrument may get to the mouth of the tube.

Second, the patient is apt to shut his eyes spasmodically and contract his facial muscles, and thus prevent the relaxation of the parts that is necessary during the manipulation. This difficulty is only to be overcome by persuading the patient to open his eyes and look about the room, which can be done if the surgeon have a quiet, assuring manner. With the second or third use of the instrument this trouble passes away, and sometimes it does not arise.

Having introduced the catheter we may force air through it into the cavity of the tympanum, by means of an air-bag whose nozzle should fit accurately in the funnel-shaped extremity of the nasal instrument. After air has been forced into the middle ear in this manner, the membrana tympani may again be examined by the surgeon to determine if it has become injected, or if it has undergone any change in position; that is to say, he should see whether the current has actually reached the cavity of the tympanum or not.

The catheter would be much more widely employed were instruments of small calibre and curve generally figured in the text-books and sold in the shops.

Most authorities recommend the use of an instrument like the stethoscope, which is placed in the ear of the patient while the air is being forced through the tube. It is sometimes difficult to distinguish sounds proceeding from the pharyngeal mouth of the Eustachian tube from those produced in the tympanic cavity. More dependence can be placed upon the appearance of the drum head and the sensations of the patient than upon the sounds heard through the diagnostic tube.

Dr. D. D. Achscharumow, of Poltava (southern Russia), practices a new method of dilating the Eustachian tube, which is well worthy of a fair trial.

INFLATION BY THE DOUBLE AIR BAG.

By this method the air is blown into the tympanic cavity by means of a part of the ordinary apparatus used for spraying the nostrils or larynx. On the free end of the rubber tubing a proper tip to fit the nostrils is inserted, and for convenience of use, the tube between the two air bags should be doubled in length by an intermediate piece. The patient who wishes to treat himself sits or stands before a table upon which the apparatus lies, having inserted the nose-piece and closed the nostrils over it with two fingers of the left hand, *the mouth being open,* the procedure begins. Seizing the terminal air bag of the apparatus with the right hand, it is pressed together several times until the second air bag is well distended. This widens the opening to the Eustachian tube and the strong tension of air is felt in the inner ear. The opening of the tube and the membrane of the drum remains in this moderately dilated condition so long as the nose is hermetically closed, and the second air bag fulfils its function of not allowing the air to pass backward. The right hand is then pressed on the second air bag and pressure made with strokes that are light and quickly following each other, by which the opening of the tube is enlarged in spurts and the drum head put in vibration. This pressure must be made very rapidly, at the rate of 150 times in a minute, perhaps more. When the nose is kept closed, the bag air tight, and the tension of the air moderate, these passive gymnastic exercises can be kept up on both structures as long as we like, but in general, in consequence of incomplete closure of the nostrils, the air bag becomes relaxed and must be filled again by a little pressure, consequently some minutes will be taken up. Each pressure of the hand, even the resting of the fingers on the second air bag, causes the sensation of a light blow in the ear. This method constitutes a kind of vibratory massage of the affected portion, the walls of the opening of the Eustachian tube, the Eustachian tube itself and the membrana tympani.

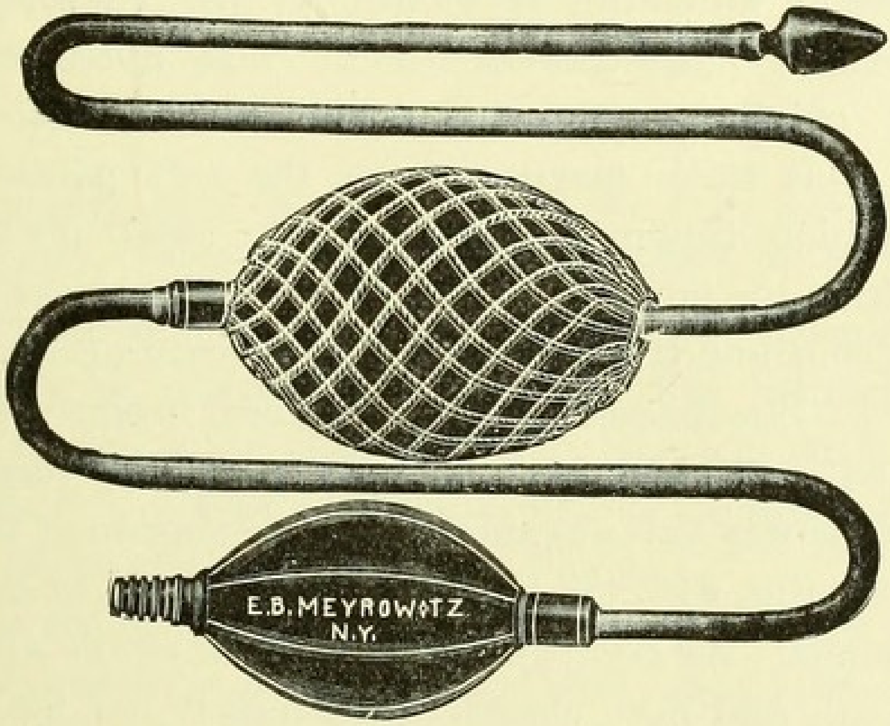

Fig. 20—Double Bulb Inflator.

The blowing of air into the tympanic cavity while the mouth is open and with free action of the respiration, is an entirely new method. A complete separation of the superior naso-pharyngeal space from the pharynx, can occur only by the contact of the soft palate from above downwards at that part of the hard palate which surrounds the upper opening into the nose. Such a position of the soft palate still appears paradoxical, since it occurs in spite of the stream of the compressed air coming from above, which must incline it downwards. This position of the soft palate during the action of the apparatus, each person can see for himself by making the procedure before a mirror. According to the view of the inventor of this method, this upward movement from the pharynx can be caused by nothing less than the irritation of the levator muscles caused by the entrance of the compressed air, that is to say, of the two muscles, the levator and the tensor of the soft palate, especially the latter, which are attached to the cartilaginous parts of the Eustachian tube. The fibres of the azygos of the uvula are involved in this movement. But these movements of the soft palate, and the complete separation of the upper small post-nasal space from the much larger and lower pharyngeal space, do not continue if there is strong pressure of air. The excess of this passes out by a lateral fissure with a noise, without changing its position, so that this is as it were a safety valve against excessive tension of the air. This explains why the closing of the mouth is entirely superfluous. As regards the blowing in of the air with the mouth and nose closed, we certainly get by this a strong pressure and a momentary larger dilatation of the Eustachian tube, but it interrupts the respiration at the same time and the circulation of the blood in the lungs.

When used by the patient himself, the two air bags are placed upon the table with the tubing. The nose-piece is then adjusted in one nostril and the other closed over with one hand, so as to be absolutely air tight. This being done, with the other hand pressure is made upon the air bag No. 1, for say a dozen times, or even more, until the second or reservoir bag is well distended. Rapid pressure is made upon it, taking care at the same time not to omit keeping the olive shaped nose-piece well in the nostril and the other nostril closed over it, so that it may be air-tight. There seems to be no ill effect from the use of this apparatus for some minutes twice a day. In certain cases of chronic swelling of the tube, with consequent want of proper ventilation of the tympanum, it seems for self-use at least, to be preferable to Politzer's apparatus, but just how much its value is, remains as yet unsettled. The authors are using it in their daily practice.

CATHETERIZATION OF THE EUSTACHIAN TUBE THROUGH THE NASAL CAVITY OF THE OPPOSITE SIDE.

This method is only used when for any reason it is impossible to reach the Eustachian tube through the nostril of the same side. It is at best unsatisfactory and usually it is a better plan to remove the obstructions within the nostril on the affected side.

The curve of the catheter is elongated .5 or .75 c. m., and the procedure is exactly similar to that already described, until the catheter reaches the posterior edge of the nasal septum. As soon as this point is reached it is rotated toward the opposite side, the end of the catheter outside of the nose is carried away from the nasal septum so that the curved end may reach the opposite side of the naso-pharynx, and the catheter is then rotated until the tubal orifice engages it. The compressed air is introduced in the usual way.

EXAMINATION OF THE EUSTACHIAN TUBE WITH A BOUGIE.

This is a valuable method of obtaining information of the condition of the entire length of the Eustachian tube. It is also believed by some authorities to be an exceedingly valuable means of treating the lesions of the tube. The bougies are made of gold or silver, sometimes of silkworm gut or whalebone, and occasionally of celluloid. They should always possess an olive-shaped end. In this method of examination the bougie is passed into the Eustachian catheter until its tip is exactly at the end of the catheter. The Eustachian tube is then catheterized according to the method already described, and when the catheter is within the tube the bougie is gently pushed through the catheter into the Eustachian tube. The examiner must carefully note how far the bougie has been passed, for it is never safe to introduce the bougie farther than 2 c.m. past the tip of the Eustachian catheter. If the bougie slips easily through the tube for 2 c.m. it may be assumed that there is no stricture, but if on its way through the tube it meets with slight resistance and then after a moment's pause passes further into the tube, we may consider that the tube is the seat of a congestion or thickening which is not yet organized.

Failure to pass the Bougie.—Instead of entering the Eustachian tube the bougie may travel along the surface of the pharynx. This is a common occurrence and results from the improper adjustment of the end of the catheter within the tubal orifice. It is recognized by the absence of the characteristic sensation of pain in the tympanum which is experienced when the bougie is within the Eustachian tube, as well as from the fact that the bougie can be easily passed more than 2 c.m. past the end of the catheter. It is also and more surely recognized by the effects of deglutition upon the position of the catheter. The movements of swallowing do not dislodge the catheter when it is within the Eustachian tube, but when the bougie is within the pharynx, these movements cause the catheter to slip from its place. Sometimes when the bougie does not enter the Eustachian tube it will penetrate the delicate mucous membrane of the naso-pharynx and dissect its way for a certain distance between this membrane and the fascia, and may give rise to an emphysema of the pharyngeal tissue and the skin of the neck.

EMPHYSEMA OF THE PHARYNGEAL TISSUE AND OF THE SKIN OF THE NECK.

This very rare condition arises from perforation of the pharyngeal mucosa. It is usually caused by a wound from the Eustachian catheter or the bougie. The wound allows air to enter between the submucosa and the fascia of the neck either during the process of using compressed air through the catheter or by forcible expiration, and sometimes from blowing the nose. As soon as air enters the cellular tissue of the neck a constant crackling sound is heard by the patient, the tissues of the pharynx are puffed out on the wounded side and some discomfort from tension is experienced. In many cases the emphysema is confined to the pharyngeal tissue, but it may spread through the fascia and reach the region beneath the cervical skin. If the emphysema is extensive, the air may pass through the entire cervical region on the affected side as far forward as the median line, downward to the clavicle, and posteriorly to the sterno-mastoid muscle. The evidences of emphysema, are the puffing of the skin of the neck and the fine crackling sound which is heard whenever the head is moved or the skin touched.

The development of this condition may be avoided by gentleness in fixing the end of the catheter in the tubal orifice and by never using compressed air under a greater pressure than ten pounds to the square inch, except in cases where the resistance of the tissue has been tested by applications of the air at this pressure. It is then justifiable to use a higher pressure in dilating the tube when necessary. It may be said to never occur in the use of the air bag to pass air through the tube. Great care should also be used in introducing the bougie into the Eustachian tube. The greatest danger with the bougie is in cases of stricture of the tube, for the point of the bougie may enter one side of the stricture and dissect its way beneath the mucosa of the tube without passing the stricture. If compressed air is used immediately after passing the bougie, the tendency to the development of emphysema is increased, and therefore the compressed air should never be used within twenty-four hours after the bougie has been passed into the Eustachian tube.

CHAPTER II.

ANATOMY OF THE AURICLE AND THE EXTERNAL AUDITORY CANAL.

THE auricle (*auricula*, external ear) is an appendage to the human organ of hearing. Its general shape is that of a funnel. Its framework is made up of flexible fibro-cartilage, one to two millimetres in thickness. The edge of the auricle is called the *helix,* from a Greek word, ελιξ *anything twisted,* ελίσσω *to turn around.* This ridge varies in breadth. It begins at a point on the concave surface of the cartilage, called the spine or crest of the helix, *spina seu crista helicis.* It does not extend to the lobe of the ear. The lobe is formed of integument alone.

Just beneath the helix is the *fossa navicularis* (boat-like fossa) separating it from a second ridge-like border, the *anti-helix.* Just in front of the opening into the auditory canal the cartilage becomes thickened, and forms a projection or edge called the *tragus* (goat) because hairs usually grow upon this part and give it a resemblance to the beard of that animal.

On the opposite side of the auditory canal, is a similar projection, called the *anti-tragus.* The greatest cavity of the auricle is called the *concha* (shell). This concavity passes into the *meatus auditorius externus,* or outer opening of the ear. Above the concha and separated from it by a projection is the *fossa triangularis.*

Elastic fibrous bands, springing from the malar bone and mastoid process, fasten the auricle in its position, and allow it a certain mobility. The auricle is completely covered by the common integument of the body. This integument is more firmly adherent to the anterior surface of the cartilage than to the posterior and from it, at the lower edge of the ear, the lobe is formed. This contains no cartilage but fat and connective tissue. It is also poorly supplied with blood and nerves.

MUSCLES OF THE AURICLE.

There are three muscles which move the auricle and which are attached to the surrounding parts. They are:

1. *Levator* or *Attollens auriculam.*
2. *Attrahens auriculam*
3. *Retrahens auriculam.*

They are placed immediately beneath the skin. In man they are usually rudimentary; but they are large and important muscles in some of the mammalia.

Some persons and especially those whose hearing has become impaired from chronic aural disease acquire considerable power in employing these muscles, as well as the intrinsic ones.

The *levator* is the largest of the three muscles. It is thin and fan-shaped. It arises from the aponeurosis of the occipito-frontalis and its fibres converge to be inserted into the upper part of the auricle.

The *attrahens auriculam* is the smallest of the three. It arises from the lateral edge of the aponeurosis of the occipito-frontalis muscle. Its fibres converge and are inserted in front of the helix. This muscle is separated by the temporal fascia from the temporal artery and vein.

The *retrahens auriculam* consists of two or three bundles of fibres which arise from the mastoid process. They are inserted into the lower part of the inner surface of the concha.

The names of these muscles indicate their action; the levator slightly lifts the auricle; the attrahens draws it forward and upward, and the retrahens draws it backward.

INTRINSIC MUSCLES.

The auricle has also a set of intrinsic muscles. With a single exception these muscles run between different parts of the cartilage of the auricle and of the auditory canal. They are all very slightly developed and are pale and thin and flat. They lie closely upon the cartilage and are inserted into its fibrous covering by means of short tendinous fibres. They are sometimes absent. They generally exist at birth but they subsequently atrophy from want of use. Two of these intrinsic muscles of the auricle belong to the cartilage of the auditory canal, the remainder to the auricle. The former occasionally run over into the latter.

1. *Tragicus*—This muscle lies on the anterior surface of the anterior wall of the cartilage of the auditory canal, near the upper and the lateral border. It is quadrangular in shape and nearly as long as it is broad. It is composed of parallel fibres running nearly in a vertical direction.

2. *Anti-Tragicus*—This muscle lies on the posterior surface of the posterior wall of the cartilage of the meatus.

3. *Helicis Minor.*—This is the most constant and strongest of the muscles of the auricle. It is fan-shaped and is found on the lateral surface of the helix between its roots and spine.

4. *Helicis Major.*—This muscle runs over the anterior margin of the helix, to which it is loosely connected and passes over by a kind of tendinous termination into the levator of the auricle.

5. *Transversus Auriculæ.*—This consists of muscular fibres combined with loose connective tissues that run on the posterior surface of the auricle from the scaphoid fossa to the concha over the deep furrow corresponding to the anti-helix.

6. *Obliquus Auriculae.*—This muscle bridges over the furrow on the posterior surface of the auricle which corresponds to the prominence on the surface of the cartilage that forms the lower, sharp root of the anti-helix.

7. *Musculus Incisurae Majoris Auriculæ Santorini.*—This arises from the anterior circumference of the external meatus, whence it runs downward and outward to the lower border of the tragus, which it draws forward and thus enlarges the space of the concha. The power of moving the auricle as a whole is by no means very rare in man and is, of course, present in all other mammals.

BLOOD-VESSELS OF THE AURICLE.

1. Posterior auricular, from the external carotid.
2. Anterior auricular, from the temporal.
3. An auricular branch of the occipital.

The blood supply of the auricle is entirely from the external carotid artery.

The veins of the external ear empty in part into the temporal vein, as well as into the external jugular, or into the posterior facial vein.

NERVES OF THE AURICLE.

The nerves are the:

1. Auricularis magnus, from the cervical plexus on the posterior surface of the auricle. The cervical plexus is formed by the anterior branches of the four upper cervical nerves.

2. Posterior auricular, from the facial.

3. An auricular branch of the pneumogastric.

4. An auriculo-temporal branch of the inferior maxillary nerve.

PHYSIOLOGY.

Politzer thinks that the concha is the important part of the auricle in assisting the hearing. He found, on examination of persons hard of hearing, that the limit of audition was nearer the head as tested with the metronome, when the concha was covered by a stiff piece of paper, while no alteration in the hearing distance was observed if the other depressions of the auricle were covered.

A careful study of the auricle renders it tolerably clear that while the auricle is only a rudimentary organ, it is of some value in hearing. The tick of a watch is heard further when the concha is uncovered, and the general hearing seems to be aided by it.

The rudimentary capacity of the auricle as a resonator is greatly increased by placing the hand behind it. Those whose hearing is impaired increase their hearing in this way. If this were not the case the human race would have long ago abandoned the habit.

EXTERNAL AUDITORY CANAL.

The canal leading from the auricle to the membrana tympani consists of two portions, an outer part, which is formed of cartilage, and an inner, which is of bone.

Its external opening, which is formed by the cartilaginous portion, corresponds anteriorly and below with the margin of the external ear. Behind, it is demarcated by the ridge which connects the anterior border of the auricle with the margin of the osseous meatus; above, it is bounded by the root of the helix.

Inasmuch as the membrana tympani is not on a plane perpendicular to the walls or sides of the canal, these do not extend equally far inward. The anterior and inferior wall is the longest. It thus becomes impossible to give an exact measurement of the canal which can be applied to all ears. The canal is also curved and its cartilaginous portion is very elastic.

The first curvature is zigzag in shape. These curvatures may be overcome, and the outer portion of the canal rendered nearly if not quite straight, by drawing the auricle upward and backward. The cartilaginous portion of the canal is interrupted, especially on its inferior wall, by gaps and fissures—the so-called *Incisurae Santorini.* These gaps are filled up by fibrous tissue. The osseous portion is an integral portion of the temporal bone, and has a groove for the insertion of the membrana tympani.

The length of the canal varies from one-half to one inch. The cartilaginous portion forms about one-third, and the osseous canal the remaining two-thirds.

The angle which the upper wall of the canal forms with the membrana tympani is obtuse; that between the lower wall and the drum-head is acute, about 45°.

The width of the canal also varies. It is widest at the junction of the osseous with the cartilaginous canal, and next to the membrana tympani.

Casts of the canal show that the canal is a spiral turning anteriorly inward and downward.

The auditory canal is lined by integument and not by mucous membrane. The nearer it approaches the membrana tympani, the thinner it becomes, and finally it covers the drum-head as a very thin layer.

The integument of the cartilaginous portion of the canal is 1½ mm. thick, and contains hairs, sebaceous glands, the ceruminous glands, and a little fat in its subcutaneous tissue. In the osseous part of the canal, the integument is only 0.1 mm. in thickness, the hairs become very few, and the ceruminous glands are found only on the posterior upper wall, where they are generally seen even close to the membrana tympani. Small papillæ can be demonstrated arranged in rows under the cuticle and also a corium with abundant elastic fibres, of which the lower layers pass into the periosteum.[1]

There are about from one thousand to two thousand ceruminous glands. The secretion of the ceruminous glands is a yellowish-white rather fluid material and cells in which globules of fat and coloring matter are

[1] *The Organ of Hearing.* J. Kessel, Stricker's Manual, p. 951. Translated by J. Orne Green.

embedded; there are also hairs and scales of epidermis from the lining of the meatus. When the cerumen has remained in the canal for a long time, its watery contents are lost by evaporation, and it becomes a hard mass.

The child at birth and for some time after has no osseous meatus. The cartilaginous portion is at first attached to a membranous part, which afterwards ossifies. This ossification proceeds irregularly and often leaves a foramen, which has been mistaken for a pathological condition, the result of caries. An inflammation of the meatus in a young child might readily pass through this foramen to the maxillary articulation or parotid gland.

RELATIONS OF THE AUDITORY CANAL.

The cartilaginous portion is bounded anteriorly and inferiorly by the parotid gland. Abscesses of the parotid have discharged into the auditory canal, through the fissures of Santorini. Enlargements of the parotid or lymphatic glands may contract the calibre of the canal by pressure. The anterior wall is also in relation with the inferior maxillary bone. Hence a blow upon the chin may produce hæmorrhage from the ear.

The posterior wall is made up by the mastoid process in such a way that the canal is only separated from the transverse sinus by two thin plates of osseous tissue and the air cells lying between them. The superior wall is covered on its upper surface by the dura mater, and forms a portion of the floor of the middle fossa of the skull.

The wall between the integument of the canal and the *dura mater* may be exceedingly thin, and inflammations of the meatus may produce meningitis.

The auditory canal is bounded above and behind by portions of the mastoid cells, that are included in the middle ear, so that, strictly speaking, a portion of the mastoid part of the middle ear is situated external to the membrana tympani. Inflammations of the mastoid in not unfrequent cases, occur with no perforation of the membrana tympani, and the pus evacuates itself in the auditory canal.

BLOOD VESSELS OF THE AUDITORY CANAL.

1. Posterior auricular artery, which also supplies the auricle.

2. Deep auricular, from the internal maxillary. It enters at the articulation of the lower jaw, supplies the tragus and then gives off branches to the canal.

NERVES.

1. From the third branch of the trifacial or fifth nerve. These enter through the anterior wall, between the cartilaginous and osseous portions.

2. An auricular branch from the pneumogastric (Arnold's nerve) which enters the anterior wall of the bony canal.

The effect of irritation of this branch is often seen by the cough produced when the aural speculum is pressed upon it, or when the part is touched by a probe.

The muscles are supplied by the facial nerve.

PHYSIOLOGY.

The length and curvature of the auditory canal prevent the membrana tympani and auditory canal, under ordinary circumstances, from being injured by wind, changes of temperature, and the like. The cerumen guards against the frequent entrance of insects. The auditory canal increases the power of tones by acting as a resonator.

CHAPTER III.

THE MALFORMATIONS AND DISEASES OF THE AURICLE.

1. *Malformations.*—Many of the so-called malformations are the results of ill-treatment of the auricle, Many women, especially those of the lower class, cover their ears so tightly with their hair, cap and hood, that they finally by the excessive pressure, flatten out and fill up the elevations and depressions which go to make a finely-shaped auricle. Children's auricles are sometimes injured in their passage from the womb to the world. Boys often get into the bad habit of pressing their caps down upon their ears. They thus cause them to lap over and give them the unsightly appearance known as "dog ears."

An operation for the relief of this deformity is performed as follows: An incision is made through the skin, along the entire length of the furrow formed by the junction of the auricle with the side of the head posteriorly. This is joined at each end by a curved incision carried over the posterior surface of the auricle. Then the skin and subcutaneous tissue included by these incisions is dissected off. Two incisions parallel to these are then carried through the cartilage and an elliptical piece of the latter about an inch and a half by one-half is cut off. The pieces of excised skin are to be larger than these, the edges of the wound are then united by sutures, the greater part of which pass through the skin, but some of them through the cartilage. The wound is then dressed with gauze and a bandage.

Detachment of the auricle has now become a very frequent operation, and is so easily performed that this operation is to be unhesitatingly undertaken whenever necessary.

ARRESTED DEVELOPMENT.

MICROTIA.

There is a class of malformations of the auricle which has the same pathological interest with other forms of arrested development such as spina bifida, and coloboma iridis, but unfortunately they are also cases for which our art can do nothing. Reference is made to those cases in which the auricle is congenitally absent, or where it exists only in a rudimentary form. In such instances the cartilaginous and osseous auditory canals are usually also wanted, but the middle and internal ear may be well developed.

There are cases, however, in which the whole ear is undeveloped. The deformity usually affects but one ear, but both ears are sometimes similarly deformed. Attempts have been made by surgeons to make a passage to the drum-head and middle ear, but as yet they have failed. It is probable that the middle ear is not in a normal condition, for the impairment of hearing is usually if not always greater than could be explained by the mere absence of a canal leading to the membrana tympani.

Superfluous auricles sometimes occur, just as do supernumerary toes and fingers. They are objects of anatomical curiosity rather than of therapeutical interest. An old writer, Beck, details a number of cases in which, by freaks of nature, the auricle was placed on the back, the shoulder, and near the angle of the mouth.

FISTULA OF THE AURICLE.

Fistulous openings in the auricle which are said to be congenital and from which pus escaped at certain times are occasionally seen in practice.

In some cases these fistulæ are associated with others in the region of the thyroid body. They are very difficult to heal. They are to be treated by free incisions to the bottom, curetting, the application of argyrol, 10-20 per cent, nitrate of silver gr. xx—℥ j or the like. Some are connected with the auricle directly and there are others over the mastoid process or even in the neck. These are very troublesome and require serious treatment, especially those communicating with the osseous bony canal. Such fistulae are sometimes led into pockets of pus which become a source of danger. General surgical principles should be followed in their treatment by clearing them up from the bottom and destroying the source of the pus. It is sometimes necessary to chisel away the bone to get at the bottom of the fistula.

FIBRO-CARTILAGINOUS TUMORS.

The fibro-cartilaginous tumor is a simple hypertrophy of the normal structure of the auricle. They are usually hypertrophy of a cicatrix. They occur more frequently among Africans than the other races. In the East and

West Indies they are seen of an enormous size. They usually occur as the result of irritation of the lobe of the ear produced by wearing ear-rings. Those of brass are much more irritating than those of gold.

ANGIOMA OF THE AURICLE.

Angioma of the auricle is not a common disease. It occurs in the form of tumors which are sometimes red but oftener have the appearance of varicose veins. The size of the tumor varies from that of a pea to an almond. They may be situated on the lobule of the ear or on the surface of the auricle, and frequently are distributed about the orifice of the external auditory meatus, and may extend from the orifice to the adjacent surface of the neck. They may be single or multiple. If single, they are apt to be large; if multiple, they may be confluent or isolated.

Cause.—These growths are frequently congenital; sometimes they are occasioned by traumatism or freezing.

Symptoms.—If the growth of the angioma is slow there may be no symptoms arising from it. Sometimes these small growths are the sites of subcutaneous hæmorrhage, then the growths and the adjacent tissue are discolored by the extravasated blood. If the growth is rapid it is frequently accompanied by a pulsating pain. Occasionally in rapid growths pulsation can be detected in the dilated vessels.

Treatment.—The treatment of these tumors varies according to their size. If the growth is small, the principle of treatment is to cause a thrombosis of the vessels causing the angioma. This may be satisfactorily done by ligation with a needle and silk thread passed under the tumor and tied over its surface. The vessels are obliterated and the superficial skin heals rapidly by granulation. The deformity caused by the scar is not marked.

Electrolysis is perhaps a better method of treatment. For this purpose a galvanic current of about 20 volts and 5 milliamperes is passed into the growth by means of two needles attached to the connecting wires of the battery. The needles are introduced slowly, so that the coagulation of blood and the cauterization of tissues occur in front of the needle. This prevents hæmorrhage. When the needles have been introduced into the growth they are allowed to remain until the adjacent tissue becomes whitened, when they are removed and introduced into another part. It is not wise to puncture the growth in more than three places at one sitting, for the inflammatory reaction is sometimes considerable. After sufficient time has elapsed for the reaction to subside, the needles are again used in other parts of the growth, and this treatment is repeated until the angioma is slowly destroyed. It generally heals without sloughing and the deformity arising from the scar tissue is unimportant.

If the tumors are large, the only correct treatment is excision. The external carotid artery is ligated previous to the excision of the growth, and then the tumor is removed with a V-shaped incision. The edges of the wound are sutured and the ordinary dressings applied.

ERYSIPELAS OF THE AURICLE.

Erysipelas of the auricle is an infectious disease which sometimes results from erosions or injuries. It is due to an invasion of the wound by the *streptococcus erysipelatosus.* The original erosion or injury is not always easy to find, being sometimes a mere scratch which escapes detection. At other times infection follows surgical injury. Erysipelas may begin upon the auricle, but it is generally an extension from an affection of the face.

Appearance.—The skin of the auricle is reddened and swollen and the entire auricle is enlarged. The skin has a brawny, shiny, red appearance which is quite characteristic of erysipelatous inflammation. After twenty-four or forty-eight hours small bullæ appear on the surface, these subsequently change to pustules which break, discharging their contents upon the surface of the infected area. When the bullæ rupture the contents dry and a scab appears over the infected area. The limit of the infection is indicated by a reddish, oedematous line of demarcation. When the lesion is established it spreads rapidly, the line of demarcation advancing over the healthy skin, the evidence of inflammation subsiding in the region of the original infection.

Symptoms.—The invasion of the disease is indicated by a chill of greater or less severity, and by a rapid rise of temperature—103 to 104°. The temperature quickly subsides to 101° and continues about this, unless complications arise or marked sepsis occurs. In this case there is a reappearance of the chill followed by high temperature. Prostration, loss of appetite, and vomiting are common accompaniments. The local symptoms are a burning pain in the auricle, associated with the evidences of cellulitis which have been already described.

Course.—In mild cases of erysipelas of the auricle the course of the disease is only for a few days, if there is no extension of the lesion. Sometimes, however, the erysipelas beginning in the auricle spreads by reinfection over various parts of the body, and the course of the disease is prolonged for weeks or months. The disease terminates by a gradual disappearance of the cellulitis or by abscess formation, or sloughing. If abscesses form, the skin becomes infiltrated and indurated, and if the abscesses are of any size fluctuation may be observed. If abscesses formation takes place, they are apt to be extensive. In the grangrenous form of erysipelas sloughing is extensive and such cases may terminate fatally.

Treatment.—As soon as a diagnosis is made, isolation is imperative; and the strictest care must be taken to prevent the infection of the nurse or physician. The patient should be put to bed, placed upon a fluid diet, and given tincture of Ferri-chloride—10 minims every hour. If there are symptoms of weakened action of the heart, cardiac stimulants are necessary. These are best administered in the form of whisky, strychnine, or nitro-glycerine. One or all of these should be given in sufficient doses to control the depressed circulation. Large doses are often necessary.

The local treatment is best carried out by means of constant applications of ichthyol. A convenient form is an ichthyol solution of 2 or 3 per cent applied over the infected area with pieces of gauze. Sometimes a 2 per cent solution of ichthyol dissolved in collodion is painted daily over the erysipelatous area. A favorite method of treatment consists in the application of solution Plumbii sub-acetatis cum opii; this is also applied with a piece of gauze. Another very successful form of treatment is the application to the infected area of gauze soaked in a solution of aceto-tartrate of aluminum, 1 drachm to the ounce.

PERICHONDRITIS OF THE AURICLE.

This is not an infrequent disease. It is generally produced from freezing or traumatism. Occasionally the cause cannot be ascertained. It first appears as an inflammation of the auricle, with swelling and redness. Afterwards fluctuation from pus appears over the seat of the swelling, and local heat is present. Pus accumulates beneath the perichondrium and dissects its way between this and the cartilage, depriving the cartilage of nutrition and causing its necrosis. Sometimes the abscess will rupture spontaneously; at other times the pus continues to burrow, the cartilage necroses and the skin ulcerates, thus producing an extensive destruction of the auricle. Granulation tissue then forms and the diseased part heals slowly. Extensive deformities of the auricle will result if the disease is allowed to pursue its own course.

Treatment.—Surgical treatment consists of early incision through the entire diseased area, with subsequent irrigation and antiseptic treatment. If possible the skin and perichondrium should be incised before pus collects. At later stages, the pus should be liberated at once. After the incision pieces of gauze dipped in a 5 per cent solution of ichthyol in glycerine, or gauze dipped in *liquor plumbii subacetatis dilute,* is used as an application. In some cases the incisions should pass through the auricle from one side to the other.

Chondritis and perichondritis of the auricle may result by simple extension of an inflammation of the cartilage of the canal. Prolonged poulticing may favor such an extension. The deformity from such an inflammation will be considerable under the most favorable circumstances, if the inflammation once sets in. When fluctuation occurs, it is better to make a thorough opening, and to connect sinuses by cutting so as to convert them into open wounds. Iodoform gauze forms a good dressing after incisions. Vaseline is a good application for the swelled tissue when suppuration does not occur. Over this, absorbent cotton and a bandage generally form a comfortable dressing, and perhaps aid in lessening the inevitable deformity. There is no reason to doubt that chondritis usually originates in the cartilage of the canal, and that any case of furuncle under unfavorable conditions may result in chondritis or perichondritis of the auricle. Perichondritis and chondritis may be readily distinguished from othæmatoma if the disease be seen early in its course, but when the canal, if once diseased, has recovered, and the auricle alone remains affected, there may be a possibility of error.

MALIGNANT DISEASE.

Epithelioma.—The auricle is sometimes, although not frequently, the seat of malignant disease. Epithelioma of the auricle usually begins as a small papule, which finally develops into an open ulcer. This spreads very rapidly, involving finally the auditory canal, and unless arrested, the deeper parts. Excision or amputation of the parts is the only proper treatment. Treatment by the X-ray should be considered. When the auricle alone is involved, this is very easily accomplished. In the healing process care should be taken to prevent the closure of the meatus by the cicatrix.

Sarcoma.—Sarcomatous tumors may occur on the auricle as well as in the auditory canal, where they arise from the cartilaginous portion. They grow very slowly but they may extend to the auditory canal, to the middle ear, and even to the labyrinth and meninges of the brain. Early removal is the only safe means of treatment, and even then the growth may return. Here again the X-ray treatment offers some hope.

ECZEMA.

Eczema of the auricle is not one of the most frequent affections of the ear. A large number of cases never come under the attention of special observers. Inasmuch as eczema of the auricle is usually attended by the same disease in the auditory canal, it will be more convenient to speak of them both at this time.

Eczema of the ear seems to occur more frequently among females than males, but it is found in both sexes. The symptoms are the same as those of eczema in other parts of the body, with some symptoms peculiar to the ear. The symptoms peculiar to the ear are redness, swelling, and the formation of vesicles which become pustular, and which finally cover the whole region with unsightly crusts, under which a discharge occurs. The auricle becomes a misshapen mass, while the swelling and incrustation of the integument lining the auditory passage and membrana tympani impair the hearing to a serious extent. Fulness and noise in the ears are then added to the patient's other symptoms. The disease is apt to run a very chronic course, if left to itself, and yet it is very amenable to proper treatment. The causes of eczema are not very clear. It rarely occurs upon the auricle alone; but it is usually found in conjunction with the same disease on other parts of the body, most frequently in conjunction with eczema of the face and head, although it sometimes occurs on the auricle and in the meatus alone.

Treatment.—The results of treatment of acute eczema are usually soon seen. Do as little as possible in the acute form. The auricle should be kept from the air. This may be accomplished by the use of oils, powders or even by a plaster-of-Paris bandage. A good application is the formula of Ausspitz:

℞.	Flor. Zinci . . . . . . ʒij.
	Pulv. Alum.
	Amyli Pulv̄ . . . . . . aa ℥ j.
M.	Ft. pulv.

This powder is dusted over the affected portion with a camel's hair brush. If the auricle be excoriated and sensitive, astringent solutions of sulphate of zinc may be used. Vaseline or cold cream in the early stages of eczema of the auricle should be used. The parts should be constantly covered with such a non-stimulating ointment as one of those just named.

At the same time with this local treatment the physician should carefully consider the general state of the patient, since in this a cause for the eczema may often be found, which being removed by appropriate management will prevent a relapse of the affection.

Eczema of the auricle and auditory canal is not often brought to the notice of the surgeon until it has become chronic. Its treatment then may require the greatest patience and care. The auricle is carefully but liberally anointed with olive oil. It is then covered with an impermeable sheeting of rubber tissue or oiled silk, in order to keep the parts soft and pliable, and bandaged. An improvement will soon be noticeable inasmuch as the crust will become detached. The inflamed corium which is now exposed will soon yield to a soothing salve.

The diachylon ointment of Hebra, spread thickly on lint and applied to the surface will act very well. After the eczema has ceased to exude, we may conveniently add the oil of tar, ol. fagi, or ol. cadini—one drachm to the ounce, either to Hebra's ointment or to the officinal zinc salve, to which a little oil of sweet almonds may be mixed. An addition of salicylic acid in non-irritating doses, three grains to the ounce of salve, will promote the formation of healthy epidermis.

The local treatment of the auditory canal is often inefficacious from the want of the personal attention of the physician. No one who is unable to examine the external opening of the ear down to the membrana tympani can tell when it is or is not clean. Without a thorough removal of the material thrown off in an eczema there can be no cure. An eczematous auricle may perhaps recover spontaneously, an eczematous auditory canal will, probably, never thus return to a normal condition. The material thrown off from the inflamed integument collects in the narrow passage and by mechanical irritation increases the swelling, and produces the most troublesome symptom of the disease—impairment of hearing. The auditory canal should be therefore carefully cleansed every day with the syringe and angular forceps or cotton holder, under a good illumination with the otoscope, and then an appropriate *liquid* application be made. A liquid preparation is to be preferred to an unctuous one. An ointment will block up the passage and thus prevent the patient from securing the full benefit to his hearing power which the removal of the epidermis, crusts and pus has produced. We may fail to cure many a case of disease of the integument lining this part, if we do not carry out our own advice; we should never give over the treatment into the hands of the parents or attendants of the patient, for they will be incompetent assistants.

The warm douche is valuable in the treatment of chronic eczema of the canal, but it must be sparingly and judiciously used. It allays itching sensations, and is usually very grateful to the patient. The use of the douche may be intrusted to the patient himself. The warm water is a direct antiphlogistic.

The application of nitrate of silver in solutions of from 10 to 40 grains to the ounce, is one of the best that can be made in the treatment of eczema of the canal.

Bichloride of mercury in solutions of from one-twelfth to one-fourth of a grain to the ounce, applied with a dropper or by means of the cotton-holder, has proved an efficient remedy in chronic and mild cases of eczema of the canal.

The only specific remedy for internal use in chronic eczema of the auricle, as well as that of the same disease in other parts of the body, is arsenic. In chronic cases Fowler's solution in connection with the local treatment is generally of great service.

OTHÆMATOMATA, OR VASCULAR TUMOR OF THE EAR.

The effusion of blood which occurs in the auricle and especially among the insane, and which is known as othæmatoma, hæmatoma auris, or vascular tumor of the auricle, has caused much discussion among scientific observers. The so-called othæmatomata may be divided into idiopathic and traumatic. The idiopathic form occurs chiefly among the insane. Before the tumor appears we find the ear or ears red and swollen and the face and eyes reddened; occasionally, however, there is no redness of the skin and there is merely some œdema of the auricle; among the insane there is no manifestation of general ill-health. In a few hours or days, an effusion of blood takes place. The tumor principally occupies the concha but it may extend over the auricle, so as to obliterate its ridges and appear like a roundish reddened tumor, varying in size from a bean to a hen's egg. This tumor is evidently of an inflammatory nature. The swelling is usually quite firm and it fluctuates.

The vascular tumor of the auricle is much more common among men than women. Hæmatoma auris, when occurring in the insane, is a symptom which is highly unfavorable and which points to an incurable form of disease of the brain.

The tumor either ruptures spontaneously, or is gradually absorbed. Rupture is more common than absorption.

The etiology of hæmatoma is deemed by Hun to be twofold, viz: cerebral congestion and centripetal irritation of the system by the emotions; and he considers either of these causes sufficient to produce the effusion. In general paresis there is, according to all authors, a tendency to repeated congestions of the head, and it is supposed that the blood-vessels of the ears become so dilated as to favor the effusion. Centripetal irritation of the sympathetic from strong emotions is also especially active among the insane.

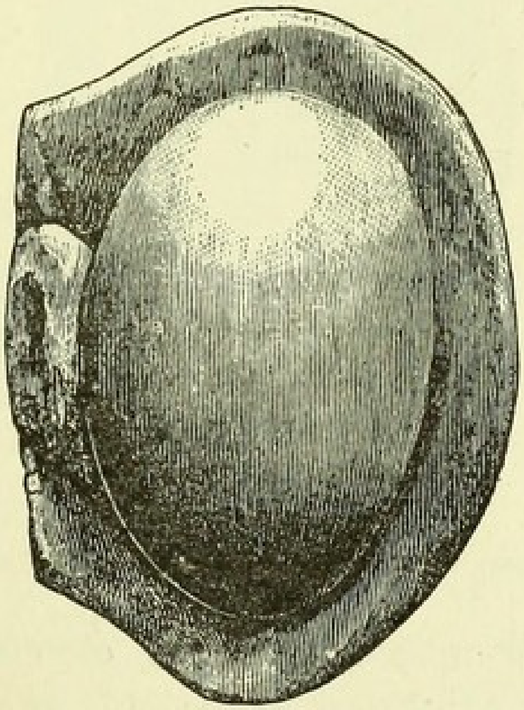

Fig. 21.—Othæmatomata at Greatest Tumefaction (Hun).

According to Virchow the morbid process is primarily a softening or deliquescing one, induced by general disturbances of nutrition, or *possibly*—although this class of cases seems to belong to itself—by local injuries of the cartilage. The tumor disappears either by gradual absorption, spontaneous rupture or by surgical interference.

Coagula often form which makes a delicate coating over the separated portions, and these afterward serve as means of adhesion. When suppuration does not take place, great deformity is apt to occur from the thickening and retraction of the soft parts, especially of the perichondrium.

From all that has been written of vascular tumors of

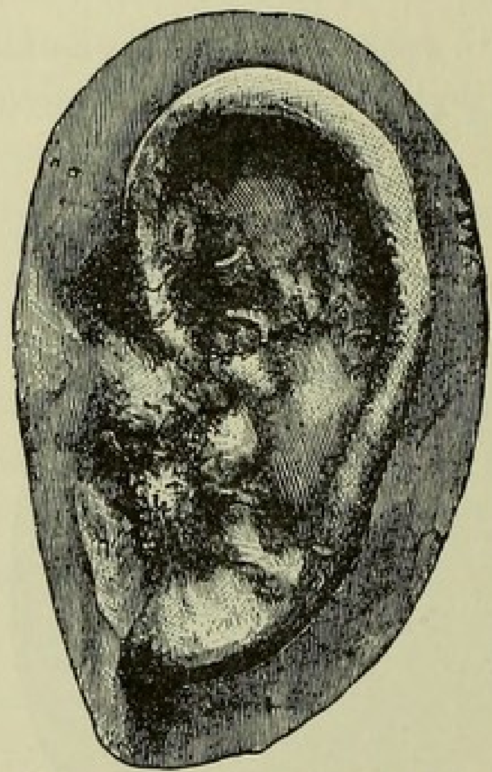

Fig. 22.—The same Ear after Rupture and Contraction (Hun).

the ear, and from our personal experience, we may safely affirm:

First.—That there are two distinct varieties of othæmatomata: Traumatic and Idiopathic.

Second.—That the idiopathic is much more common among the insane than among others, but that identically or nearly the same affection does not occur among the sane. It is probable, however, from Brown-Sequard's experiments, that the affection is caused by some lesion of the base of the brain.

Third.—The traumatic form differs from the idiopathic in being a simple extravasation of blood from vessels ruptured by violence.

Fourth.—The treatment by pressure after evacuation of the contents, followed by moderate massage, gives very good results.

SYPHILIS OF THE AURICLE.

The secondary manifestations of syphilis are sometimes seen upon the auricle. The various syphilitic eruptions may occur here as upon the other parts of the common integument. Ulcerative processes from syphilis may take place in the auricle. Gummy tumors may also occur in this part. It is hardly necessary to say anything more with reference to these evidences of constitutional syphilis than that they should be subjected to the appropriate constitutional treatment by means of mercury and iodide of potassium, while soothing local applications are made.

THE EFFECTS OF GOUT.

Calcareous formations are often found in the auricle in persons of a gouty habit, as in other parts of the body. These features of gout are often accompanied by local pain. These formations are found to be urate of soda. They are most frequent on the upper border of the helix, and are supposed not to exist on the lower part of the auricle.

Where the gouty diathesis exists, it is not uncommon to find heat and pain in the cartilage of the auricle. The practitioner should be on the lookout for such cases of apparently simple dermatitis, for they may indicate the constitutional trouble, which will only be relieved by treatment of the general condition.

INJURIES OF THE AURICLE.

Wounds of the auricle may infrequently be followed by an infectious inflammation. They usually heal promptly, without suppuration, although inflammation of the cartilage or the perichondrium may result. Injuries of the auricle from direct violence, such as pugilists inflict upon each other, generally produce deformity. The treatment of such injuries requires no special notice in a work of this kind.

Congenital absence of the auricle or its complete loss cannot be remedied, although attempts are said to have been made to transfer an auricle from one human being to another by transplantation, the two subjects being together until the sound auricle adheres to the ear of the patient. There is no justification for such an attempt to relieve this deformity.

HERPES ZOSTER OF THE AURICLE.

This lesion of the nerves consists of the formation upon the ear of vesicles filled with serum, accompanied by pain of a neuralgic character. These may be isolated or they may be grouped together and sometimes are confluent. The yellow vesicle is developed upon a reddened base. This form of lesion of the auricle may be distinguished from ordinary Herpes, by the presence of constant neuralgic pains, and by the development of the vesicles over the course of the sensory nerve of the auricle. The pain precedes the eruption and subsides with its appearance. In a few cases the pain may persist after the development of the vesicles, or it may continue after they have entirely disappeared.

Course.—In every respect the course of the lesion resembles Herpes Zoster of the intercostal nerve. After the vesicles have formed, they break and discharge and a scab forms over the seat of vesication. Usually they do not reappear. The pain generally subsides with the appearance of the vesicle, and healing follows promptly, after the formation of the scab.

Treatment.—The local treatment is directed to the relief of the pain. Solutions of cocaine and morphine may be applied to the eruption, or a cocaine and morphine salve may be used. The internal treatment consists of the administration of quinine in full doses—6 to 10 grains per day; Fowler's solution of arsenic, 6 minims three times a day; and of the coal tar preparations, antipyrine or acetanelide, in doses sufficient to control the pain. After the pain has subsided and the vesicles have discharged, the healing may be facilitated by the use of a dusting powder of bismuth subgallate (Dermatol), or by the use of compound stearate of zinc.

LUPUS.

FORMS OF LUPUS.

Lupus Vulgaris is a chronic affection of the skin of the auricle, and is generally secondary to the same disease in other parts of the body or adjacent to the auricle. A few cases of this disease have been reported where the involvement of the auricle was secondary to the involvement of the middle ear, the Lupus having originated in the pharynx, spread through the Eustachian tube to the tympanum and thence to the external auditory canal, thus reaching the auricle. It seldom originates in the auditory canal. The lesion resembles Psoriasis, but it may be distinguished from it by the presence of tubercles or nodules within the area of scabbing. These tubercles or nodules are always subcutaneous. The nodules may be isolated or grouped. When isolated, they may be seen as tiny punctate, whitish deposits within the skin, shining through the epidermis. When they are grouped, the nodules frequently coalesce, thus forming irregular, subcutaneous, nodular masses. This form of Lupus rarely ulcerates, but after a while the nodules undergo cicatrization and finally disappear. The disappearance of the nodules is followed by the formation of a bluish-white cicatrix, which remains as a permanent evidence of the former presence of the disease.

The characteristic features of *Lupus Vulgaris* are the presence of small isolated nodules in the more recently affected area, while in the older areas the nodules will be larger or coalesced, and the surface will be covered with shining scales. The still older portion of the involved area will present the characteristic bluish-white cicatrices.

Lupus Exulcerans rarely involves the auricle alone, but generally extends from the cheek, where it most frequently occurs. The type of ulceration does not differ in appearance from the disease occurring in other localities. The ulcer varies in size, the edges being undermined and irregular, and the surface covered with crusts or discharge. The nodules are similar in appearance to those of *Lupus Vulgaris.* Generally the older parts of the ulceration are undergoing cicatrization. The disease develops slowly over a long period of time, and this element of chronicity is an important one in the differential diagnosis.

Lupus Hypertrophicus.—This form of Lupus in its general characteristics is the same as *Lupus Exulcerans.* It may be distinguished from it by the presence of excessive granulation tissue which has developed upon the ulcerated surface. This form is apt to be confused with Epithelioma. By the presence of nodules, its chronicity, and the characteristic cicatrix we may distinguish it from carcinomatous affections.

Treatment of Lupus.—If the Lupus is not extensive, it may be successfully treated in a number of ways.

1. *Cauterization.*—Each nodule is touched with the cautery, the intervening skin being left undisturbed. It is necessary to cocainize the area to be cauterized by means of a $\frac{1}{4}$ of 1 per cent solution of cocaine in sterile water, which is injected into the affected area. Freezing with ethyl chloride is sometimes a convenient form of anæsthetization. After the parts have been rendered insensible, each nodule should be sought with a magnifying glass, and a very fine heated needle passed into it. The best form of cautery is the Pacquelin, but a sharp steel needle or a platinum one may be used if the Pacquelin cautery is not obtainable.

2. *Caustic Method.*—In this treatment silver nifrate fused upon a probe is used to cauterize each individual nodule. The epidermis covering the nodule is easily penetrated by the silver, the minute globule of which passes through the epidermis into the nodule and is held there until it is completely cauterized. When the

epidermis is not easily punctured, it should be removed by covering it with a 30 per cent solution of potassium hydrate. The nodules are thus exposed and may be cauterized by the solid globule of silver fused upon a probe, or by a 25 per cent solution of nitrate of silver painted over the surface. A dusting powder should be used after the application. Such a powder may be composed of compound stearate of zinc containing a small quantity of iodoform or aristol. This cauterization should be repeated as soon as the reaction has subsided, until every nodule is destroyed.

Carbolic acid forms a very satisfactory agent for the cauterization of these nodules. In this method the epidermis is removed with a 30 per cent solution of potassium hydrate, after which the carbolic acid is applied to each nodule for a few seconds. Alcohol, 95 per cent, should then be applied to counteract the cauterizing effect of the carbolic acid upon the adjacent tissue.

3. *Method with the curette.*—All forms of Lupus presenting ulceration should be curetted with a sharp spoon previous to the cauterization of the base of the ulcer. For this purpose, the entire surface of the ulceration should be scraped away with a sharp surgical spoon of suitable size and all of the nodules on the edge of the ulcer removed. It is necessary to produce anæsthesia of the surface before the curette is used, and this may be done with a weak solution of cocaine, ¼ to 1 per cent, injected into the space involved or a satisfactory anæsthesia is produced by the use of ethyl chloride.

After the curette has been used, the base of the ulceration must be cauterized. For this purpose lactic acid

C. P. may be rubbed into the base of the ulceration, or silver fused upon a probe may be used to cauterize the whole surface. Sometimes the galvano cautery may be advantageously substituted for the silver. The wounded surface should then be covered with a dusting powder of aristol, bismuth, or iodoform, mixed with a compound stearate of zinc, and a surgical dressing applied. This dressing should be changed every day. As soon as new nodules appear or areas of ulceration develop, the treatment must be repeated, until the entire area is cicatrized. The cicatrix must be watched for the reappearance of commencing nodules.

4. *Excision.*—This method of treatment is applicable only where the infected areas are very small, and consists in the removal of a wedge-shaped piece containing the lupus, and the approximation of the edges of the wound with sutures.

5. *Treatment by Roentgen Rays.*—The X-ray treatment has been used with great success in the treatment of all forms of lupus. The exposures are made for thirty minutes twice a week.

6. *Finsen Light.*—This method of treatment has been successfully pursued in Sweden and England. It should always be tried as soon as a diagnosis is made, and before other forms of treatment have been instituted. For the details of this treatment, the reader is referred to the original articles of the late Professor Finsen.

CHAPTER IV.

DISEASES OF THE EXTERNAL AUDITORY CANAL.

THE external auditory canal is subject to a variety of diseases and accidents which will be fully described in their order.

Infections of the auditory canal that are actually limited to this part of the ear are less frequent than those of the middle ear. The statistics of aural disease in general, as seen in public and private practice, indicate a percentage of about twenty-five of external affections out of a total number of cases of the various diseases of the ear.

DIFFUSE INFLAMMATION.

Symptoms.—The subjective symptoms of diffuse inflammation of the external auditory canal are itching sensations in the canal, pain and a sense of fulness and heat.

The objective symptoms are impairment of hearing, redness of the canal, and perhaps of the membrana tympani, swelling, and, at a subsequent period, suppuration of the integument. In the lower part of the canal, where we have the density and tenseness of periosteum, the pain may be as severe as that from inflammation of the lining of the tympanic cavity or paronychia.

Prolonged suppuration of the integument or even suppurative action that has been of short duration, but violent, may produce polypi, or granulations, in the external auditory canal.

The prolonged use of poultices in the auditory canal, now happily more rare than in former days, produces tedious suppuration and also granulations. Their use should be avoided. The practitioner need give himself no uneasiness about the occurrence of these granulations. As a rule, they subside spontaneously. If not, when well pedunculated they are easily removed with a curette with sharp edges.

The microscopic appearances of the growths are identical with those of polypi springing from the mucous membrane of the cavity of the tympanum.

Causes.—Sepsis from irritation of the ear by means of ear-picks by hairpins and other unclean instruments; the instillation of irritating ear-drops are frequent causes of an inflammation of this part.

Surf-bathing sometimes is a cause of inflammation of the auditory canal and outer layer of the membrana tympani. When the ears are filled with water, they should be carefully dried. Prolonged and repeated diving should be avoided. Caps of oiled silk and plugs of oiled cotton are also useful in bathing to those whose ears are sensitive to the entrance of salt water.

Cold draughts of air are often spoken of as causes of inflammation of the outer canal; but such influences are more apt to produce an inflammation of the naso-pharyngeal space and through that of the middle ear. In fact, the causes of external otitis diffusa seems to be chiefly local, that is, the disease is produced by mechanical causes acting locally. There may, however, be an antecedent eczematous inflammation.

A diffuse inflammation of the external auditory canal, quite often occurs during the latter part of the course of an acute suppuration of the middle ear, but it usually subsides without special treatment.

Physicians are often asked if the outer ear should be protected from the cold air by a plug of cotton, earmuffs, or similar means. The beginning of aural inflammation is rarely from the auditory canal, although the auricle is sometimes frozen from exposure to cold. If, however, a person sits in a railway carriage which is going very fast, and the ear is next to an open window, or if the auditory canal and membrana tympani be exposed in any similar manner, to a draught of air, an inflammation of the canal and of the tympanic cavity may ensue. But when there is no such draught upon the ear, as, for instance, when a person is walking or driving in the open air, there is no need, unless there is danger that the auricle will be frost-bitten, of using a covering to the meatus auditorius any more than to the nostrils. The natural curvatures of the canal will prevent a current of air from reaching the drum-head. This is, however, only true as respects healthy ears.

The canals sometimes become very sensitive to the cold, and require protection when healthy ears do not. When no inconvenience is felt from allowing the ears to remain uncovered it is better to leave them without protection. The habit of plugging the auditory canals with cotton on every slight pretext is a bad one, because it is apt to irritate the integument and to cause the ears to be over-sensitive and it may produce dermatitis.

There is altogether too much solicitude on the part of mothers and other persons as to the cleanliness of their children's and their own ears. The auricle and the edges of the opening into the canal, which are about all that the little finger will reach, are the only parts of the organ that require cleansing when the ears are in a state of health. Any further manipulations with towels, ear spoons and so on, are meddlesome, and may become dangerous to the integrity of the canal.

Treatment.—An attack of diffuse inflammation of the external auditory canal (*otitis externa diffusa*) in an adult may sometimes be cut short by the use of leeches. They should be applied on the tragus, for at this place the vessels which supply the canal and outer layer of membrana tympani are most conveniently and surely reached. Leeches in this form of disease are not as certain to afford relief, however, as when used for an inflammation of the middle ear. In the early stages of the disease, when the pain is severe, and suppuration has not yet occurred, but the canal is red, swelled, and sensitive, great benefit will be produced by scarifications of the cartilaginous wall. This scarification is made with a tenotomy knife. The incisions should be from three-fourths to an inch long on the walls of the canal. Hot water should also be allowed to run into the ear, by means of the fountain syringe, or any similar means. When patients are told to apply hot water to the ear, unless they are particularly instructed, they will almost invariably use an ordinary syringe; but what is required is the steady flow of warm water upon the part, and this is best attained by means of the aural douche, so called irrigation. Patients should be instructed in its use, and especially should they be told that, unless the auricle is kept on the stretch, so that the walls of the canal are apart, the water will not enter the ear in a full stream.

The temperature of the water should be from 90° to 102–104° F.

Objections are made by some writers to the continuous use of hot water in inflammation of the canal, but there is great value in the use of the hot douche in the vast majority of cases of acute inflammation of the canal and tympanum. There are a few patients who can bear it only for a time, but most patients, even young children, who at first object to its use, soon find in the warm douche a continuous source of relief from pain.

In the absence of the bag a bit of rubber tubing and an ordinary bowl, by the application of the principle of the siphon, will make an efficient and simple douche. If the use of leeches, the employment of scarification, and the warm douche do not wholly subdue the pain, a flaxseed poultice may be applied in the meatus, over the mastoid, and in front of the auricle; but the auricle should not be covered by a poultice.

At night the ear should be kept warm by wrapping it in cotton, and the patient should lie on a pillow that is warmed from beneath, by means of a rubber bag filled with hot water, or some similar contrivance. A plug of cotton saturated in glycerine or smeared with diachylon ointment, is also of value in subacute cases. In addition to the local treatment it will sometimes be necessary, although not often, to give one of the preparations of morphine, or a dose of chloral or codeine internally.

The popular remedies for earache, dependent upon whatever cause, are usually sweet-oil and laudanum, molasses, sweet oil, glycerine, or a roasted onion. The oil, laudanum and molasses are tolerably efficient; but although they are useful in their property of stilling pain, they are far inferior to the leeches, scarification, and warm water. The onion acts just as the conical flaxseed poultice, and may be resorted to if the warm water fails, and leeches are not to be had. Stimulating applications do nothing but harm, and increase the suffering. Warm vapor of any kind, the vapor of chloroform for example, is very grateful to an inflamed auditory canal or membrana tympani; and a steam nebulizer becomes at some times a very useful adjuvant in treatment of acute aural inflammations. Sometimes children with earache may be quieted by breathing slowly into the auditory canal.

Some practitioners are in the habit of advising blisters behind the ear in all forms of aural disease. Harsh as is the remedy apparently, it is sometimes very efficient.

Speedy relief from the severe pain of otitis is as imperative as in peritonitis or iritis, the various remedies have therefore been discussed at some length, in order that the practitioner may be at no loss for some agent that will cut short the inflammatory action. The remedies are tabulated in the order of their value.

If, in spite of our efforts, suppuration is once fairly established or if the disease has advanced to this point when first seen by the practitioner, we must endeavor to limit the suppuration. To this end thorough cleansing of the ears is necessary. This is best accomplished by syringing—a simple procedure, but one which is not always carried out efficiently and with neatness. The appliances necessary for a thorough syringing of the ear are, first, a good syringe. The small piston syringe is the best, the common soft rubber enema syringe called "Davidson's" in this country is not as good. The glass syringes are of no use whatever.

Where patients are likely to need an aural syringe for a long time it is better to advise them to get one made of brass or German silver. The hard rubber syringes are carelessly made as a rule, and are not easily kept aseptic.

Then a bowl is needed—a small one, not a large wash-bowl, but one such as is used as a finger bowl—being thin and easily held, and a receptacle for the warm water which is to be used in the syringing process. The patient, being seated, holds the bowl well under the auricle, in the hollow just under the lobe, keeping the head perfectly straight, and using both hands to steady the vessel. The surgeon should straighten the auditory canal with the left hand and placing the nozzle of the syringe well into the meatus, direct the stream with the right, down to the membrana tympani. It is well to prepare the patient for the shock of the water, by allowing a part of the first syringeful to pass into the concha, and not into the canal. No patient is capable of thoroughly syringing his own ear. This may only be intrusted to a nurse or other qualified person.

The ear affected with chronic external suppurative otitis should be syringed from one to three times daily while the secretion is at its height. It should afterward be carefully dried by means of absorbent cotton, upon a cotton-holder. The cotton-holder may be made of wood or metal. Neither syringing nor cleansing with a cotton-holder need be at all a painful process; it must be done *gently,* and this direction applies to all the applications to the ear of astringents and caustics.

The agents which may be used in checking ulceration in the canal are numerous. Solutions of nitrate of silver, of alum and of the sulphates of zinc and copper and argyrol, are all useful. The nitrate of silver should be used in strong solutions, from twenty to forty grains to the ounce, pencilled over the parts; the sulphates and the alum in solutions or from one to four grains to the ounce, instilled into the ear. The choice of the astringent is, however, much less important than the thorough removal of the pus.

Indeed, careful and thorough cleansing, without the subsequent use of astringents, will often effect a cure. The use of astringents should be delayed until we are sure that no progress is being made in a case without them. In some cases we are never compelled to resort to any other treatment, than the use of sterilized water. This fact is sometimes overlooked by those who attach much importance to the use of constitutional remedies or internal medication in the treatment of localized suppurations of the ear. A suppuration of the external auditory canal, like the same disease in the middle ear, has a natural course, which often needs mere guidance to lead it to a successful termination.

If the pain be severe and the tension evidently marked, the proper treatment is incision. A narrow scalpel is a very good knife for the operation. The incision should be deep and free. In very delicate and sensitive patients it may be well to put the patient under the primary anæsthetic effect of sulphuric ether before making the cut. This is done by causing the patient to inhale the fumes of the ether in the usual way, holding up the arm while inhaling. When the arm drops, usually in twenty seconds, the incision may be made without causing pain, while not enough ether will have been taken to cause nausea or vomiting or other serious inconvenience. In place of the ether, patients may be anæsthetized with nitrous oxide gas or chloroform. Cocaine, used as a local anæsthetic, will not prove satisfactory.

"Desquamative inflammation" of the external auditory canal is merely one of the very common stages of diffuse inflammation. A certain degree of desquamation must occur in any severe inflammation of the integument of the canal. Bichloride of mercury, gr. $\frac{1}{10}$ to gr. $\frac{1}{4}$ ad ℥1, and nitrate of silver and pure alcohol are well adapted for the treatment of these cases, as is also carbolic acid followed by alcohol.

The practitioner should always be on his guard, lest he mistake a chronic suppuration in the middle ear for one of the auditory canal, with an intact membrana tympani. It will be seen by the statistics in the chapter on the former disease, that a long continued suppuration in the ear *usually* has its origin, not in the canal or outer layer of the drum-head but in the cavity of the tympanum, whence it advances and perforates the membrana tympani. Chronic suppuration in the external auditory canal is a rare disease. When it does exist, it is almost always curable, if properly treated, by the free use of the warm douche, and astringents.

CIRCUMSCRIBED INFLAMMATION OR FURUNCLES OF THE EXTERNAL AUDITORY CANAL.

These generally arise in connection with the existence of furuncles in other parts of the body. They produce impairment of the hearing by mechanically closing the auditory canal. Tinnitus-aurium—noise in the ear—a symptom which is apt to be very troublesome in almost all other aural affections, is not generally present when furuncular inflammation exists. It may be, however, after the pus from the boil has been evacuated, and some of it, perhaps, remains in the canal and presses upon the membrana tympani, and through it upon the *ossicula auditus* and auditory nerve. Tinnitus is absent in the early stages, because there is no pressure exerted upon the drum-head by a circumscribed swelling of the canal.

There will be no difficulty in the diagnosis if the ear be examined by means of the otoscope. One or more circumscribed swellings are found in the calibre of the canal. Their usual situation is on the cartilaginous canal at a point near the tragus, on the anterior wall, and we may have two or more at a time.

The proper treatment is to make an incision at as early a period as possible, and then to continuously apply warm water, giving the ear an uninterrupted warm bath, as it were. It makes little difference whether pus or blood be evacuated by the incision. The relief following is generally immediate in either case. If the pus be deeply situated it will be better to make the incision with a scalpel, cutting downward. If it be near the surface a bistoury may be used, and the cut made from below upward. The ear should be syringed with warm water after the hæmorrhage has ceased, and carefully dried with the cotton-holder, or the impairment of hearing and sensations of fulness will be greater than before the opening was made.

After the furuncle is opened and the pain caused by it has disappeared, it is well to smear the passage with ointment, in order to hasten the softening of the indurated tissue surrounding the furuncle, but as long as pain continues the use of warm water should be persisted in by means of the aural douche. The thorough cleaning will usually relieve the impairment of hearing caused by the swelling and closure of the canal, while the incision and douche will cut short the pain. Each new furuncle is of course to be treated in the same way. Sometimes steam, conducted into the canal from any suitable vessel, is of great comfort to the inflamed part.

Leeches are not usually of much service in furuncular inflammations of the canal. Warm water is not always well borne, but in the majority of cases it is of the greatest value in palliating this troublesome affection. Politzer [1] thinks the warm douche gives rise to fresh eruptions, but this is certainly not generally true. After a long experience, in this painful, although not dangerous affection, the present writers still hold to the knife, warm water, small poultices in the meatus and in front and behind the auricle, and the internal administration of narcotics, as being the best means of treatment.

The surgeon should feel about very carefully with a probe for the most sensitive part before operating. If

[1] Text Book, p. 153.

needful, he should make two incisions at different points and be sure to make them deep enough. If the inflammation be not plainly circumscribed, the disease will have passed over the narrow boundary line between this and diffuse inflammation. If incisions are then useful, several must of necessity be made. A plug of glycerine, or diachylon ointment or a boroglyceride tampon, or a small finger-shaped flaxseed poultice is of much service after the incision.

Auditory furunculosis is an indication of a low state of the system, as well as of local infection. A primary affection of this kind in a thoroughly well person is very rarely seen. The question of the value of internal medication is one notoriously hard to solve; but certain it is, however, that calcium sulphide has not obtained a firm hold upon the profession as a means of aborting or checking suppuration. We have not as yet any specific for aural inflammations of a suppurative character. We shall probably not be done with the case when one furuncle has been evacuated, and has healed; for here, just as in other parts of the body, one boil is apt to follow another in rapid succession. Pure carbolic acid followed by alcohol is an excellent application to incised furuncles (S. D. Powell). Our very recent experience leads us to recommend this as the best of all the applications.

Causes.—Furuncles are very apt to occur in anæmic persons. When iron is administered and nourishing diet substituted for slops, the boils cease to recur.

Dr. Lowenberg examined furuncles of the auditory canal, prior to their opening, before the pus formed in them had come into contact with the atmosphere, and found the micro-organisms of pus. The pus freshly obtained was cultivated in beef soup or diluted extract of beef. Lowenberg regards these micro-organisms (the *staphylococcus progenes albres* and *aurens*) as the cause of furuncular inflammations. Micrococci suspended in air and water get into the canal, and passing into the glandular structure set up inflammation.

Lowenberg goes on to say that once having entered the follicle, the micrococci propagate themselves by "autoinfection." The parasitic origin of furuncles is further substantiated by the fact that they chiefly occur in parts exposed to the air, the face, the hands, the neck. "The first aural furuncle," he continues, "is found at the entrance of the canal, the succeeding ones affect the deeper parts.

The contagiousness of furuncle is also insisted upon by this writer, and he records a case where a strong and healthy man suffered from one in the ear after his wife had been affected by one. The furuncle in the man was in the left ear, in a corresponding situation to one in the right ear of the wife. These theories first announced by Lowenberg, are now generally adopted.

PARASITIC INFLAMMATION OF THE EXTERNAL AUDITORY CANAL.

The literature of vegetable fungus in the human ear became very large after the publication of the cases of Schwartze, Wreden, and of the observers immediately after them. But of late the importance of the subject has not been maintained, since parasitic growths are generally recognized at once.

Causes.—Parasitic otitis is not a *primary disease*, but a consequence of a diffuse otitis, which may have been of such a mild character as scarcely to have attracted the attention of a patient. The formation and development of a vegetable fungus growth, may result from an eczema, or probably from any form of inflammation of the canal, especially if oils have been dropped into it. A case of *otitis parasitica* in which there was any evidence to show that the ear was sound just before the growth occurred is not known. The soil must first be prepared by a loosening of the epidermis before the fungus will grow.

The origin of the disease may generally be traced back to an inflammatory affection of the canal that has softened the tissues. Added to this, oils, generally the common sweet oil, have been used to combat the inflammation. Given these two factors, the inflammatory basis and the oils, and the propagation of the aspergillus fungus may be pretty accurately predicted. One of the best reasons against the use of oils in the canal is their liability to cause the growth of a fungus.

The fungus is actually a mould, such as clings to damp walls and adheres to bread that is not kept thoroughly dry. There is hardly a doubt that these cases of vegetable fungus growths in the ear were formerly mistaken for impacted cerumen or eczema, and *otitis externa diffusa.*

It is not very uncommon to find a growth of aspergillus at the bottom and on the sides of an auditory canal that was packed with cerumen. Otitis parasitica is not an uncommon affection in our new possession, the Philippine Islands. The writers have seen several cases in officers and their families who have been stationed there.

Symptoms.—The subjective symptoms of the growth of a vegetable fungus in the ear are very similar to those from inspissated cerumen. There is a sensation of fulness in the ear, with tinnitus aurium, vertigo, impairment of hearing, and sometimes pain. As is well known, pain is not a common symptom of inspissated cerumen,

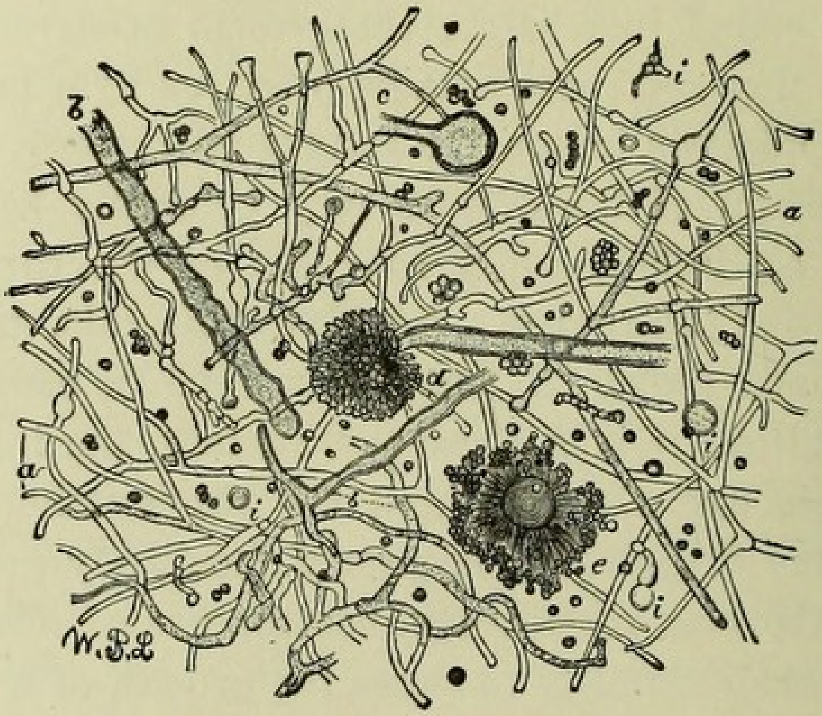

Fig. 23.—Aspergillus Nigricans.

although it does occur. Pain is, however, usually one of the symptoms of otitis parasitica. It is not usually, however, the severe pain of a furuncle, or of acute catarrh of the middle ear, but is a dull heavy sensation in the ear.

The objective symptoms consist in the adherence to the walls of the canal and to the outer surface of the membrana tympani of whitish, or blackish, or even reddish flakes, that may be readily mistaken for simple epidermis or hard wax. Sometimes these flakes or casts block up the whole passage. They cannot be removed by a syringe; but the angular forceps are required to detach them. When the casts are removed the tissue beneath is found to be reddened and tender, and in a very few hours the growth will be found to be reproduced.

The microscope must be called in to make the diagnosis certain. The appearance of the growth, as seen by the aid of this instrument, will soon be detailed. The practitioner who has once carefully observed the objective and microscopic evidences of a vegetable fungus, will, however, not be apt to fail to recognize it in a subsequent case without a microscope.

The varieties of vegetable parasites that may be found in the ear, and which there cause or increase inflammation, are:

I. Aspergillus $\begin{cases} \text{flavus.} \\ \text{glaucus.} \\ \text{nigricans.} \end{cases}$

II. Penicillium glaucum.

III. Graphium pencilloides.

IV. Trichothecium roseum.

V. Otomyces purpureus.

The aspergillus fungus which, in one of its varieties, is the parasite most commonly found in the ear, seems to have a peculiar affinity for a diseased auditory canal and membrana tympani.

Dr. Hassenstein[1] of Gotha observed one case in which a patient suffering from the usual symptoms of aural catarrh was found to have a yellowish-green secretion

[1] *Archiv fur Ohrenheilkunde*, Bd. iv., p. 164.

upon the membrana tympani. This secretion continued for some ten days in spite of treatment, and there was considerable redness, swelling, and pain in the auditory canal and drum-head.

This secretion was found to contain three varieties of vegetable fungi, as an examination by Professor Hallier, of Jena, showed: 1, Aspergillus glaucus; 2, Stemphylium, which was very like stemphylium polomorphum belonging to the aspergillus; 3, Graphium pencilloides. Dr. Hallier was unable to say whether the second variety sprang directly from the aspergillus or not. The graphium pencilloides of which an accurate botanical description is given in the article from which we are quoting, occurs in nature on wood, especially on elder wood.

Dr. F. Steudener,[1] of Halle, described another form of fungus which occurs in the ear, *Trichothecium roseum.* The evidence on this point is not quite conclusive. The different varieties of the aspergillus fungus are by far the most common kinds of vegetable parasites that have been found in the ear.

The fungus consist of three essential parts; first, the mycelium, a dense network of delicate fibres, which form the groundwork or roots, as it were, from which the second part or fructifying portion (fertile hyphen) arises perpendicularly; and third, the free spores, which lie thickly strewn upon and in the mycelium.

The physiological relation of the fruitful fibres to the mycelium is not shown in the accompanying cut, but may be at once made clear by examining a portion of common mould with low power.

[1] *Archiv fur Ohrenheilkunde,* Bd. v. p. 163.

The fibres of the network are unfruitful, branched, straight, or curved, and frequently somewhat swollen at the joints. In the broader fibres transverse cell-walls are distinguished and all, broad and narrow, contain faintly granular plasma. The breadth of the mycelium fibres was from 0.00015 to 0.0002 of an inch (0.0038 to 0.005 of a millimetre.)

In the fruit-bearing portion are found the changes in form which establish the varieties. It consists of a filament, which, especially in the aspergillus nigricans, is stouter than those of the mycelium, bearing upon its summit an enlargement, the receptacle or sporangium.

The specimen represented in the accompanying woodcut exhibited a mycelium and fully developed sporangia (*a*). The spores, of which a collection is represented at *b*, were of a brown color and oval outline, of about the same size as the spores of aspergillus nigricans. Under a magnifying power of 300, some of these spores showed a double outline. Mingled with this growth there was a close network of very fine mycelium.

Treatment.—The treatment of otitis parasitica is exceedingly simple, but it is often very tedious, and the practitioner must not expect that all the aural symptoms will be relieved when the vegetable fungus has ceased to appear. We may only expect to relieve the most troublesome symptoms, pain, vertigo, and impairment of hearing, by the destruction of the parasite. The inflammation will continue, in some cases, long after the microscope has failed to find any traces of aspergillus in the auditory canal.

But the loosened epidermis and the flakes of mould should be carefully removed every day by means of the forceps and syringe, the ear being well illuminated while the former is used, frequently douched with warm water by the means of the fountain syringe. The canal should be swabbed with nitrate of silver in strong solution, after the cleansing process is over, for the purpose of destroying the fungus, and subduing the inflammation of the integument. At the same time, any affection of the middle ear, that may co-exist with that of the canal, is to be treated by the appropriate means.

Alcohol, bichloride of mercury, acetate of lead, tincture of iodine, carbolic acid, hypochlorate of lime, one or two grains to the ounce of water, Fowler's solution, solutions of tannic acid, gr. x. ad. ℥ j. are all useful remedies. The bichloride of mercury in solution gr. j. ad ℥ j and pure alcohol are efficient in the destruction of the fungus. Either may be dropped into the ear; alcohol causes some burning but the pain is not usually severe, nor does it last long. Carbolic acid immediately neutralized by alcohol is also efficient.

In the treatment of parasitic otitis antiseptic precautions should be observed. 1. Do not use oils or fat. 2. Use alcoholic solutions. 3. Dilute these solutions with boiling water before using them. 4. Heat all instruments—sterilize them.

SYPHILITIC ULCERS. CONDYLOMATA.

In the course of secondary syphilis ulcers and condylomata may occur in the auditory canal, just as syphilitic eruptions may occur on the auricle and on other parts of the general integument. They are, however, somewhat rare. The manifestations of syphilis in other parts of the body, with the characteristic appearance, and the absence of itching sensations, will usually make the diagnosis clear. It is important to decide as to the existence of syphilis in a person suffering from ulcers or granulations of the auditory canal, for if syphilis be not present, local treatment will often be all that is required. If, however, the ulcers be the manifestations of the venereal poison, or be modified by it, the use of mercury and iodide of potassium will be essential.

NARROWING AND CLOSURE OF THE CANAL.

Congenital closure of the auditory canal in connection with absence or deformity of the auricle has already been described. There remains to be mentioned, however, a narrowing or even closure of this passage, which sometimes occurs as a result of a neglected inflammation —usually if not always of an ulcerative character. It will perhaps be better to discuss the whole subject of contractions of the canal under the head of bony growths, exostosis and hyperostosis, these being usually the result of inflammatory action. The reader is therefore referred to the chapter upon the results of chronic suppuration for a consideration of the subject of closure of the canal as a result of inflammation.

DIPHTHERITIC INFLAMMATION.

That diphtheria of the middle ear may and does occur, has been shown by numerous observers. A suppurative inflammation of this part may readily take on a diphtheritic form in case the patient be attacked with the constitutional disease. Diphtheria of the canal is sometimes developed on the excoriated parts of an auditory canal already suffering from simple inflammation during an epidemic of diphtheria. The approved treatment is by anti-toxin injections and local use of hydrogen peroxide.

SARCOMA OF THE EXTERNAL AUDITORY CANAL.

Sarcoma is rarely found in the external auditory canal. It occasionally appears on the auricle. Various histological forms have been reported including round-cell sarcoma, mixed sarcoma, angio sarcoma, adeno sarcoma, spindle-cell sarcoma, and osteo sarcoma. These tumors are generally of small size, have a well-defined limit, occasionally are pendulous, and tend to remain inactive. They may, however, take on a malignant form at any time, when they spread rapidly to the adjacent tissue and result fatally. The only treatment is by surgical excision or exposure to the Roentgen ray. The Roentgen ray should be applied for thirty or forty-five minutes three times a week.

CARIES.

Caries of the osseous canal as an independent affection is very rare, but it may occur, especially perhaps in persons of advanced age. The junction of the osseous with the cartilaginous canal is the point which we have seen affected. Thorough curetting of the diseased bone with subsequent use of carbolic acid followed by alcohol will be usually sufficient to restore the bone if the caries be superficial and of small extent.

CHAPTER V.

INSPISSATED CERUMEN.—FOREIGN BODIES IN THE EAR.

Among the laity and even in the profession, hardening of the ear-wax is generally regarded as a very harmless affection. The first treatment that many aural patients receive at the hands of their medical advisers is a vigorous syringing, or worse still, probing, in order to *see* if the wax be not hardened. No one is competent to remove hardened cerumen without careful instruction.

The hardening of cerumen is scarcely ever a condition by itself, but rather one of the symptoms of more or less general disease of the ear. A person subject to this annoying trouble, who does not give some attention to the general conditions of his ears and to his hearing will finally find that his hearing is impaired even if on the first occasions when the hardened wax has been removed, his hearing seemed to be again perfect.

Hardening of the cerumen often occurs in the course of suppurative processes in the middle ear, as well as in cases of chronic non-suppurative disease. It also occurs in disease of the internal ear—the nerve or labyrinth. In such cases removal of the wax may slightly or even considerably improve the hearing. If it be improved, a superficial examiner may be led to believe that impaction of the wax was the only disease, but an exact test of the hearing power will often convince him that the patient still has defective hearing, even though it be greatly benefited by the removal of a large plug of cerumen. The cases of inspissated cerumen, in which the hearing becomes perfect after its removal, were in the beginning cases of inflammation of the canal or of the tympanic cavity, which have run their course, leaving behind them the wax made hard by the evaporation produced by the abnormal heat, when the canal or tympanum or both were inflamed.

Cases are sometimes seen where the patient can state positively that there was, some time prior to the impairment of hearing from the blocking up of the ear, a period, although a brief one, of decided pain. In many cases, also, it is easy to see the evidences of inflammation in the epidermis of the canal, after the wax has been removed. In some this is not, but close examination will show in every case, a probability at least, that an inflammation in some part of the ear, a morbid condition, preceded the period when the wax was not removed by the motions of the jaw, but when it remained as a nucleus about which the whole secretion of the canal collected, until it finally became an obstruction to hearing. The proper way to classify inspissated cerumen would be to say, for example, inflammation of the canal *with inspissated cerumen.* Suppurative inflammation of the middle ear *with inspissated cerumen,* and so forth. In many of these cases, unless the ear be subjected to appropriate treatment, not only may the wax soon become again inspissated, but the fundamental disease which caused the impaction of the wax remains uncured, and it may become permanent.

The activity of the ceruminous glands is usually increased, and the canal becomes exceedingly hot and moist during a subacute or acute catarrh of the tympanic cavity. It is in this increased action of the glands that the beginning of impacted cerumen is to be sought.

Symptoms.—The prominent symptoms of true cases of inspissated cerumen are: 1. Sudden impairment of hearing. 2. Tinnitus aurium. 3. Vertigo. 4. Pain in the ear.

If they be produced by impaction of the cerumen, a glance at the auditory canal by means of the speculum and otoscope will determine the fact, or at least it will give us positive evidence as to the presence of the inspissated substance.

The surgeon should rely upon an ocular examination and not upon the use of a probe without illumination of the ear, to make the diagnosis of inspissated cerumen, serious inflammation of the ear and even perforation of the drum-head have occurred from probing the ear.

The appearance of inspissated cerumen is characteristic. Wax which presses upon the walls of the canal and upon the membrana tympani, in adults, is of a dark brown or black color, and usually nearly *fills* the canal. In children, however, in whom the disease also occurs, the wax is usually of a yellow color, and is more apt to be in layers. The presence of even quite an amount of soft yellow cerumen, which still leaves an opening, however narrow, down to the drum-head, can hardly cause any unpleasant symptoms.

The diagnosis of inspissated cerumen is sometimes obscured, by the useless habit of pouring olive or other oils into the auditory canal on the appearance of any aural symptoms. A lady once came two thousand miles to consult a New York physician in regard to a loss of hearing. She had been seen by no less than six physicians, all of whom had prescribed applications to be dropped into the ear, and none of whom had made an examination. She had suffered for six years from great impairment of hearing and came to New York as a last resort. The ears were found filled with oils, but beneath all this, hardened cerumen which was easily removed; and, although her hearing had been impaired for so long a time, the removal of the wax restored it to the normal power, so that she heard ordinary conversation with ease, and a watch several feet. In this case it was not imagined by the last examiner until the ears were cleansed by the syringe, that impacted cerumen was the cause of the loss of hearing.

Fig. 24.—Gross's Spoon and Hook.

In cases of disease of the acoustic nerve with impacted wax, the tuning-fork will sometimes be heard better by bone than by aerial conduction, but when the wax is removed, the hearing remains impaired, but the tuning-fork is heard better through the air than through the bones. Of course, if the hearing be nearly or absolutely gone from disease of the nerve, the presence of wax will make no difference in the ability to hear the tuning-fork, so that, if the tuning-fork be not heard better through the bones with impacted wax the prognosis as to improvement of the hearing is very poor.

The loss of hearing from hardening of the cerumen, as has been intimated, is apt to occur very suddenly. There are cases where patients can tell the very instant when the ear "closed up" as they often say. The jolting of a ride in a rumbling vehicle often displaces the hardened material, and presses it into the canal, causing troublesome symptoms in an instant; and these symptoms do not occur, no matter how much cerumen may be in the ear, until the *impaction* takes place, when the loss of hearing, the tinnitus aurium, and the increased resonance of the patient's own voice, call his attention to the ear.

Pain of the most distressing nature sometimes occurs from the impaction of cerumen. The pressure of the hardened wax upon the canal is often, when long continued, sufficient to excite severe pain. Suppuration of the drum-head may result from hardened wax, which is not removed in time. The mass of cerumen is sometimes evacuated spontaneously, like a cork from a bottle of champagne, and with a report like that of a pistol. These rare cases of suppuration caused by wax, should not be confounded with those frequent ones of chronic suppuration where the wax hardens over the opening of the membrana tympani.

It is probable that some of the cases reported by the earlier authors as instances of great damage to the ear from inspissated cerumen, were cases of this kind. Toynbee's [1] cases of absorption of the bone, imbedding of wax in the mastoid cells, are possibly only cases where hardened wax supervened upon chronic suppuration of the middle ear. Sometimes the patients with inspissated cerumen say that they perspire excessively; and again, they are not at all aware of any such peculiarity. Often, indeed, they state positively that they do *not* perspire any more than is natural. We must reject this

[1] Text-Book, English edition, p. 51.

from among the causes of this disease, although it is given by some authors.

The bad habit of cleansing the auditory canal with the end of a towel, or with an *aurilave*—a bit of sponge fastened on a handle—or the like, has a tendency to pack the cerumen in the canal; but after all a cause must be sought for behind this; and this is to be found in an inflammation of the middle ear, which has extended to the auditory canal, or in an inflammation of the canal itself.

Almost all patients suffering from inspissated cerumen ascribe the attack to "cold" which they have taken. In many of these cases no evidence is found to substantiate the theory, for patients are very apt to ascribe all kinds of diseases to cold, even when they cannot positively remember that they have suffered from a cold in the head, throat or chest. Yet there are many cases in which there was a naso-pharyngeal catarrh, coincident with the impaction of cerumen, or with the aural symptoms.

A very slight swelling of the auditory canal may prevent the free removal of the cerumen, which naturally takes place from the motion of the lower jaw, as it presses upon the lower part of the wall of the meatus. When the wax has once collected, partial evaporation of its watery contents occurs, and we get the characteristic black color, and the mass becomes, on its surface at least, as hard as soft wood, and in rare cases as hard as some kinds of stone.

Cases enough have been seen to show, that inflammation of the canals does favor inspissation of the cerumen; the only question upon which any doubt may be thrown is, whether impaction of cerumen does ever occur without an antecedent inflammation, and from purely mechanical causes, such as packing of the secretion by improper attempts to cleanse the canal, or from a peculiar tendency to excessive action of these numerous glands. Certain it is, that some cases require only local treatment and that whatever inflammation preceded the evaporation of the fluid of the cerumen, was fully removed when the patient came under treatment.

Treatment.—The treatment of inspissated cerumen is exceedingly simple. The hardened material should be removed by the use of a syringe and warm water. In some cases but a few minutes are necessary to remove the mass. In many cases, however, we are compelled to use a solvent for a few hours prior to the syringing process. A saturated solution of the bicarbonate of soda is used for this purpose with a drachm of glycerine added when the wax is unusually hard. The cerumen is sometimes so hard and so tightly wedged into the auditory canal that a daily sitting for a week or more is necessary to its removal. When it becomes necessary to make an opening in wax upon which the stream of water may act, nitric acid may be used, or a saturated solution of caustic potash (Blake), a small hole being burned in the centre of the mass.

The auditory canal may contain a surprisingly large quantity of hardened cerumen, and it is necessary to examine the ear quite often during the syringing process, in order to see how much remains, lest we continue the injections after the wax is removed, and thus injure the drum-head, or cause vertigo. *All* the wax should be removed. The thinnest scale or flake left upon the drum-head is sometimes sufficient to keep up the disturbing symptoms.

If the hearing is very much improved after the removal of the wax, the ear should be protected from the shock of sounds by a little pledget of cotton placed lightly in the meatus. If the drum-head be sunken inward, or the hearing be not normal. Politzer's method of inflating the middle ear, or the Eustachian catheter, should be employed to restore it to a normal condition. Since some persons are disposed to frequent attacks of inspissated cerumen, it is well to advise them to have the ear syringed with warm water once in two or three months. It is probable that it requires a longer time than this for cerumen to become so hard or so tightly packed in the canal, that it cannot be readily removed by the patient or a non-medical friend.

It is always well to examine both ears even when only one is complained of. The ear in which the hearing was still unimpaired is often quite as full of wax as the other, although it has not yet become pressed upon the drum-head, and thus has given no trouble.

COMPOSITION AND FUNCTIONS OF CERUMEN.

According to J. E. Patrequin,[1] cerumen is of a smeary consistency, on account of the soapy material made by the potash which it contains. A part of it is soluble in water, another in water and alcohol. It also contains about one tenth per cent of water, a mixture of oil and stearine and a dry material not soluble in water, alcohol

[1] *Archiv fur Ohrenheilkunde,* Bd. V., p. 230, from *Comptes Rend. de Acad. des Sciences,* xvi, pp. 940, 941.

and ether, in which potash and traces of chalk and soda are found. As age advances, the parts of the cerumen that are soluble in water and soluble substances increase, but those soluble in alcohol diminish; so that in older persons the cerumen becomes dry and brittle.

Kessel's account of the cerumen is as follows:[1] "The contents of the ceruminous glands only differ from those of the sweat glands in the fact that the former contain masses of very fine coloring matter. The substance secreted by the ceruminous and sebaceous glands *together*, is a yellowish-white, rather fluid material which consists essentially of small and large fat globules, corpuscles of coloring matter in masses, and cells in which single globules of fat and coloring matter are embedded; hairs and scales of epidermis from the lining of the canal are also found in the canal.

Hallucination Caused by Hardened Wax.—In rare instances the relief of hallucination by the removal of hard wax from the ear has been reported. There are also accounts of the cure of epilepsy by the removal of hard wax. Such cases are certainly exceptional. Hard wax occurs among the insane as well as the epileptic. Removal of it will only in very exceptional cases, of which the writers have as yet seen none, restore the mind or cure epilepsy.

The writers have seen cases of cough and persistent sneezing relieved by the removal of wax and also very marked mental depression, but such symptoms are seldom produced by impaction of wax in the ear.

[1] Striker's Manual: *The External Ear*, by Kessel, translated by J. Orne Green, p. 951.

FOREIGN BODIES IN THE EAR.

Although the presence of a foreign body in the external auditory canal is comparatively infrequent, the subject is an important one, since a wrong method of practice will be productive of disastrous results.

Foreign bodies in the auditory canal are not necessarily dangerous, while one in the tympanum is generally so; the usual point of entrance is the canal, but they sometimes pass beyond this part into the tympanum, or even into the Eustachian tube, the latter occurring in very rare instances. Foreign bodies that enter the ear may be classified under three heads, insects or the like which creep into the passage, their larvæ which are generated in the ear, and various articles such as beads, buttons, peas, beans, and so on which are pushed into the ear by young children or silly adults. Besides in the accidents or casualties of life shot or bullets may enter the ear from accidental or intentional shooting.

The opinion that the importance of the subject has been exaggerated, by the great mass that has been written upon it, is not founded altogether upon the relative infrequency of the cases. If cases that are comparatively uncommon, are still very dangerous, in nearly every instance when they do occur, the medical teachers have a right to call attention to them as being very important and to dwell upon them, even at the risk of wearying their listeners and readers. But foreign bodies in the auditory canal, as a rule, are not dangerous. In this respect they have none of the importance of foreign bodies within the eyeball. *Foreign bodies in the tympanic cavity,* are necessarily dangerous and destructive to the functions of the ear, but in the vast majorities of cases of foreign bodies in the ear, the foreign body is outside of the drum-head.

This much is said by way of introduction, with the hope that it will enable the practitioner who may consult these pages, to enter upon the management of a case of foreign body in the ear, when it comes to him, with coolness and without fear that he has one which will brook no delay, and which will tolerate no mere palliative means, without danger to the hearing or the life.

INSECTS.

When a live insect gets into the ear, the pain produced is usually intense and agonizing. Insects are more apt to get into the ears of sportsmen while hunting in thicket and underbrush, and of farmers in the field, than of dwellers in cities and towns. Yet, on the hot days of summer, when insect life is very active, the city practitioner will sometimes be called to remove a bug from the ear, if the agony induced by the foreign body does not stimulate some of the family to a successful attempt at its removal.

There is an insect which lives on the leaves of fruits and flowers, and which, like others, sometimes flies into the ear, which is called an earwig, and there was an ancient superstition that it crept into the brain through the ear. The *forficula auricularis*, or so-called earwig, has probably no more propensity to fly into the ear than any other insect; any of the ordinary flies may do so.

Cockroaches as well as croton bugs sometimes enter the auditory canal. There is no difficulty in removing them. In some instances, they die in the ear and then they become the nucleus for the collection of cerumen about them.

The most efficient and the speediest means of removing an insect from the ear is the use of a syringe and warm water. As little animals usually get into the ear when the patient is in the fields or forests where physicians are not always at hand, laymen should be taught in the case of the occurrence of such an accident, to immediately pour water or any bland fluid in the meatus. This will disturb the animal and either drown it or cause it to run out.

Some writers advise the use of an oil dropped into the ear before the water is used, but this is waste of time. The insect may be promptly dislodged by the use of the syringe and water, which will cause insects to come out at once.

LIVING LARVÆ IN THE EAR.

Insects sometimes deposit their eggs upon the pus of a suppurating ear. According to Wood, quoted by Blake,[1] insects have a very acute sense of smell. "No flock of vultures can be directed more unerringly to their revolting prey by scenting its odors from afar."

The odor of an *otitis media purulenta,* thus brings the insect to deposit its eggs in the auditory canal and cavity of the tympanum, where they soon become grubs or larvæ. These larvæ always excite considerable, and sometimes very severe pain, but in the cases which I have seen, the patients complain much more of the

[1] Living Larvæ in the Human Ear. *Archives of Ophthalmology and Otology,* vol. 11, No. 2.

wriggling movements of the grubs in the ear than of the pain.

The ancient works on aural diseases say a great deal of worms in the ear and of the proper means of removing them. It is probable that these so-called worms were the larvæ of insects which germinated from eggs deposited in the pus of a chronic suppurative process. Certain it is, that the practitioner of the present time, sees very little of worms in the ears, since the habit of cleansing an ear from pus has become a well-recognized duty. The pain from the presence of these grubs, which actually fasten themselves when hatched, into the tissue of the canal, and bite upon it, as it were, is apt to occur suddenly.

Dead insects are sometimes found in the pus washed out from an external auditory canal, and it is undoubtedly true that we should, equally with the ancients, have many cases of living larvæ in the ear, were it not that suppurating ears are usually now-a-days regularly cleansed.

The larvæ that have thus far been found in the ear are those of the *muscida sarcophaga* (Blake, Gruber), and of the *muscida lucilia* (Blake). Blake made a study of the nature and habits of these grubs, by taking them from the ear at a very early period of development; as near as could be ascertained within twelve hours of the time of their deposit. He placed a specimen on the bottom of a thin glass vessel, and covered it with a piece of raw beef, soaked in warm water, in such a manner that by inverting the glass the movements of the larvæ could be easily studied under the microscope. Blake found that the apparatus by which the larvæ attaches itself and which pierces and tears the tissue, is made up of a strong but delicate framework of horny consistency and of two hooks also of a stout horny structure, articulating with this framework. The larva burrows its way into the tissue on which it feeds by repeated extension and contraction of the hooks, alternately piercing and tearing. These movements explain the agonizing pain which patients experience when the larvæ appear from the eggs. These hooks are very large in proportion to the size of the body of the larvæ.

Blake says that the instincts of the animal lead it to bury itself beneath the surface, and to seek warmth and moisture and a soft, yielding tissue for its work. Hence they are always found at the end of the canal or in the cavity of the tympanum. As yet, they have always been found in connection with suppuration of the middle ear, with its consequent perforation of the membrana tympani.

The examination of the auditory canal infested by living larvæ, shows small white worm-like animals moving rapidly about, very much as a mass of common earthworms. The dead grubs are about half an inch in length and of the diameter of a large knitting needle. Gruening reported one case of living larvæ in the ear when the tissues were sound, but this case remains unique. Very small fish have been known to enter the auditory canal while the victim was bathing. There are authentic accounts of such an occurrence, and cases have been seen by the authors.

Treatment.—It is generally impossible to remove living larvæ by means of the syringe. The more they are syringed the more lively they become. Before the syringing is attempted, some agent should be instilled into the ear which will kill them, when the syringe will usually remove them. Sometimes, however, even after death, their hooks penetrate so deeply into the tissue that they can only be removed with the forceps. The forceps should not be needlessly used, however, for even with the most careful manipulation, and with tractable patients, they often abrade the integument of the canal, and thus cause pain. Labarraque's solution of chlorinated soda will kill these grubs as will the vapor of chloroform. It will be sufficient to force the vapor into the external ear or to drop the solution of soda chlorinata into the canal.

INANIMATE FOREIGN BODIES.

The foreign bodies that are placed in the ears of children by themselves or their playmates, from the time of the first writers on Otology, formed a fertile field for the labors of surgeons. From some source or other, the laity have got the impression that a foreign body in the ear, like a wild beast accidentally let loose upon a civilized community, is to be hunted down at all hazards. The presence of a foreign body in the canal is, after all, however, not a very serious matter. Children do not usually push them in far enough to do any harm. It is the meddlesome interference of nurses and friends, and sometimes of unwise practitioners, that forces them into dangerous positions.

There was a notion prevalent in England, in Shakespeare's time,[1] that poison poured into the ears was as

[1] Hamlet, Act III, Scene 2.

dangerous as if taken into the stomach; and from this, in some manner or other, has come the idea that a foreign body in the ear becomes at once a very dangerous thing.

It would be well, if this fear of foreign bodies in the ear, were transferred to cases where they have entered the eyeball, where the most serious results do occur from the neglect to promptly remove a foreign substance. Unskilful or indiscreet attempts to remove a foreign body from the ear, are often more dangerous than the foreign body itself. In the case of a foreign body in the eye, it is the loss of sight that is threatened and it is usually the worst to happen; but it is not a very rare experience, that improper attempts to remove a foreign body from the ear, have cost the life of the patient.

When, therefore, a child in whose ear there is, or there is supposed to be a foreign body, is brought to the practitioner, let him first, by ocular examination, be sure that the diagnosis is correct, and then let him attempt to remove it by a safe means.

"First catch your hare," is the quaint and familiar beginning of the old recipe for cooking this animal; and in imitation of this sage advice the writers, taught by experience that the diagnosis of mothers and nurses is not always to be trusted, would urge upon their readers the wisdom of not attempting to remove a foreign body which they cannot *see*. There is nothing more deceptive than the tactile examination. Some practitioners have been even seen to click with a probe what they supposed to be a foreign body when they were simply striking the bony wall of the canal.

The surgeon should not take the testimony of the most intelligent nurse in the world, as to the presence of a foreign body in the ear, unless he sees it himself. Such testimony is only valuable to prove that a foreign body was once in the ear. Any attempt to remove a foreign body that is not seen, but which is supposed to be in the ear, will usually lead to a dangerous and mortifying failure. Even when it is seen, a forcible or violent attempt is always a dangerous procedure.

Voltolini,[1] in writing on this subject, said " that even the point of a dagger, if allowed to quietly remain in the ear, will not do as much harm as forcible attempts to remove it."

The danger to be apprehended from attempts to remove a foreign body by the use of force is, that it will be pushed through the membrana tympani into the cavity of the tympanum and even into the labyrinth. Unfortunately for the fair fame of surgical science, such cases are on record.

Treatment.—If the physician sees a case in which a foreign body has really got into the auditory canal—a fact which he should determine by the use of the speculum, and the otoscope—before it has been meddled with, he will almost always be able to remove it by the process of syringing the ear with warm water. Children, however young, will readily submit to this operation, and it is almost always successful, if, as has been said, there have been no previous manipulations with instruments. Unfortunately, however, the cases are not usually seen by a physician until the friends of the little patient having found by the child's own statement, that a bead, or a pea, or a shoe-button, or the like, is in the

[1] *Monatsschrift fur Ohrenheilkunde*, Jahrgang 11, No. XI.

canal, and having been able to see it have pushed it well in, in their misguided zeal to remove that which in itself is not dangerous to the ear or its functions. Many cases are on record where foreign bodies, which had not occluded the auditory passage have remained in it for years without doing harm.

If, however, the foreign body has become impacted by the attempts to remove it, and if serious inflammatory symptoms have arisen, it is better to wait until these have subsided before any further attempts at removal are made.

Then, if instruments are to be used, the child should be placed under the influence of ether, and by means of a small bent probe or hook (a wire loop will often do good service), or the instrument used for dividing the capsule of the lens in the operation of extraction, it should, if possible, be dislodged from its wedged position, and then removed by the syringe. No manipulation of this kind should be attempted, however, unless the foreign body is well illuminated, so that the surgeon can see exactly what he is doing during the whole of his manipulations.

In cases where injections made while the patient is in an upright position, do not remove the foreign body, the following method has been adopted with success: The child is laid upon a table, so that its head may hang a little over the end of it. The membrana tympani then forms a plane with the upper wall of the auditory canal, that turns obliquely downward. The syringing is then performed in the usual way (Voltolini).

The galvano-caustic has been used in breaking up the so-called *Johannis brod,* or carob bean. The bean having become so firmly wedged into the ear that it was impossible to move it one way or the other, the needle is inserted "with lightning-like rapidity" into the body, and when it cooled, in one case the bean broke with a snap audible to the patient and to those about. When sufficiently broken up, it was removed by syringing (Voltolini).

Foreign bodies such as peas, beans, and the like, are harder to remove after they have been in the ear for some time than metallic bodies, because they swell and thus become wedged firmly in the canal, and if they have been pushed into the cavity of the tympanum, they excite still more trouble and become still more unmanageable.

No pictures are given in this volume of the numerous hooks, forceps, perforates, drills, picks, *et id genus omne,* that have been devised by surgeons, with more ingenuity than wisdom, for the removal of foreign bodies from the ear, because the vast majority of such instruments are very dangerous weapons; while they are usually greatly inferior in efficiency to the use of the warm water and syringe. Cases will occur, however, in which syringing will not be sufficient; but there need be no haste unless the body has become impacted in the tympanic cavity, or is causing unpleasant or serious symptoms. In such cases the ordinary armamentarium of the surgeon will generally contain instruments adapted for the individual cases as they occur. Let him remember, however, that once beyond the membrana tympani, he is dealing with parts whose injury becomes dangerous not only to hearing but to life.

Dr. Gross's instrument (see page 102) is essentially the cystotome used in cataract operations and often used by aural surgeons. It is passed behind or to the side of the foreign body, when it is easily fastened upon, and dislodgment occurs.

Beads have been removed from the auditory by stringing them on a lachrymal probe (F. M. Wilson). A flexible silver hook, the concave side of which is roughened, is sometimes efficient (Knapp). Alcohol may be used in the canal to avoid swelling from the prolonged use of water (Politzer), and for the purpose of shrinking the tissue of a vegetable body.

The ancient suggestion of Hippocrates, Paul of Aegina, and Du Verney, which was revived and resuggested by Tröltsch, to detach the auricle from the ear, should be adopted when it is found impossible to remove a foreign body through the canal. It is not a dangerous operation, and it is much to be preferred to any risk of serious injury to the cavity of the tympanum or the labyrinth. The operation was performed in this country by Roosa in 1874; Orne Green in 1881; A. H. Buck in 1882. According to Politzer it has also been performed by Langenbeck (*Berliner Med. Wochenschrift*, 1876), who removed a button from the tympanic cavity after partial separation of the posterior attachment of the auricle. Moldenhauer,[1] in 1881, also removed a stone from the auditory canal of a boy of three and a half years of age, after completely detaching the auricle posteriorly. Schwartze adds a note to Moldenhauer's article, the latter writer having quoted him from Tröltsch's text-book, to state that he has separated the auricle in three cases for the removal of foreign bodies from the ear. Schwartze gives no more exact date to his operations than to say " In the beginning of the last ten

[1] *Archiv fur Ohrenheilkunde*, Bd. xviii, p. 59.

years," (*Aus dem Anfange des vorigen Decenniums*). This probably means in the years 1872, 1873 or 1874. From this it appears that Schwartze or Roosa was the first to perform this operation, after it was suggested by Paul von Aegina and resuggested by Tröltsch in the first edition of his text-book.

The operation of detachment of the auricle, has now a sufficient foothold in the experience of surgeons, to relieve it from the stigma cast upon it by a distinguished professor, who once said " that the idea of separating the auditory canal from the squamous process of the temporal bone, with a view of obtaining access to the extraneous substance, as suggested by Von Tröltsch, is so absurd that it ought to be ranked among the exploded notions of the barbarous ages." It is now a sound surgical procedure, based on an experience that fully justifies its performance whenever it may be indicated by an inability to get at a foreign body through the canal.

It goes without saying, as Tröltsch said when he advised a revival of the operation, that it is to be reserved for urgent cases. Yet no surgeon need be deterred from it by the idea that it is a formidable surgical procedure.

Dr. Lowenberg[1] reports an ingenious method by which he removed from the ear a small ivory ball, from the tip of a quill pen-holder, which had been forced into the ear of a boy nine years of age. Various attempts at removal, by other hands, wounded the canal, perforated

[1] *Report on the Progress of Otology*, by C. J. Blake, Transaction American Otological Society, 1872.

the membrana tympani, and excited severe inflammation. After the inflammation had subsided, Dr. Lowenberg attempted to remove the body by syringing, by Valsalva's and Politzer's methods of inflating the ears; but he failed. He then extracted the ball by bringing the point of a small brush, dipped in joiners' glue, in contact with its outer surface, allowing the glue to harden, and then extracting brush and ball together.

Dr. E. H. Clark, who is quoted by Blake in the same report from which the description of Dr. Lowenberg's method is taken, once adopted a similar procedure with success. The foreign body was a hard, smooth ball, and it was extracted by passing a thread through a small square of adhesive plaster, and bringing the latter, by means of a fine tube, into contact with the surface of the ball, when sunlight was concentrated upon it by means of a lens, until it softened and adhered, when it was easily extracted. These two methods are to be commended as both ingenious and safe.

It is interesting to note that foreign bodies such as beans which are used in the game of *flipping* are sometimes thrown into the auditory canal, by accident to one engaged in the game or even to a passer-by.

The late Dr. J. Marion Sims published an article, illustrated by three cases, in the *American Journal for Medical Sciences*,[1] that very warmly and ably advocated the use of the syringe for the removal of foreign bodies from the ear, but which did not receive the attention it deserved. This was the first important article Dr. Sims ever published. So impressed was the literature of the period of Dr. Sims' writing, with the idea that forceps,

[1] Vol, IX, p. 336, 1845.

and so forth, must first be used before any other means are tried, that it was only by accident, as it were, when washing away the blood caused by fruitless attempts to remove a foreign body by such instruments, that he found the syringe and warm water the very best means of removing such offenders. Dr. Sims gives Mr. Carpenter, of Castle Comer, Ireland, the credit for being the first to call the attention of the profession to the universal applicability of the syringe for the removal of foreign bodies from the ear. He also narrates the experience of no less a person than Sir Benjamin Brodie, who with characteristic British honesty, tells us how he failed to get a foreign body, a pea, from the ear, after using all sorts of methods, and finally " left it to rot and come out by itself, or to be washed out by a syringe."

Dr. Sims maintained his interest in this subject long after he had won great fame as a gynæcologist. He read a paper upon " The Extraction of Foreign Bodies from the Ear " before the British Medical Association in 1878, in which he repeated his views as to the value of the syringe. He criticised the ear syringes made in London as being clumsy, as having a large nozzle, so that they threw a large stream of water.

Dr. Sims recommends for occasional use, in removing foreign bodies for example, the ear syringe so commonly sold in the United States. It is of hard rubber, and holds about an ounce. It is very light and is easily managed with one hand. Useful as this syringe is for occasional use, it is usually so carelessly made and is so small, that the practitioner who has much use for an aural syringe will prefer one of metal, a size or two larger, but having the same nozzle, and made on the same general plan as the "American hard rubber ear syringe." Even *patients* who are obliged to use a syringe for a long time, will find a metal syringe the cheapest.

Pressure with the fingers "upon the skin close to and in front of the tragus, carried upward and around the meatus, upon the auricle, and back again to their starting point, when the manœuvre is repeated several times," for the removal of a foreign body found in the cartilaginous portion of the canal, and lying upon the wall, has been recommended.

The same movements of the canal are advised to effect a change in position of a foreign body lying beyond the centre of the cartilaginous canal, or even one that has been pressed partly into the osseous portion. Dr. Speir gives several instances in which the position of foreign bodies in this canal has been changed by this procedure. It is especially recommended for foreign bodies that have not been tampered with by improper means. It is just these that may be easily removed by a syringe.

Mr. Pilcher, in his work on the ear,[1] reported a very instructive case from the *Lancet,* in which surgeons of a London hospital attempted to remove from the ear of a child of seven years of age, the head of a nail, which they never saw, but which they felt with a probe. The first surgeon to whom the child was brought said he saw the head of the nail but he did not attempt to remove it because four men could not hold the boy's head still. A director and dressing forceps were both bent in

[1] *Treatise on the Ear*, American Edition, by George Pilcher, Philadelphia, 1843, Reprint p. 219.

the forcible efforts, forceps with hooks were used, and they were also bent straight, but the nail could not be removed. An incision was then made behind the auricle, and the meatus was exposed. A search was then made for the nail, with forceps and an elevator. Tooth forceps were then used; three pieces of metal, which appeared to be pieces of the nail, were removed by these *delicate* instruments. The *malleus bone* was then removed by the forceps. The patient was now so exhausted that " his pulse could scarcely be felt, and his skin was bedewed with cold perspiration." The operator then stated that he had used " more force than was warrantable." He thought, however, there was now a large opening (*sic*) through which pus might escape, and yet he feared that a portion of the petrous bone might exfoliate, and that meningitis and abscess of the brain might occur. He stated that he had seen three or four cases which had terminated in this manner. Of course the little victim died, and that too on the third day after these operative attempts.

The post-mortem examination revealed softening of the base of the brain, and of the anterior part of the hemispheres. Not a vestige of the bony part of the external auditory canal remained, it having been removed during the operation, and the floor of the tympanum was also wanting. There was considerable pus in the tympanic cavity.

" *The nail not being in the tympanum, sections were made through the cochlea, vestibule, semicircular canals, and mastoid cells; but there was no nail to be found.*"

The fact has already been alluded to in this chapter, that persons sometimes suppose there is a foreign body in the ear, when there is actually none in it, and when there probably never has been one there. At times delusions occur on this subject. The writer has seen several cases of the kind which are quite remarkable. In two cases the patients, who were women of the lower class of life, supposed that pins were in the auditory canal. No amount of reasoning nor the subterfuge of pretending to remove a pin from the ear, by syringing could satisfy these females. And in another case a woman brought her son to the authors' clinic and stated that he was passing pieces of anthracite coal from the external meatus. She had quite a quantity of coal in a handkerchief, which she said had been passed from the ear. The boy agreed with his mother in her insane statements. These cases passed from observation before the cause or motive for the delusion could be investigated.

The hairs of the auditory canal sometimes lie on the drum-head and thus become irritating foreign bodies.

The conclusions as to the mode of a procedure in cases of suspected foreign bodies in the ear, may be formulated as follows:

1. Assure one's self by ocular examination of the presence of the foreign body.

2. Try syringing with a large syringe with a small nozzle, the patient being placed in various positions according to the situation of the body.

3. If this fail, use a Daviel's spoon, a wire loop, a bent probe, a cystotome used by oculists, or the like, and attempt to change the position of the foreign body, so that the stream of water can get behind it and force it out. This displacement should generally be done under

ether, especially in the case of children who have been frightened by previous attempts at removal.

4. If the foreign body be so wedged in that this method fails, Lowenberg's gluing procedure, or some one of the numerous aural forceps may be tried.

5. If no urgent symptoms occur, and these attempts at removal have caused excoriation and inflammation of the auditory canal, wait until they have subsided, meanwhile syringing the ear with warm water several times a day.

6. If all ordinary and safe procedures through the meatus have failed, separate the auricle and get at the foreign body from behind.

7. In a case where there are no symptoms of injurious effects from the presence of a foreign body, do not act hastily but reassure the patient's family, that no danger will result from delay, and wait until proper means can be taken to safely remove the offending substance. It is very seldom, indeed, that there is any urgency in the case, except in the minds of the friends of the generally infantile patient.

We see from all this that it is by gentle manipulations, made with delicate instruments, under the guidance of personal skill and ingenuity, that these cases are to be managed. An eminent artist was once very earnestly inquired of by an amateur, as to what he mixed his colors with. His answer was, "With brains, sir!" Perhaps nowhere in surgery, does this old anecdote better illustrate the necessity of using instruments with brains, than in the removal of foreign bodies from the ear.

FOREIGN BODIES IN THE EUSTACHIAN TUBE.

Among the cases whose statistics are reported there are two where laminaria bougies were broken off in the Eustachian tube. Dr. Hecksher, of Hamburg, relates an interesting case that belongs to this class. The patient had been accustomed to treat his own ears—which were affected with chronic catarrh—by the use of the Eustachian catheter.

When Dr. Hecksher reached the patient, he gave the following history: He had introduced through a metallic catheter a whalebone probe into the tube. On the end of this probe was fastened with a silk thread a raven's feather, which he used for the purpose of washing away the mucus from the tube. One evening as he was using the apparatus he drew back the probe without the feather and he found that he had left it in the tube. It caused so much pain that he could not sleep. Attempts were made by a physician to remove the foreign body, but they failed. Dr. Hecksher then attempted to remove the body, but the parts were so swollen that he could not practise rhinoscopy, and see the feather, and he failed with various kinds of forceps to remove it.

So much inflammation ensued that he was obliged to desist and use antiphlogistic treatment; but the patient finally removed the feather himself by the aid of the catheter introduced in the usual way, and his finger passed behind the uvula.

Politzer[1] also relates two cases, quoted from Urbantschitsch and Schalle, where foreign bodies have reached the cavity of the tympanum from the pharynx. The first was an oat husk, which had stuck in the throat in

[1] Text-Book, English translation, p. 631.

chewing an ear of corn. It entered the Eustachian tube, and the tympanic cavity and came through the external meatus.

In Schalle's case a piece of hard rubber syringe, employed in douching the nose, broke off, and entered the tube and tympanum. In the drum cavity it caused acute suppuration and was removed by incision of the membrane.

EAR-COUGH.

Every practitioner who has been at all in the habit of examining ears has observed a cough which occurs in many patients, whenever a certain part of the auditory canal is touched by a cotton-holder, a probe or the like. There is the greatest variation in the sensitiveness of patients in this regard. Some of them scarcely tolerate any contact with the osseous canal without responding by a cough, while others, and by far the greater number, during a long course of treatment never exhibit any disposition to cough when the canal is touched.

Certain other reflex symptoms from irritation of the walls of the canal have been observed for centuries. Such are sneezing and vomiting and even epileptic seizures, Tröltsch [1] quotes from Pechlin, who, writing in 1691, says he knew a man in whom contact with the external auditory canal always caused vomiting. Arnold,[2] also quoted by Tröltsch, tells a story of a now famous girl, who suffered for a long time from a severe cough and expectoration, who besides often vomited and gradually became very thin, and who was finally re-

[1] *Lehrbuch, Sechste Auflage,* p. 522.
[2] Loc. cit.

lieved from all her symptoms by the removal of a bean from each ear. Arnold relates another case where a "disease of the chest" was cured by the removal of a foreign body from the ear. Toynbee[1] also records the case of a patient who suffered from a cough which no treatment subdued, until a portion of dead bone was removed from the auditory canal. The most important of all the cases of reflex symptoms from irritation of the external canal of the ear yet reported, is that of Fabricius von Hilden, whose case Tröltsch also quotes. A girl of ten years of age put a small glass ball in her ear. Many attempts were made to remove it but they were unsuccessful. Finally she was seized with hemicrania, anæsthesia of the entire left side of the body, alternating with severe pain, until at last epileptic attacks occurred, with atrophy of the left arm. At eighteen years of age she came under the care of Fabricius, who drew out the story of the glass bead, which had been well-nigh overlooked, since she never complained of earache. He removed the foreign body and cured the patient of all her troubles, as he writes to his friend Bauhinus, "*Resti tuum est quoque brachium.*"

Schwartze and Kœppe[2] also speak of reflex phenomena from foreign bodies in the canal. Kœppe[3] in an article upon "Reflex Psychosis from Aural Diseases" relates two cases where treatment of the nose and throat and ears restored the patients to sound mental condition. In the first case there was ozæna and catarrh of the ears; in the second hardened blood was removed from the auditory canal, where it had remained

[1] *Treatise on the Ear*, English edition, p, 39.

[2] *Archiv fur Ohrenheilkunde,* Bd. V. S., 283.

[3] Ibid. Bd. ix, p. 220.

for years as the result of a hæmorrhage from a fall, or several falls, upon the head. These cases are exceedingly interesting.

Dr. Kupper[1] reports a case of epilepsy from a foreign body in the auditory canal, and also a case of cerebral irritation from inspissated cerumen.

Wilde[2] also quoted a "case of epilepsy and deafness, dependent on the presence of a foreign body in the ear." After the seed of a sycamore, which had been in the ear ten years, was removed, the epileptic attacks ceased, and the deafness declined. Sir William seems to have been somewhat skeptical about this case and he says, "I must confess that I am inclined to bring in the Scotch verdict of 'not proven,' as far as the seed is concerned. The state of the ear, either before or after the removal of the foreign body, has not been recorded; nor whether the seed ruptured the membrana tympani, or caused any disorganization of the parts." Wilde goes on to say that if the introduction of a foreign body into the canal causes epilepsy, it must be by pressing upon the sensitive part which he had met in some persons, in syringing the ear. He was not able to explain the phenomenon, but later on in his book he quotes another writer,[3] who explains it by hyperæsthesia of the auricular branch of the pneumogastric. There remains a doubt, from the varying statements of anatomists, as to whether the auditory canal is or is not supplied by the pneumogastric. Quain[4] only speaks of the auricular

[1] Ibid. Bd. xx. p. 167.

[2] *Aural Surgery*, p. 189.

[3] *Loc. cit.*, p. 326.

[4] *Elements of Anatomy*, eighth edition, p. 560.

branch of the pneumogastric as supplying "the integument of the back of the ear."

Sappey[1] describes it as supplying the canal, as do other authors, for example, Gruber,[2] who says: "The auricular branch of the vagus extends not only to the posterior surface of the auricle but also to the cartilaginous part of the auditory canal."

Tröltsch[3] also described an auricular branch of the vagus which, as he says, enters the posterior part of the osseous canal. The truth of Arnold's discovery of the auditory branch of the pneumogastric is usually accepted, although a complete article on ear-cough, that by Cornelius B. Fox,[4] agrees with Quain, that the auricular branch of the pneumogastric only supplies the posterior part of the auricle. In about twenty per cent of the persons examined by Dr. Fox there was found a hyperæsthetic state of the nerve supplying the auditory canal, that is, they were persons in whom any slight titillation of the nerve produced a sense of tickling in the throat. These are the persons alluded to in the opening sentences on this subject in this book. Dr. Fox also believes that when this condition exists, it is a congenital peculiarity and that the connection between the nerves involved takes place in the brain. The cases of ear-cough cited by Fox are similar, and in some instances identical, with those enumerated. There is no attempt made to trace cough to evanescent or tem-

[1] *Traité d'Anatomie,* Tome III, p. 842, 1877, "La peau du conduit externe est extremement sensible . . . soit enfin au rameau auriculaire de pneumogastric, qui vient se perde dans la peau de la portion osseuse du conduit."

[2] *Lehrbuch,* p. 144.

[3] Ibid, VI., Aufgabe, p. 39.

[4] *British Medical Journal,* Dec. 18, 1869, p. 650.

porary influences, such as cold upon the face and auditory canal. In the two cases of his own cited by Fox, in the one instance the cough was caused by wax and an ulcer of the canal; in the other, by an inflammation of the canal produced by the use of spirituous irritant. Lockhart Clarke[1] supports Fox's view as to the origin of ear-cough, " in the fibres of the fifth cerebral nerve distributed to the auditory canal." Mr. John Wood,[2] an examiner in anatomy of the University of London, states positively that he has traced a branch of the vagus into the auditory canal, " Passing through a minute foramen between the jugular fossa and the glenoid."

From the facts so well established since the time of Fabricius, theoretical writers have made the most possible. Woakes[3] hardly considered them exceptional, and argues with ingenuity, that there may be quite a large class of cases of affections of the larynx, that are due to auditory irritation. He suggests spasmodic croup as *occasionally* owing its origin to a draught of cold air falling upon the ear. He also attempts to explain " derangement in the innervation of the laryngeal muscles " as possibly due to reflex influence from the auditory branch of the vagus. He instances the coachman exposed to east wind and rain, and who finds his voice " husky, shrill or faltering," in the evening, and he argues that the exciting causes are draughts of cold air and wet upon the surface, " the impression of which, is conveyed by the afferent vaso-motor nerves associated with the cerebro-spinal nerves of the surface receiving the chill, to the sympathetic ganglion with which they

[1] *British Medical Journal*, 1870, p. 51.

[2] *Loc. cit.*, p. 328.

[3] *Deafness, Giddiness and Noises in the Head*, p. 74 et seq.

communicate; in this instance, the superior cervical ganglion." Dr. Woakes traces the irritation, 1, from the vaso-motor fibres associated with the auricular branch of the pneumogastric; 2, to the secondary vaso-motor centre, the ganglion of the pneumogastric whence, he says, it is deflected through a sympathetic fasciculus to the first cervical ganglion; 3, thence by the *nervi molles* to the vessels distributed to the mucous membrane of the larynx. He rejects the simple idea that the morbid impression is conducted along the sensitive fibres, from one region to another.

Orne Green[1] suggests, in a review of Dr. Woakes' book quoted by Woakes himself, that the mechanical commotion of the larynx caused by the cough, is the cause of the local inflammatory mischief in this organ. The cases of reflex phenomena from irritation of the canal are too infrequent to justify the deductions of Woakes in regard to laryngeal paresis, and subsequent inflammation. Dr. Woakes quotes an amusing story, from Miss Edgeworth's tales, which will bear repetition: This author relates that a choking Norwegian clergyman at a feast, was relieved by a blast of air from a bellows, which a friendly companion blew into his ear. "The effect was magical; the expulsive action of the laryngeal muscles, called into play by this novel method, speedily got rid of the food which the gluttonous haste of the pastor had caused to go the wrong way."

Woakes[2] points out that sneezing caused by irritation of the auditory canal, cannot be due to or explained by referring it to "an irritation of the third branch of the

[1] *Boston Medical and Surgical Journal,* 1879, p. 911.
[2] *Loc. cit.*, p. 93.

fifth nerve exciting the motor laryngeal branches of the vagus, through communications existing between the roots of these nerves," as claimed by Fox, Clarke and Russell, because with the act of sneezing the vagus, as a motor nerve, can have nothing to do.

These cases are rare and exceptional; we are not ready to accept Dr. Woakes' theories of laryngeal paresis and cough, or to believe that we have any but very infrequent occasion to refer to the auditory canal for the explanation of coughs.

Ear-cough is a very uncommon disease; when it does occur, we may usually find an obvious local cause for it in the auditory canal, as in the classical cases, such as a foreign body or inspissated cerumen. To trace any considerable number of laryngeal affections to transient impressions on the auditory canal, to impressions that act more directly upon other parts of the surface of the body, is to go beyond the bounds of logical reasoning. To produce ear-cough, we must have a continuously acting irritant. A blast of air upon an auditory canal, in cases such as make up the twenty per cent contingent of Dr. Fox's tables, may produce ear-cough, but withdraw the draught and the cough will cease, just as it does when the bean, or wax, or probe is removed from the ear. It seems very unlikely that a permanent lesion is produced by such a temporary influence.

ANATOMY AND DISEASES OF THE MIDDLE EAR WITH DISEASES OF THE NOSE AND PHARYNX THAT MAY CAUSE AURAL AFFECTIONS.

CHAPTER VI.

ANATOMY OF THE MIDDLE EAR.

By the term middle ear, is meant the membrana tympani, the cavity of the tympanum, the mastoid cells, and the Eustachian tube.

THE MEMBRANA TYMPANI.

The membrana tympani, or drum-head, forms the

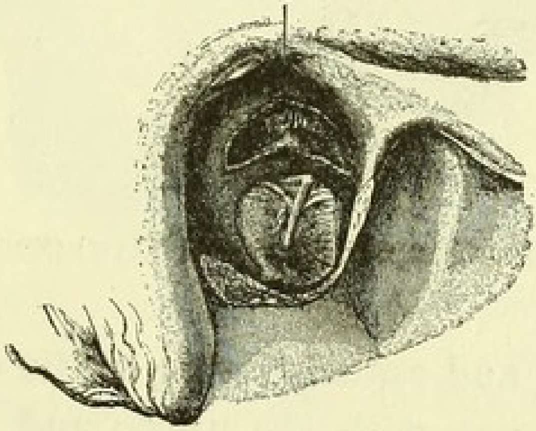

Fig. 25.—Membrana Tympani and Epitympanic Recess (Zuckerkandl's Atlas).

boundary between the external and middle ear. It partakes of the characteristics of these two parts, in being composed of integument and mucous membrane, while it has one structure—the middle or fibrous layer—that is peculiar to itself.

The upper border of this membrane lies 7 mm. nearer to the entrance of the external auditory canal than the lower. The posterior border is about 5 mm. nearer this entrance, or meatus, than the anterior. The angle that the membrana tympani makes with the axis of the auditory canal, is one of about 55°.

There is no perceptible difference between the inclination of the membrane of the newly born and that of the adult.

The peculiar manner in which the membrana tympani is placed in the canal, causes it to form an acute angle

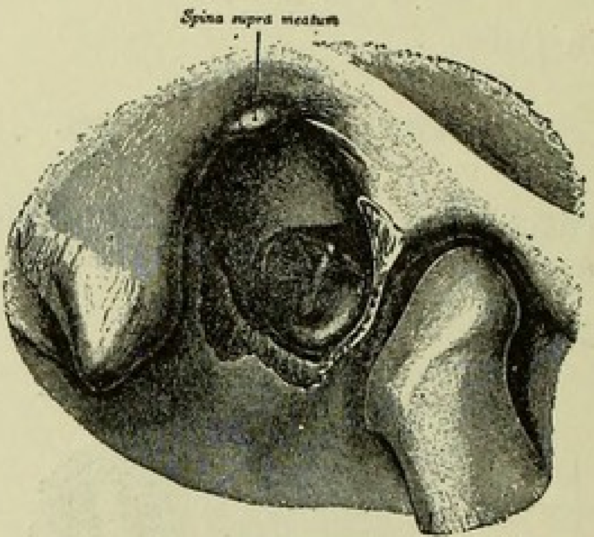

Fig. 26.—Membrana Tympani (External View) (Zuckerkandl's Atlas).

with the lower and anterior wall of the auditory canal, but an obtuse one with the upper and posterior wall. The general shape of the membrane is elliptical; but the regularity of the ellipse is broken in upon by the incompleteness of the bony ring surrounding the membrane. In the upper part of this bony ring an oval section is wanting; this space is known as the segment of Rivini. The long axis of this ellipsoid runs downward and forward, the shorter backward and downward. If the diameters of the membrane are measured in the direction of the axis of the ellipsoid, that of the long axis is 9.5-10 mm. and the horizontal is 8 mm. Measured in the usual manner, the horizontal diameter is 8-8.5 mm. and the vertical 8.5-9 mm.

The Rivinian segment is filled by the tissue of the cutis and the mucous membrane of the tympanic cavity. The greater part of the fibres of the tendinous ring of the membrana tympani bend from their former course, and at this point turn toward the short process of the malleus, which lies more deeply where it is inserted. The remainder of the tendinous fibres of the ring pass up-

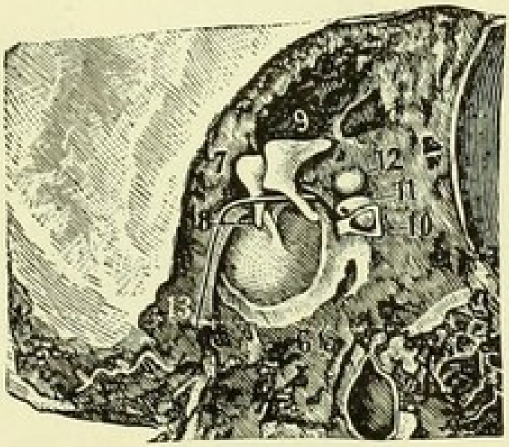

Fig. 27.—Membrana Tympani and Ossicula Auditus (Rüdinger).

ward, and are lost in the connective tissue of the periosteum.

This causes an irregular triangular space to be formed, bounded above by the Rivinian segment, and on each side by two bands, which attach the apex of the small process of the malleus, to the anterior and posterior corners of the osseous groove.

This space and the tissue filling it, is often called Shrapnell's membrane. Shrapnell considered that the function of this flaccid membrane was to protect the more tense fibres during the effects of sudden and loud sounds, or the actions of coughing and sneezing, when by yielding it saves the tense fibres from being ruptured. In the hare and the sheep, that would be otherwise defenceless animals, were it not for the great power of their ears to warn them of approaching dangers, this structure is remarkably developed. The tissue composing Shrapnell's membrane is less tense than the remainder of the membrana tympani, and sometimes falls in like a pouch toward the tympanic cavity. It consists of a very thin layer of cutis and of mucous membrane.

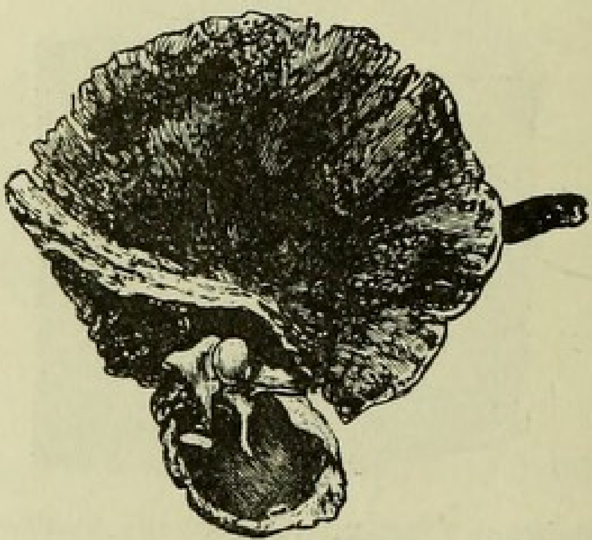

Fig. 28.—Left Temporal Bone with Membrana Tympani and Ossicles.

The mucous membrane extends to the osseous edge of the Rivinian segment, and from here passes over to the projecting neck of the malleus bone, which lies opposite.

The existence of a minute opening in the membrane—the so-called Rivinian foramen—has been warmly disputed from the time of its discovery.

If the Rivinian foramen, or canal, does exist in the membrana flaccida, it is so small that only a fine bristle or hair will pass in it, and the anatomist must sometimes persevere for hours in order to find it. The foramen of Rivinus occasionally exists as our observations show, and air may be occasionally heard to whistle through it, although the opening itself cannot be seen.

The objects in the membrana tympani, which first strike the attention of the observer, are the handle, or long process of the malleus bone, and the triangular spot of light. The membrane is now spoken of, when viewed through the auditory canal. When this is detached, the reflection called the light spot, is not seen because one of the conditions for its formation is removed, as is also true, to a certain extent, of a membrane

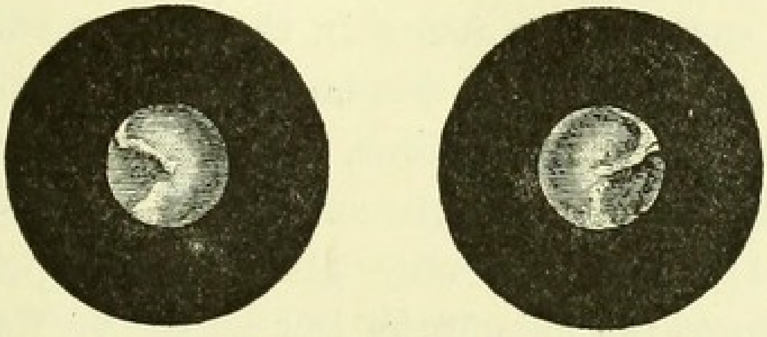

Fig. 29.—Normal Membrana Tympani.

seen after death, when the tissues are macerated. The long process of the malleus, also called the handle or manubrium of the malleus, divides the membrane into two parts. The anterior part is smaller than the posterior.

At the extremity of the handle of the malleus is situated the apex of the light spot. This point is also the place of greatest concavity of the outer surface of the drum-head, and is called the *umbo* (boss of a shield) or navel of the membrane. The light spot is one of the important standpoints for the diagnosis of certain affections of the middle ear. The study of the conditions necessary to its formation is therefore of importance.

An account of the normal color of the membrana tympani will be found in the chapter on chronic non-suppurative inflammation. The ordinary breadth of the light spot, at its base, is from one and a half to two millimetres. It is sometimes interrupted in its continuity. The chief causes of the existence of the light spot, according to Politzer,[1] are the inclination of the membrane to the axis of the external auditory canal, and the concavity produced by the traction of the handle of the malleus. If light be thrown upon a dried preparation of the human ear, as in the examination of the living subject, through the auditory canal, the light spot will be found in the same position as it is seen in life. It is also displaced very little by moving the eye in different directions, because the axis of vision corresponds so nearly to the axis of the meatus, that the light spot can change very little with respect to the inclination to the membrana tympani. No light would be reflected to the eye, if the membrane were a plane surface; for, with its inclination to the auditory canal, all rays thrown upon it would be reflected against the anterior and lower wall of the canal. In consequence, however, of the inward curvature from the traction of the handle of the malleus, its parts undergo such a change of inclination that the anterior portion stands directly at right angles to the axis of vision of the observer, and the light thrown upon it is reflected back to the eye.

Politzer proved the correctness of this opinion by stretching an animal membrane over a large ring, and giving it the inclination of the membrana tympani. No reflection will be perceived until the central portion is

[1] *The Membrana Tympani*, p. 26. Mathewson and Newton's translation.

pressed inward, or made concave by traction from behind it.

The light spots depend upon three factors, viz:

I. The inclination of the membrana tympani to the auditory canal.

II. The traction of the malleus, which renders it concave at the center.

III. Its polish or brilliancy.

THE LAYERS OF THE MEMBRANA TYMPANI.

The membrana tympani is not quite 0.1 mm. in thickness, about as thick as very fine letter-paper or gold-beater's skin. This thickness varies within small limits.

There are three layers in the structure of the membrana tympani.

1. A layer of integument (External layer).
2. A fibrous layer. This layer forms the principal thickness of the membrane (Middle layer).
3. A mucous layer continuous with that of the tympanic cavity (Internal layer).

The integumentary layer may be easily separated from the fibrous layer but the mucous membrane is so closely connected to it that it is impossible to separate them.

It is made up of many layers of pavement epithelium with a Malpighian mucous layer. It has, however, a very thin layer of connective tissue, which is arranged differently from the fibre of the lamina propria, and in which a constant relation to the vessels and nerves of the outer layer is observed.

The first or integumentary layer of the membrana tympani has none of the hairs or glands of the lining of the canal, of which it is a direct continuation. The papillæ are found as far as the short process of the malleus.

The epidermal cells, the cuticle and corium diminish gradually in thickness from the periphery toward the handle of the malleus; they then increase and are thickest on the outer edge of this bone.

The fibrous layer consists of lamellæ, each one of which forms a mesh work of smooth fibres with narrow almost fissure-shaped apertures. The fibres have an average breadth of 0.01 mm.

The majority of the fibres run to the malleus in a radiating or circular direction. A small number of them, however, run in different directions, between these two sets of fibres. The radiating fibres are external, beneath the curis, the circular next to the mucous membrane.

The fibres of the membrana tympani are sharply outlined, and opaque, flattened on the sides, swelling out in the middle. They are from 0.0036 mm. to 0.0108 mm. in thickness. Sometimes they appear to be homogeneous, but they are actually fibrillated. The fibrous layer might be well described, according to Kessel, "as a deep layer of the corium changed and adapted for physiological purposes." The apertures which have been spoken of are usually empty and appear to glisten, or on their edges they are covered by a finely granular mass.

Cells are sometimes found which fill them exactly. Tröltsch called these cells the corpuscles of the membrana tympani, and they are named Tröltsch's cells. The larger spaces contain encapsulated nuclei, and are frequently filled with amœboid cells. On the periphery the thin layers of the membrana tympani interweave, leaving large and small spaces between the fibres for the passage of vessels and form, by union with the outer and internal layers, the "tendinous ring," which is attached by means of a thin periosteum to the osseous ring, or *annulus tympanicus.*

All the layers of the fibrous portion are united to the osseous ring. Kessel confirms Gruber's observation

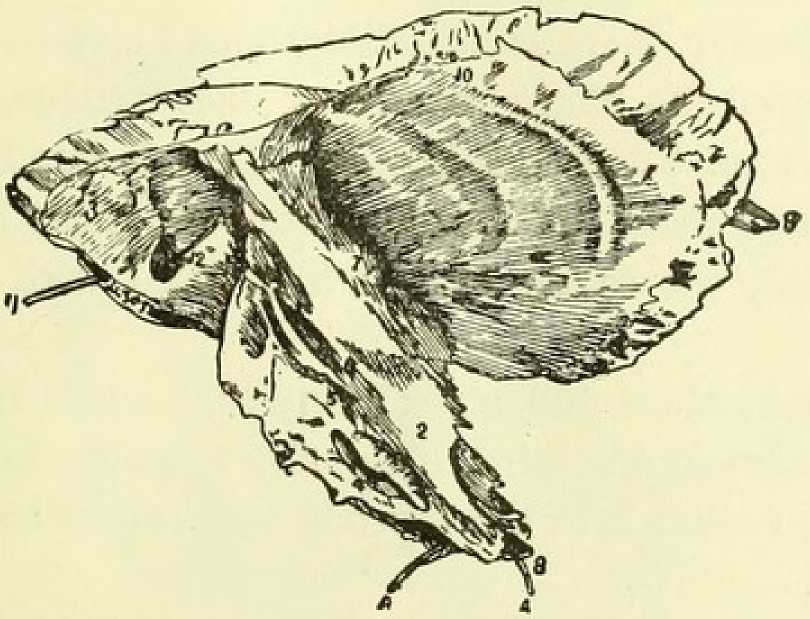

Fig. 30.—Left Temporal Bone (two-thirds of the normal size). 1, Squamous portion of temporal bone ; 2, petrous portion of temporal bone ; 3, mastoid portion of temporal bone ; 4, internal auditory canal ; 5, depression from dura mater ? 6, sup. petrosal sinus ? 7, eminence from semicircular canal ; 8, carotid foramen ; 9, zygomatic process ; 10, groove for meningeal artery ; 11, mastoid foramen ; 12, lateral sinus.

that the circular fibres may be followed into the tendinous ring; but he adds, "these fibres singly, and at some distance from each other, pass off again from the ring at very acute angles, collect together and reach nearly as great thickness as that which results from the union of the fibres, coming from the epidermis, cutis, and mucous membrane." The tension of these fibres causes a convexity of the radii of its surface toward the meatus externus, giving the membrane a general convexity. The circular fibres do not exist on the lower third of the handle of the malleus and the adjacent parts.

The organic muscular fibres described by Sir Everard Home have been rediscovered by Prussak, as spindle-shaped fibres in the membrane.

The handle of the malleus is attached to the fibrous layer between the radiating and circular fibres. According to Gruber, there is a cartilaginous formation, which begins over the short process of the malleus, and extends $\frac{1}{2}$ mm. below the handle. This is firmly united below; but above, at the short process, there is a kind of a joint, the cavity of which is filled with synovial fluid.

Prussak, Moos and Kessel[1] say that while this cartilage exists—and a third of the short process is of cartilage—it passes into the osseous portion without interruption.

There is also, according to Prussak and Moos, a thin layer of cartilage cells under the periosteum of the handle of the malleus not only in infants but also in adults. At birth, the malleus is only closely united to the membrana tympani at two points,—at the short process and at the lower third of the handle. The fibrous layer is united with the periosteum of the upper portion of the handle of the malleus only by loose connective tissue, so that a slight motion of the bone is possible at this point, without an articulation.

The mucous layer consists of an epithelium and a fibrous framework beneath it. On the inner side of the

[1] *Stricker's Hand Book*, p. 955.

membrane, at the upper part of its posterior half, is found an irregularly triangular fold, 3 mm. to 4 mm. broad, which arises close behind the annulus tympanicus, and extends to the handle of the malleus. A cavity is thus formed which opens below, which is called by Tröltsch,[1] who described it "the posterior pouch" of the membrana tympani. The best view of this duplica-

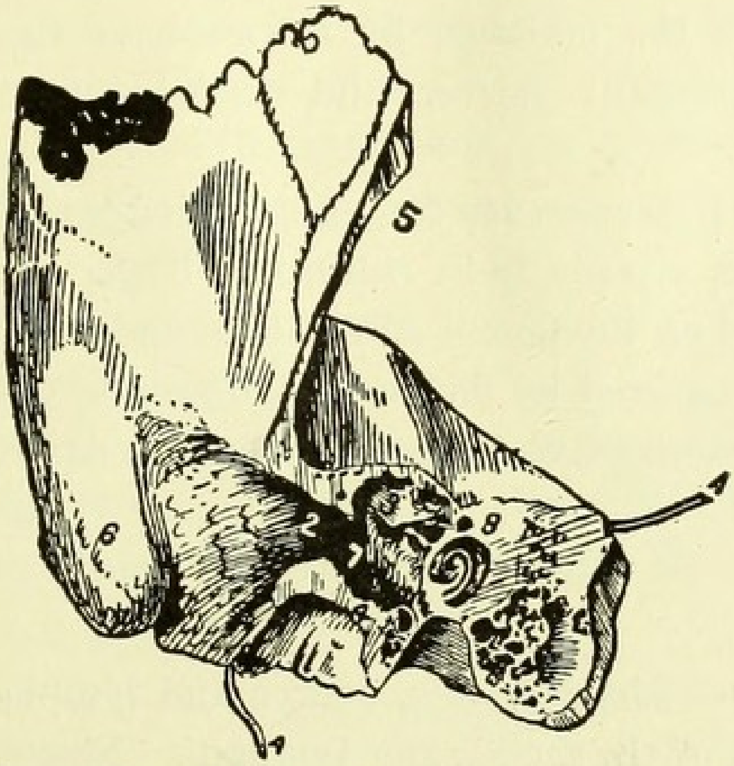

Fig. 31.—Vertical Section of Left Temporal Bone (actual size. From the late Professor Darling's museum). 1, Cochlea with lamina spiralis; 2, external auditory canal; 3, opening of mastoid cells; 4, plate of bone separating the tympanic cavity from carotid canal; 5, squamous portion of temporal bone; 6, mastoid process; 7, tympanic cavity; 8, aquæductus Fallopii.

ture is seen by viewing the membrana tympani from the inside, while it is still in position, after the roof of the tympanic cavity has been removed, and the incus detached from the malleus; but it may even be seen from the outer surface, by a good illumination, in the

[1] *Von Tröltsch. Lehrbuch der Ohrenheilkunde, Vierte Aufgabe,* p. 38.

living subject. The tissue of the pouch is the same as that of the fibrous layer.

A similar space is found in front of the malleus, but this is not formed by a duplicature of the fibrous layer, but by a small long process turned toward the neck of the malleus, by the mucous membrane that lines the tympanic cavity, and by all the parts that enter and leave the Glaserian fissure, that is to say by the long process of the malleus, by its anterior ligament, the chorda tympani nerve, and the inferior tympanic artery.

Villous processes are found on the edge of the mucous membrane, especially in children. These processes are also found on the pouch of Tröltsch and on the malleus. They are covered by flattened epithelium, and are composed of connective tissue in which there are capillary loops.

BLOOD-VESSELS.

There are blood-vessels, nerves and lymphatics in all the layers of the membrana tympani. There is a direct passage of blood-vessels from the outer layer of the membrana tympani to the cavity of the tympanum; a complete capillary network in the fibrous layer communicates with the cutis and the mucous membrane. The blood-vessels that pass from the auditory canal down upon the membrana tympani, come from the deep auricular artery, which is a branch of the internal maxillary.

Those on the mucous membrane arise from the vessels of the tympanic cavity.

NERVES OF THE MEMBRANA TYMPANI.

The nerves of the mucous membrane of the membrana tympani are numerous. There is a plexus near the vessels, and a sub-epithelial plexus. The former accompanies the lymph rather than the blood vessels. It receives its fibres, in part, from threads of the tympanic plexus, which pass on to the membrane, with the mucous membrane, from different parts of the periphery, and partly from the nerves of the cutis, passing through the fibrous layer. The sub-epithelial plexus is a fine network directly under the epithelium, which it supplies with threads.[1]

The outer nerve supply of the membrana tympani is from the fifth pair. The main trunk is a branch of the superficial temporal nerve, from the third branch of the trifacial or fifth nerve. The chorda tympani nerve runs along the inner surface of the membrana tympani, but gives no branches to it.

LYMPH-VESSELS

They are arranged in three layers, like those of the blood-vessels. The first layer belongs to the cutis, the second to the fibrous layer, and the third to the mucous membrane. In the cutis they form a very fine network immediately under the *rete Malpighii.* This network passes over the capillaries at many points. They gradually pass into large capillaries, and finally unite in independent and larger trunks. These run either posteriorly and above, or, exactly like the blood vessels, pass at various points to the periphery and to the auditory canal.

[1] Kessel, p. 963.

In the mucous membrane, also, there is, although not in large number, a sub-epithelial network, lying near the tendinous ring. These vessels are distinguished from the blood capillaries of the same width by their manifold dilatations.[1]

THE CAVITY OF THE TYMPANUM.

The tympanum (*drum*) cavity of the tympanum, or drum of the ear, is the irregular, air-containing space lying beyond the membrana tympani. The mastoid cells, also containing air, and lying in the mastoid portion of the temporal bone, are connected with the tympanum at its upper and posterior part; while the Eustachian tube permits the entrance of air from the naso-pharynx into the cavity through the upper part of its anterior wall.

The points to be noted in the description of the tympanic cavity are indicated in the following scheme:

THE TYMPANUM PRESENTS FOR EXAMINATION ITS

- 1. Dimensions
- 2. Walls
  - the Anterior
  - the Posterior
  - the Outer
  - the Inner
  - the Upper
  - the Lower
- 3. Ossicles
  - Malleus
  - Incus
  - Stapes
- 4. Ligaments
  - Ligaments of movable joints
    - Malleus—Incus
    - Incus—Tympanum
    - Incus—Stapes
  - Ligaments of immovable joints
    - Obturator Stapedis
    - Mallei Superior
    - Mallei Anterior
    - Incudis Superior
- 5. Muscles
  - Tensor Tympani
  - Stapedius
- 6. Mucous Membrane
- 7. Vessels
- 8. Nerves

[1] Kessel; *Handbuch der Lehre von den Geschwulsten*, p. 851.

1. *The dimensions* of the tympanum, like those of the exterior auditory meatus vary much in different individuals. The following table shows about the average diameters as given by Tröltsch:[1]

Antero-posterior diameter			13 mm.
Vertical	"	at anterior part	5 to 8 mm.
"	"	at posterior "	15 mm.
Transverse	"	at anterior "	3 to 4.5 mm.
"	"	opposite the drum-head	2 mm.

Distance from attachment of upper part of the membrana tympani to the superior margin of the opening of the Eustachian tube, $1\frac{1}{3}$ line; from opening of Mastoid cells above to the superior margin of the opening of Eustachian tube, $3\frac{1}{2}$ lines; from opening of mastoid cells above to the superior margin of the opening of the Eustachian tube, $6\frac{1}{2}$ lines; vertical diameter of the tympanic cavity, 6 lines; distance from the membrana tympani to upper inner wall, 2 lines; to lower inner wall, 1 line; opening of Eustachian tube, vertical diameter, $1\frac{1}{2}$ line; horizontal diameter, 1 line. A plaster-of-Paris cast contracts somewhat so that these measurements are actually too small.

2. The *anterior wall* presents, at its upper part, an opening of considerable size—the tympanic orifice of the Eustachian tube. Below this is a bony plate.

The *posterior wall* separates the cavity of the tympanum from the mastoid cells. The opening into the cells, the mastoid antrum, is at its upper part, close under the roof, and considerably higher than the orifice of the Eustachian tube.

[1] Text-book, Roosa's translation, p. 171.

The outer wall of the tympanic cavity is composed, for the most part, of the membrana tympani; but it extends much further backward than the membrane, and contains three small openings; the aperture of the iter chordæ posterius, the Glaserian fissure, and the aperture of the iter chordæ anterius.

The opening of the *iter chordæ posterius* is on a level with the centre of the membrana tympani and close to margin, and gives entrance to the chorda tympani nerve. The nerve then runs upward under the long process of the incus, on the free margin of the posterior pocket of the membrane, then forward across the neck of the malleus, and finally enters the *iter chordæ anterius,* or canal of Huguier. The *Glaserian fissure* opens above, and in front of, the membrana tympani; while just above it is seen the aperture of the *iter chordæ anterius.*

The *inner* wall of the tympanum is the outer boundary of the labyrinth and consists of bone. It has two small apertures closed by membranes. The upper and larger opening is called the *fenestra ovalis,* or oval window, and leads into the vestibule; while the lower and smaller one is called the *fenestra rotunda,* or round window, and communicates with the cochlea. The former is closed by the periosteum of the vestibule, to which the base of the stapes is attached. The fenestra rotunda lies below the fenestra ovalis, and is closed by the *membrana tympani secundaria.* Both these openings may perhaps more properly be called canals, since they have considerable depth, the membranes which close them lying at their inner extremities.

In front of the fenestrae, and partly between them, lies the *promontory,* a projection of the first whorl of the cochlea. Upon it may be seen three shallow grooves for branches of the tympanic plexus. In front of the

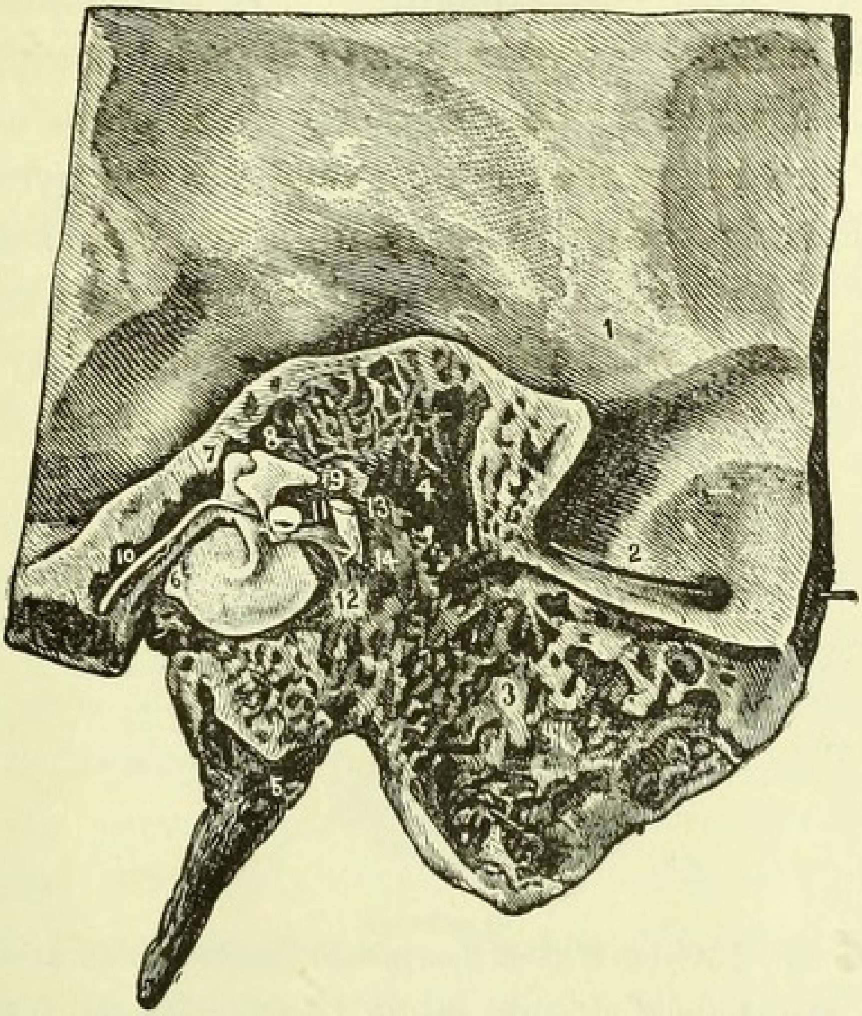

Fig. 32.—The Right Temporal Bone, with the Membrana Tympani and Ossicula Auditus of an Adult. 1, Squamous portion—under figure 1 the sulcus of the transverse sinus runs downward ; 2, a bristle passes through the mastoid foramen ; 3, mastoid cells ; 4, antrum of the mastoid, communicating both with the mastoid cells and with the tympanic cavity ; 5, styloid process : 6, membrana tympani—a point of mucous membrane of the tympanic cavity is seen under the nnmber 6 ; 7, the malleus—under the chorda tympani we see the divided tendon of the tensor tympani muscle ; 8, the incus ; 9, the short process ; 10, the chorda tympani nerve ; 11, the stapes ; 12, stapedius muscle ; 13, facial nerve ; 14, stapedius nerve, branch of facial. The relations of the mastoid cells to the cavity of the tympanum and the relations of the former to the transverse sinus are well shown. (After Rüdinger.)

promontory the inner wall of the tympanum consists of a very thin plate of bone separating this cavity from the carotid artery. This plate is pierced by many minute openings for vessels and nerves, and has, besides, many irregularities on its tympanic surface.

Just above and behind the fenestra ovalis, is a slight rounded ridge, corresponding to the *aquæductus Fallopii,* which gives passage to the facial nerve. This canal is covered by an extremely thin plate of bone. Behind and below the fenestra ovalis is the *pyramid,* a hollow, bony projection, containing the stapedius muscle. The bottom of this cavity of the pyramid is in communication with the aquæductus Fallopii by means of a minute canal. Just behind the ridge of the Fal-

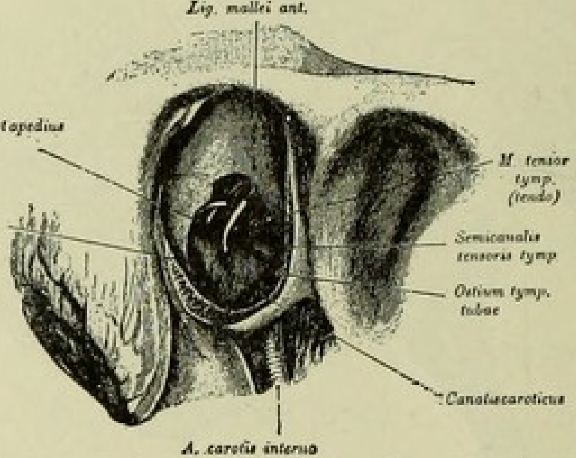

Fig. 33.—Anterior Wall of Tympanum (Zuckerkandl's Atlas.)

lopian canal and about on a level with the fenestra ovalis, is seen a hard, smooth, bony surface, which corresponds to the external or horizontal semicircular canal of the labyrinth.

The *upper wall* or roof of the tympanum, is the partition between this cavity and that of the cranium. Its thickness and density vary considerably in different subjects. It is sometimes very thin and porous, or entirely wanting.

The lower wall, or floor of the tympanum, separates this cavity from the jugular vein. Like the roof, it varies greatly in thickness, being sometimes wholly membranous. It is very irregular on its upper or tympanic surface; and lying much below some points in the floor of the external auditory meatus, and below the orifices of the Eustachian tube and mastoid cells.

Studied with an eye to pathological conditions, some of these walls present very important relations. Thus the roof of the tympanum lies in contact with the meninges of the brain, so that in caries of this wall, the patient may die of purulent meningitis or cerebritis. Again, caries of the lower wall may be followed by phlebitis of the jugular vein; while caries of the inner wall has sometimes caused destruction of the coats of the carotid artery and fatal hæmorrhage, or a suppurative inflammation of the labyrinth, with extension into the cavity of the skull. It is easy to see, too, how even a non-suppurative inflammation of the tympanum may affect the facial nerve, since, during a part of its course, the nerve is separated from the mucous membrane only by a thin plate of bone, which may even be deficient in many places. Indeed, swelling of this nerve, causing temporary facial paralysis, or destruction of it, producing permanent paralysis, is not uncommon in connection with a suppuration in the middle ear, or after an operation upon the tympanum.

OSSICULA AUDITUS.

3. The three small bones of the ear, the *ossicula auditus,* are the *malleus,* or hammer; the *incus,* or anvil; and the *stapes,* or stirrup.

The ossicles are articulated to each other, and extend, although not in a straight line, from the membrana tympani to the fenestra ovalis.

The *malleus* may be described as consisting of the head, neck, short process, manubrium, or handle, and the long process or processus gracilis.[1] The head is the larger, upper extremity of the bone. Posteriorly it has an elliptical depression, twice or thrice as long as it is broad, and of considerable depth for articulation with the incus. Below the head is a constricted portion called the neck, and just below this, and on the upper end of the manubrium, is a prominence to which the processes are attached. The manubrium extends downward and inward, being inserted into the drum-membrane between the circular and radiating fibres of

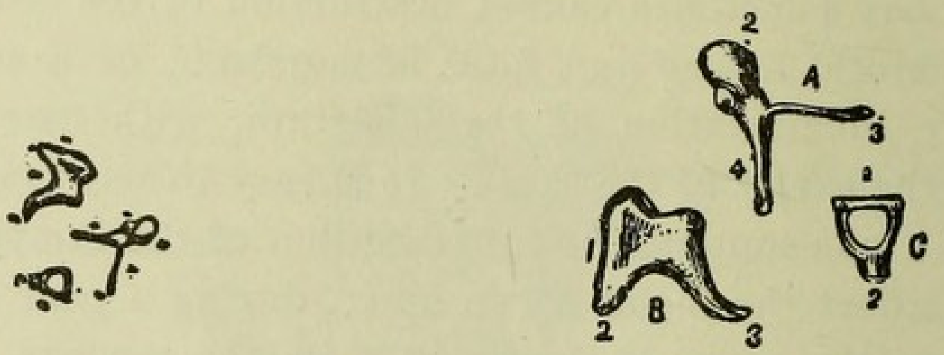

Fig. 34.—Ossicles (actual and twice the natural size. From the late Professor Darling's Museum.) A, Malleus. 1, Short Process ; 2, head ; 3, processus gracilis ; 4, handle. B, Incus. 1, Body ; 2, short process ; 3, long process. C, Stapes. 1, Head ; 2, base.

the middle layer. The processus gracilis passes from the eminence below the neck forward and outward to the Glaserian fissure. The *short process* lies at the base of the manubrium opposite where it gives attachment to the tensor tympani.

The *incus* lies just back of the malleus, and may be described as having a body and two processes. On the anterior and inner surface of the head is seen the surface for articulation with the malleus. The short process projects backward and articulates with the posterior wall of the tympanum. The long process, much

[1] Some writers call the handle of the malleus the long process.

more slender than the other, descends at a right angle with the short process, and parallel with and behind the manubrium, to end in the *processus lenticularis,* which articulates with the head of the stapes. This articulation lies a little higher than the tip of the manubrium.

The *stapes* consists of the head, neck, crura, and base, and is the innermost and smallest of the bones of the ear, and indeed of the body. The head presents on its outer part a surface for articulation with the lenticular

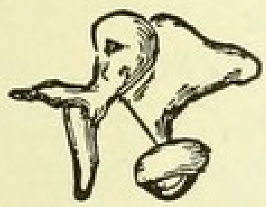

Fig. 35.—Posterior Surface of the Malleus, Incus, and Stapes. Twice the natural size.

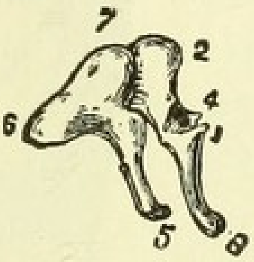

Fig. 36.—Anterior Surface of Malleus and Incus. (Twice the natural size.) 1, Short process of Malleus; 2, head; 3, handle; 4, broken processus gracilis; 5, Long process of incus; 6, short process; 7, body. All from the late Professor Darling's museum.

process of the long process of the incus. Just internally to the head is the constricted portion called the neck, into which is inserted the stapedius muscle. From the neck the crura diverge horizontally, the one forward and inward, the other backward and inward, to be inserted into a thin plate constituting the base, which lies upon the membrane of the fenestra ovalis. On the outer side of the base is a delicate ridge running from the extremities of the crura and into which is inserted the obturator stapedis.

The dimensions of the ossicles are: length of *malleus* from summit of head to short process, about $4\frac{1}{2}$ mm.; from short process to the end of the handle, 4 to 5 mm. Long process or handle, about 2 mm. Length of the *incus* from summit of head to the end of the long process, about $6\frac{1}{2}$ to 7 mm.; to the end of the short process, about 5 mm. Length of the stapes, about 3 mm. Greatest distance between the crura, about 2 mm. Length of the base, about 3 mm.; width, about 1 mm. The long process, or processus gracilis, is sometimes

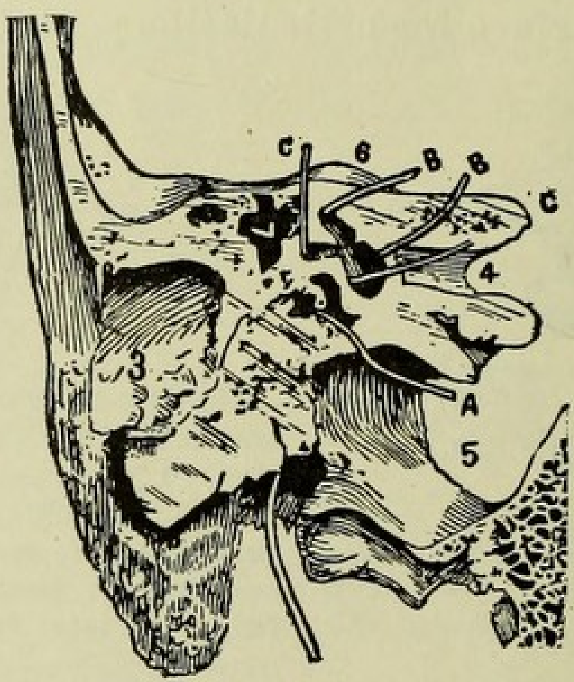

Fig. 37.—Vertical Section through Right Temporal Bone (posterior half, actual size. From Professor Darling's museum). 1, Squamous portion of temporal bone; 2, mastoid process; 3, external auditory canal; 4, internal auditory canal; 5, carotid canal; 6, eminence of sup. semicircular canal; A, A, aquæductus Fallopii; B, B, sup. semicircular canal; C, C, horizontal semicircular canal; 7, mastoid cells.

called the processus *Folianus* (Cœlius Folius, Venice, 1645), and also the process of Rau, after Professor Jacob Rau, of Leyden.

4. Of the *ligaments of the ossicles* we have two classes: the ligaments of the movable joints and those of the immovable joints.

The *malleo-incus* joint may be classed with the gynglimus articulations on account of the character of the articulating surfaces. These surfaces are covered by cartilage about 0.04 mm. in thickness. The capsule is tense. This joint is provided with synovial membrane. The articulation between the short process of the incus and the posterior tympanic wall is an amphiarthrosis, and is surrounded by a tolerably thick and tense capsule. The motion is quite restricted. The joint between the processus lenticularis of the incus and the head of the stapes is an arthrosis, the processus lenticularis corresponding to the ball and the head of the stapes to the socket. Both surfaces are covered with cartilage. The cartilage is much more delicate than those of the other joints, and is characterized by being rich in elastic fibres.

The *ligamentum obturatorium stapedis* is a thin membrane inserted into the ridge on the outer side of the base of the stapes and into the inner edges of the crura, closing the opening formed by these parts. The head of the malleus sometimes lies in contact with the roof of the tympanic cavity. More frequently it is connected with the roof by the cylindrical *lig. mallei superius* (Soemmering). The neck of the malleus is held in place by the cartilage which sometimes takes the place of the long process, and by the *lig. mallei anterius* (Arnold), which goes from the spina angularis of the sphenoid parallel with the fissura petro-tympanica, to be inserted upon the head of the malleus. The incus, when not in immediate contact with the roof of the tympanum, is attached to the roof by means of the *lig. incudis superius* (Arnold) and is inserted into the posterior border of the body of the bone.

The posterior surface of the head of the malleus is oblong, and it extends in spiral form from above downward and inward to the boundary of the neck. The incus has an auricular surface corresponding to this. These surfaces are covered by a thin layer of hyaline cartilage. The capsular ligament connecting the bones allows of considerable motion. A fold, described by Pappenheim (1840) and Rüdinger, projects into the cavity of the joint. The mechanism of the joint between the malleus and incus is compared by Helmholtz to the *cog* contained in certain watch-keys, where the handle cannot be turned in one direction without carrying the steel shell with it, while in the opposite direction it meets with only slight resistance. When the handle of the malleus moves inward, the inferior cog of the malleus catches the inferior cog of the incus, and causes the long process of the incus to follow the motion of the handle of the malleus inward. When the handle of the malleus moves outward, a strong movement of the articular surfaces follows, the inferior cog of the malleus recedes from that of the incus, and the incus will consequently only follow the motion of the malleus outward to a slight extent. The articulation of the incus and stapes does not admit of much separation of the bones, but they can move sideways to a greater extent.

The articulation between the stapes and the margin of the fenestra ovalis consists of elastic fibres, which run in a radiating direction, converging toward the margin of the foot-plate. These margins are covered with a thin layer of cartilaginous tissue.

The *stapedius* muscle arises from the bottom of the pyramid, or eminentia stapedii, the hollow of which it fills. At the orifice of the canal it becomes tendinous, and thence runs, at an obtuse angle with the rest of the muscle, to the neck of the stapes. This is the smallest distinct muscle of the human body.

The *tensor tympani* muscle arises in front of the anterior opening of the canalis musculo-tubarius from the pyramid of the temporal bone, from the upper wall of the tubal cartilage, and from the neighboring border of the sphenoid. It passes over the septum tubæ into and through the canal of the tensor tympani. Just before leaving the canal it becomes tendinous. The tendon is inserted on the inner margin of the handle of the malleus, at the anterior edge of the rhomboidial surface, obliquely to the longitudinal axis of the malleus.

The *mucous membrane* of the tympanum is a continuation of that of the Eustachian tube and naso-pharyngeal space. It is extremely delicate and consists chiefly of an epithelium and a layer of connective tissue underneath. On the lower, the anterior portion of the inner, and the posterior walls, the epithelium consists mainly of columnar cells; while on the promontory, roof, membrana tympani, and ossicles, pavement cells predominate. The thinness of the connective tissue is such that the mucous membrane cannot be separated from the periosteum, and that every catarrh is a periostitis. But, according to Kessel, the connective tissue of the mucous membrane in some places forms a fibrous framework which separates it from the periosteum, and passes from one projection of bone to another through the free space of the cavity. One such bridge has frequently been observed to pass from the eminentia pyramidalis to the processus cochleariformis, while many are seen on the floor of the tympanum.

BLOOD-VESSELS.

The anterior and middle parts of the tympanic cavity are supplied:

1. By the branches of the ascending pharyngeal artery, from the external carotid.

2. By branches of the middle meningeal, which pass through the *hiatus canalis Fallopii* and the petroso-squamosal fissure into the tympanic cavity.

3. By the internal carotid, which sends a few small branches from the carotid canal into the tympanic cavity.

There is a vascular communication between the middle ear and the labyrinth through the osseous wall separating them (Politzer). The blood vessels of the middle ear proceed from the deeper layers of the lining membrane, accompanied by numerous prolongations of connective tissue and penetrating almost perpendicularly into the bony substance.

This vascular connection readily explains the easy transference of disease of the middle ear to the internal ear.

NERVES.

The tensor tympani muscle is supplied by a branch from the otic ganglion, and from the internal pterygoid, a branch of the third division of the trifacial.

The stapedius is supplied by a filament from the facial nerve.

The nerves of the mucous membrane are derived from the tympanic plexus, consisting of a combination of the great sympathetic, the trifacial, and the glosso-pharyngeal.

The branches of distribution of the tympanic plexus are to the tensor tympani and the tensor palati muscles. It sends a twig to the external pterygoid branch of the fifth nerve, and several communicating branches to the auricular nerve of the third branch of the fifth nerve.

By this ganglion the soft palate, the drum-head and tensor tympani, and the integument of the external ear are put in relation with each other and with the general nervous system.

The chorda tympani nerve seems to pass through the tympanic cavity without being in any physiological relation to it. Division of this nerve in operations upon the tensor tympani muscle usually has no effect upon the functions of the ear.

THE MASTOID PROCESS.

The mastoid portion of the temporal bone (mastos, a nipple or teat) is situated at the posterior part of the temporal bone. Its external surface is rough, and perforated by numerous foramina. One of these, of large size, situated at the posterior border of the bone, is called the mastoid foramen. Through it a vein passes to the transverse sinus and a small artery. This foramen does not always exist in the mastoid process, but is sometimes found in the occipital bone, or in the suture between the temporal and the occipital.

The roughened appearance of the mastoid is sometimes so marked that it resembles the inner cellular structure of the bone. In some rare cases there is even complete absence of the outer layer of bone, so that the air cavities open externally, as well as into the cavity of the tympanum and the external auditory canal. The mastoid portion is continued below into a conical projection. To this process or tip are attached the sterno-mastoid, the splenius capitis, and trachelo-mastoid muscles. On the inner side of the mastoid process is a deep groove, called the fossa sigmoidea. In this groove

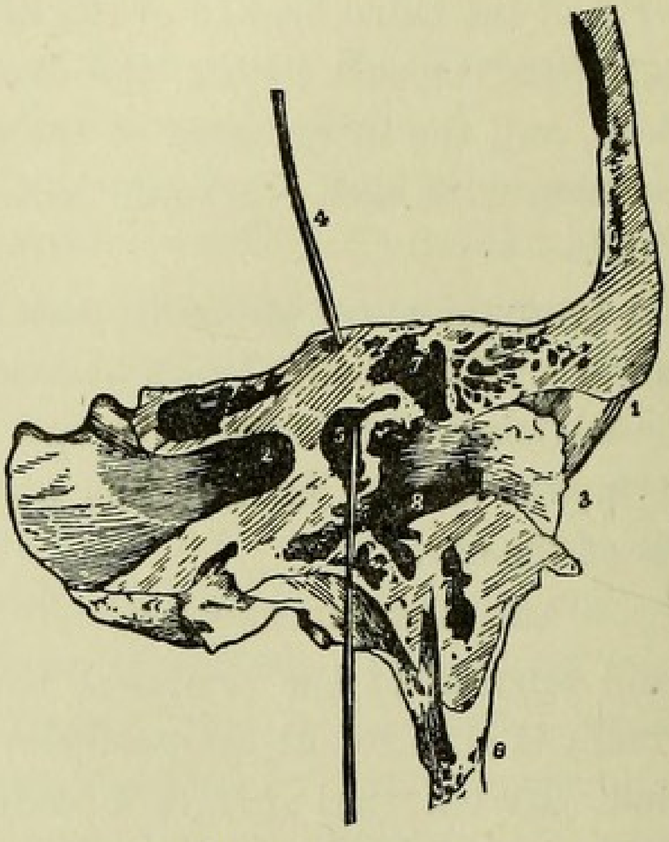

Fig. 38.—Vertical Section through Right Temporal Bone. 1, External auditory canal; 2, internal auditory canal; 3, tympanic process; 4, sup. semicircular canal; 5, vestibule; 6, styloid process; 7, mastoid cells; 8, tympanic cavity. (From Darling's museum.)

is a part of the lateral sinus, and the mastoid foramen opens into it. The mastoid process is hollowed out into a number of spaces of various sizes, which are called the mastoid cells.

THE MASTOID CELLS.

The upper or horizontal part of the process, called also the *antrum mastoideum,* is in communication with the tympanum by means of one or more openings in the posterior tympanic wall. It exists in the new-born before the development of the mastoid process. The second part of these cells, lying in the mastoid process of the temporal bone, are below the horizontal part. The whole consists of a great number of irregular spaces of varying sizes—sizes that also vary much in different individuals. The whole are inclosed by a dense cortical layer of bone, separating them from the cavity of the skull, and limiting them externally. This cortical layer also is of different thicknesses in different individuals, a fact of some practical importance in cases of suppurative inflammation of the middle ear implicating these cells. Several small foramina are seen in the mastoid portion of the temporal bone—openings for branches of the middle meningeal artery and the vasa emissaria Santorini. The cells are lined by a mucous membrane similar to that of the membrana tympani, but it is more delicate.

The epithelium consists of smooth cells of the same consistency and arrangement as those of the membrana tympani. Under this we find two layers of connective tissue, corresponding to the periosteum.

At birth the mastoid process is but the rudiment of what it is afterward to be. It is a small tuberosity, and contains but one cell of any considerable size, which afterwards becomes the mastoid antrum. Dr. E. Zuckerkandl investigated the anatomy of the mastoid process. He found the cells even into the antrum filled with diploetic tissue, and the adjacent ones to this latter part also containing fat. Subsequent examinations showed him that in many cases the mastoid process was entirely diploetic in structure or fully plugged with fat, and that these tissues appeared together and in connection with air-cells. Zuckerkandl examined 250 ears. He found that the external appearance gave no positive indication of the internal structure. He found the following varieties in the examination of 250 temporal bones:

1. The whole process filled with air-cells. The air-spaces more or less of the same size. The surface thin, in spots transparent.

2. The process containing air-cells, but the cavities small.

3. The cells of unequal size. Generally those of the *pars squamosa* were larger.

4. The process entirely an air-chamber. The cells are large, and extend to a line drawn from the lower wall of the auditory canal through the mastoid process.

5. The cells of the *pars squamosa* were large, while the *pars petrosa* of the apophysis contained one large cavity.

6. There were in the whole process only three or four tubular cavities, whose termini made up the antrum.

7. The process involved only cavities, on whose walls were ridge-like partitions.

The varieties in diploetic and fatty contents were equally great. Of 100 temporal bones belonging to 50 subjects, the mastoid process was completely pneumatic in but 40 cases. In 22 cases, the process up to the antrum contained red or yellow adipose tissue. Nine times the lower half of the process was diploetic or contained fat, while the upper part was pneumatic, and in the remaining 29 cases only the apex, or from 3 to 5 mm. was narrow-celled, diploetic; otherwise it contained air-cells. In 8 of the 100 cases the mastoid processes of the same person were different in structure. In 150 macerated temporal bones the results were as follows: Fifty-two times the process was completely filled with pneumatic spaces. Twenty times only the lower half contained diploetic spaces, while the upper was pneumatic. Thirty-eight times the apex only of the process was diploetic from 3 to 5 mm. Several times the diploetic structure extended only to the *pars petrosa* of the process. These investigations make it probable that many, if not all, of the reported cases of hyperostosis or sclerosis of the mastoid were really only normal conditions.

Zoja,[1] of Pavia, examined 68 fresh preparations and 100 dry ones, in order to get the average size of the mastoid process and its cavities. The result of his investigation is that the breadth of the mastoid is 19 mm., its thickness 13 mm., and its length 12 mm. About 1 millimetre should be deducted from these measurements in the bone of the female subject. The cortical layer according to these examinations, has an average thickness of from one to two millimetres.

In two of the 68 specimens belonging to one subject the cells were united into one large cavity, so that they formed, as it were, a mastoid cavity. This was also found in another case on one side only. The cells in the centre of the process are usually the larger, and communicate with one another, if they are not separated by the membrane that has been described. In several cases there were cells only in the base of the process. Occasionally these cells extended to the side of the skull or even to the middle of the petrous part of the temporal bone.

In five of the sixty-eight specimens the antrum was

[1] Gruber's *Lehrbuch*, p. 33.

found to be separated from the other cellular spaces by a membranous partition.[1]

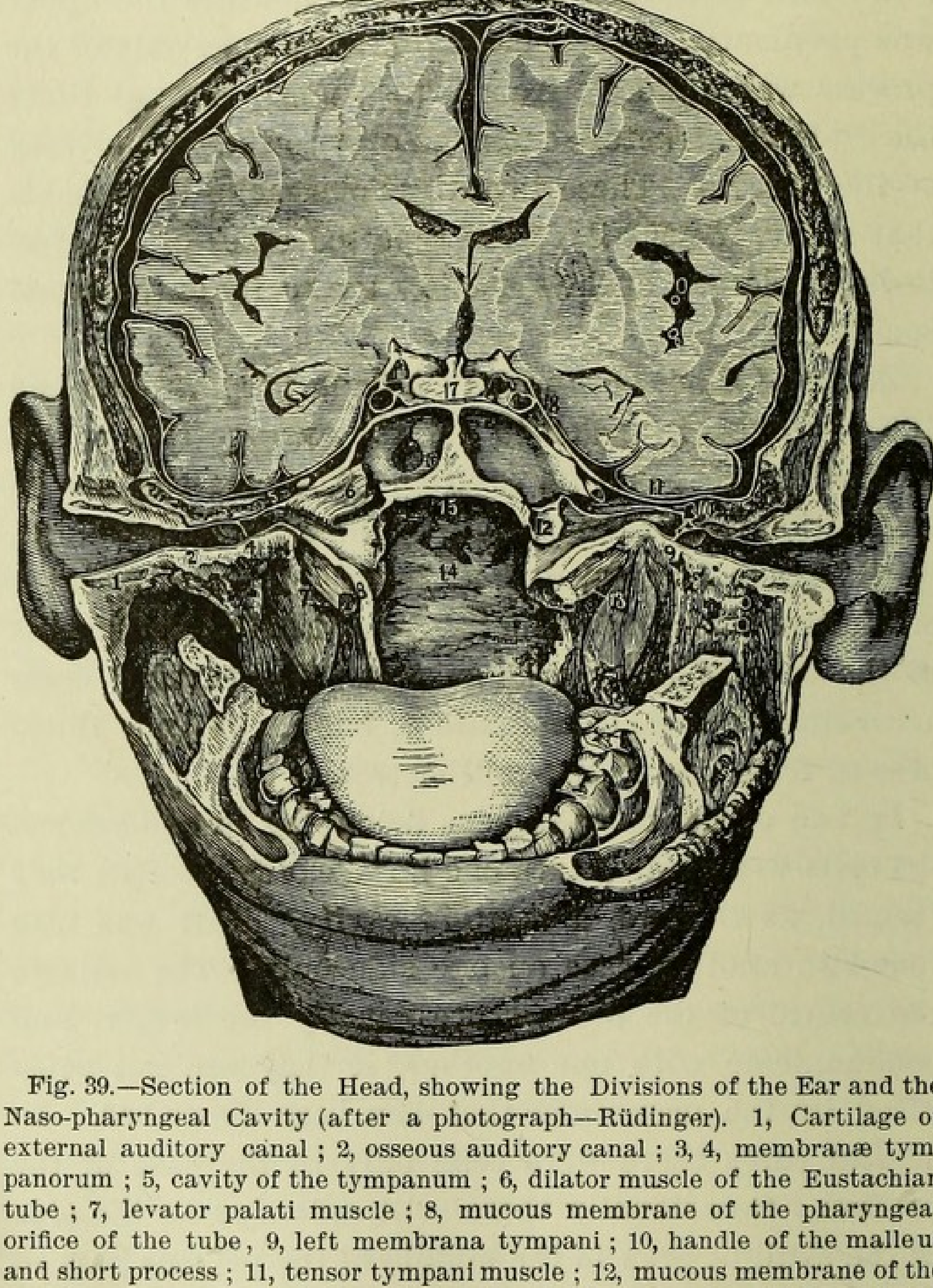

Fig. 39.—Section of the Head, showing the Divisions of the Ear and the Naso-pharyngeal Cavity (after a photograph—Rüdinger). 1, Cartilage of external auditory canal ; 2, osseous auditory canal ; 3, 4, membranæ tympanorum ; 5, cavity of the tympanum ; 6, dilator muscle of the Eustachian tube ; 7, levator palati muscle ; 8, mucous membrane of the pharyngeal orifice of the tube, 9, left membrana tympani ; 10, handle of the malleus and short process ; 11, tensor tympani muscle ; 12, mucous membrane of the membranous portion of the tube, perforated by a needle : 13, levator veli palati muscle ; 14, mucous membrane of the posterior surface of the pharynx ; 15, mucous membrane of the pharynx, attached to the lower surface of the body of the sphenoid bone ; 16, sphenoidal sinus ; 17, hypophysis cerebri and its relations to the cerebral arteries and the cavernous sinus.

[1] Henle : *Lehrbuch*, p. 751.

BLOOD-VESSELS OF THE MASTOID PROCESS.

The blood-supply of the mastoid cells is furnished by the stylo-mastoid branch of the posterior auricular artery, while their nerves come from the tympanic plexus.

THE EUSTACHIAN TUBE.

The Eustachian tube, like the external auditory meatus, consists of an osseous and a cartilaginous part.

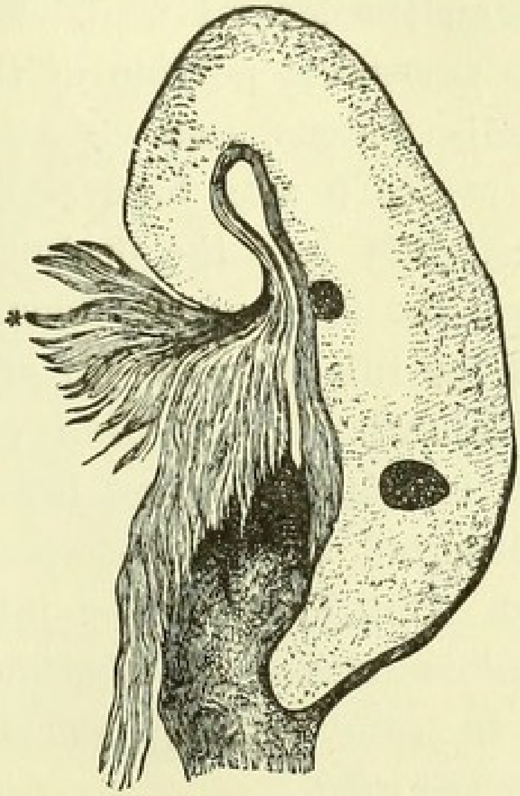

Fig. 40.—Transverse Section of Upper Part of the Eustachian Tube (Henle). * Fibres of the spheno-staphylinus muscle.

The former measures 11 mm., the latter 24 mm., so that the whole length of the tube, from its opening into the tympanic cavity to its pharyngeal orifice, measures 35 mm. The tube, from its tympanic end, runs forward, inward, and downward. Its axis makes an angle of 135° with the axis of the external auditory canal, and an angle of 40° with the horizontal plane.

The diameter of the osseous portion of the tube is about 2 mm. The walls are smooth, and covered by a mucous membrane, which, like that of the tympanum, is closely adherent to the periosteum. The lateral wall belongs to the pars tympanica; the median wall separates the tube from the carotid canal; the upper wall is formed by the septum tubæ, the floor of the canal for the tensor tympani muscle.

The shape of the anterior extremity of the osseous tube is very irregular, the inner wall extending forward much further than the lateral wall. This part, "the isthmus," is the narrowest portion of the tube. Here the tube gradually widens, and ends anteriorly in a trumpet-shaped orifice 9 mm. high and 5 mm. broad, which projects slightly into the post-nasal space, and lies a little above the level of the floor of the nostril. The cartilage of the tube is made up of two plates—a median and a lateral. The median plate, which is much the larger, is triangular, and into its upper and outer part is inserted the hook-shaped and smaller lateral cartilage. But most of the lateral wall and all of the lower is formed of membrane instead of cartilage, the membrane forming nearly a half of the circumference of the tube.

The median wall of the cartilage of the tube is below 1 mm. in thickness on its posterior extremity, but increased in size gradually to 2½ to 3 mm., and on its free anterior border may even reach 7 mm. The tissue of the cartilage is chiefly hyaline, but it has a fibrous base substance at various spots; sometimes on the surface, sometimes on the interior, and especially near the edges. The mucous membrane which fills up the concavity of the cartilage, and which changes the calibre up to the vicinity of the pharyngeal orifice to a plane surface, is 0.6 mm. thick at its densest portion. It is connected to the perichondrium by loose connective tissue. It is made smooth by numerous acinous glands of about 0.6 mm. in diameter and 0.15 mm. in thickness.

These glands form a continuous layer backward from the pharyngeal orifice, for some distance. Toward the cavity of the tympanum they are less numerous. Toward the pharyngeal orifice large mucous glands

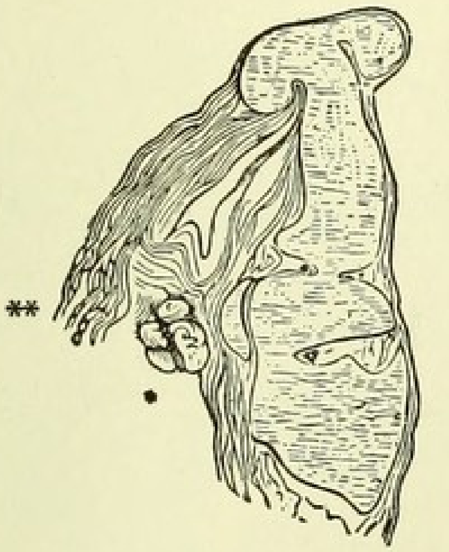

Fig. 41. — Transverse Section through the Lower End of the Eustachian Tube (after Henle). *. Mucous glands ; **, fibres cf petro-staphylinus muscle.

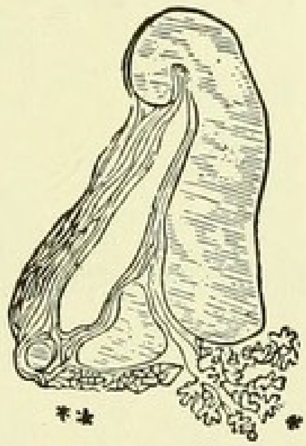

Fig. 42. — Transverse Section through the Lower End of the Eustachian Tube (after Henle.) *, Mucous glands ; **, transverse section of the petro-staphylinus muscle.

appear lying on the outer side of the cartilage. The lateral wall of the tube, which, with its upper border, bounds the convex surface of the enveloping ridge of the cartilage, has about the same thickness as the median wall, and the same covering of mucous membrane. The tissue in the upper half is quite firm, in the lower more relaxed and spongy. Fat is its chief structure.

A portion of the tendinous origin of the spheno-staphylinus muscle unites with the firmer portion of the wall, and for some distance this origin runs in a thin layer between the upper border of the soft wall of the tube, and unites with the convex surface of the latter. The spheno-staphylinus muscle being thus attached to the tube has the power of rolling over the upper inverted border of the cartilage, and of enlarging the angle which the lateral wall forms with the median. The opening or gaping of the tube depends upon this action, which occurs with the act of swallowing. At the

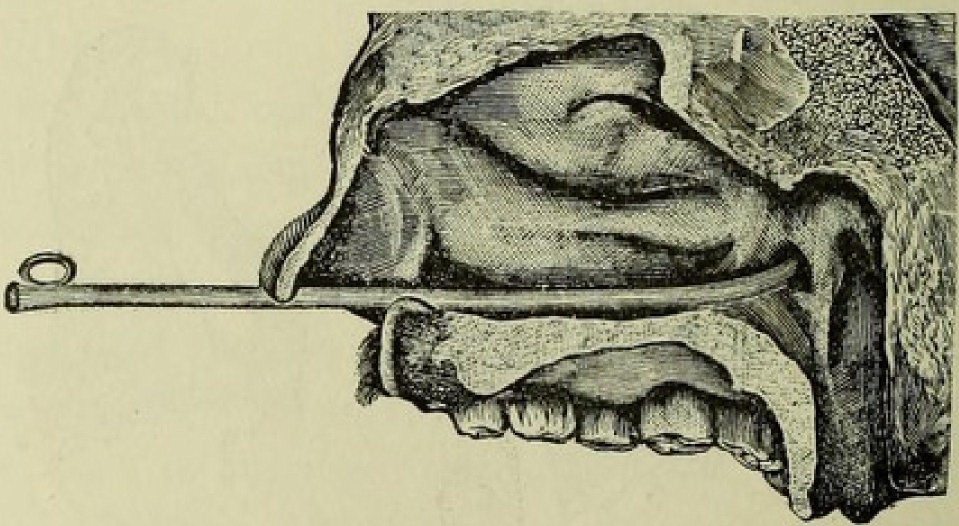

Fig. 43.—Vertical Section showing the Mouth of Eustachian Tube and Rosenmüller's Fossa with catheter in position.

point where the lateral wall of the nasal cavity passes into the pharynx, at the same height with the posterior end of the inferior turbinated bone, lies the pharyngeal orifice of the tube (Fig 43).

Since the inner wall of this canal projects into the calibre of the naso-pharyngeal space, the mouth of the tube lies more in a frontal than sagittal plane. It has a puffy median border, while the lateral wall passes without any distinct line of separation into the nasal cavity. The width of the mouth of the tube varies in different persons, and has the general shape of a funnel.

The known functions are to conduct away the secretions of the cavity of the tympanum, and to act as a ventilator of this part. Clinical observations have clearly demonstrated the important part played in the hearing power by the Eustachian tube.

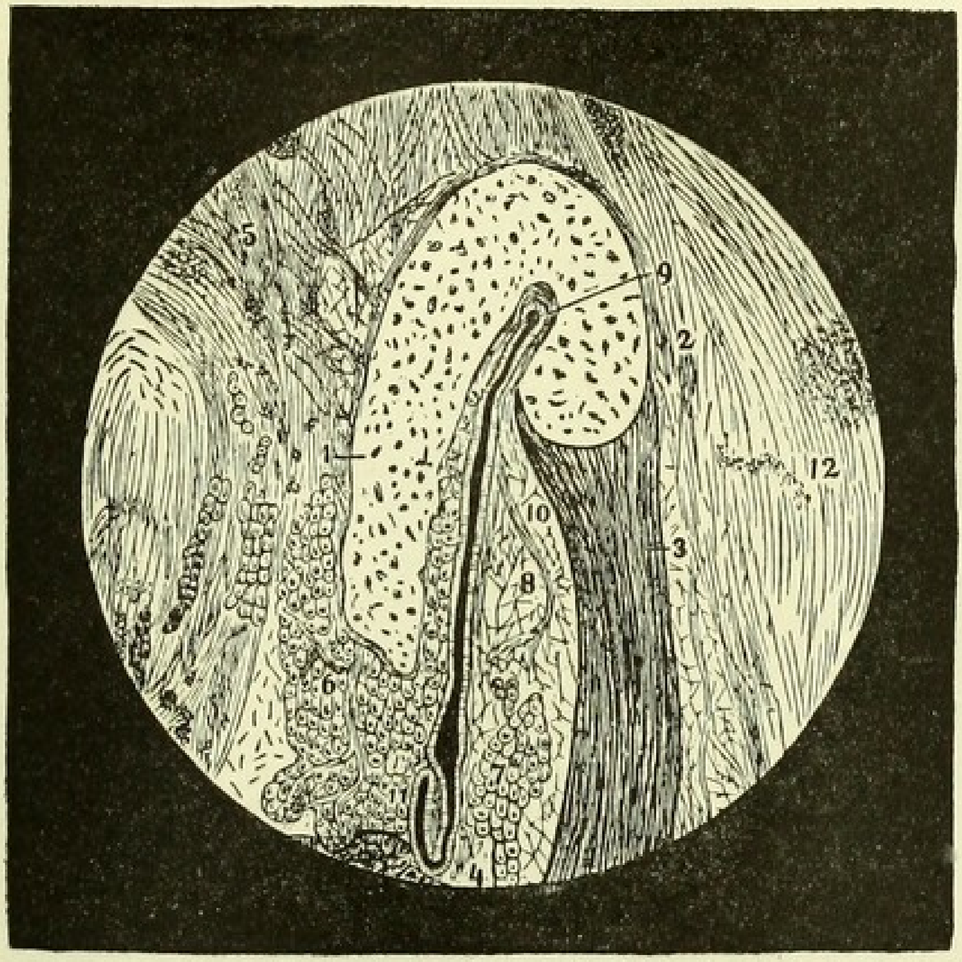

Fig. 44.—Transverse Section of Eustachian Tube and Surrounding Parts (after Rüdinger). 1, Median cartilaginous plate ; 2, lateral cartilaginous hook ; 3, dilator of the tube ; 4, lavator of the soft palate ; 5, basilar fibrocartilage ; 6, 7, acinous glands ; 8, fat in the lateral wall ; 9, safety tube ; 10, accessory fissure ; 11, fold of mucous membrane ; 12, adjacent tissues.

The mucous membrane of the tube is at its lower part quite thick, like that of the pharynx, of which it is an immediate continuation. Its epithelium is ciliated, the motion being in the direction of the pharynx. The tube of the infant differs much from that of the adult. It is shorter, wider, and more nearly horizontal.

The question whether the tube is normally open—that is, when the muscles of deglutition are at rest—is one which has been much debated. Throughout the narrowest part of the tube the larger part of the outer and inner walls are in contact, but at the upper part is a small chink, which, as some authors claim, remains

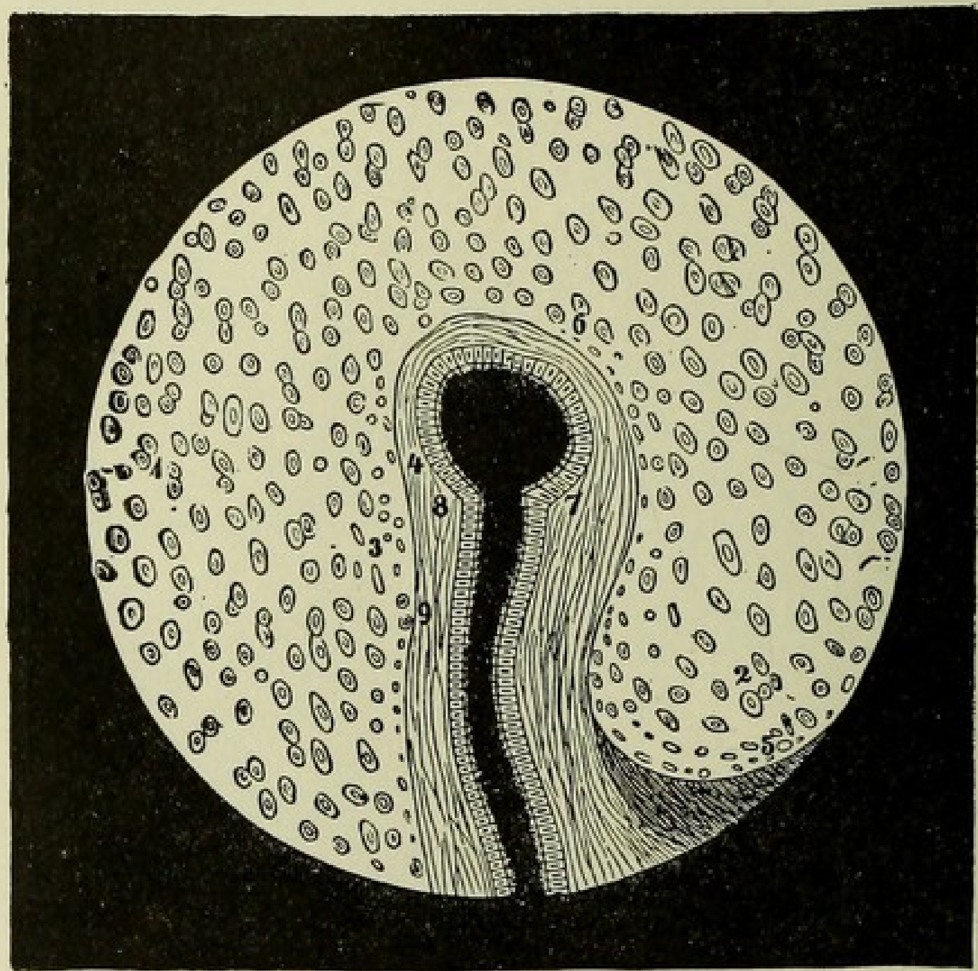

Fig. 45.—Section of the Upper Third of the Eustachian Tube (after Rüdinger). 1, Median cartilage; 2, lateral cartilage hook: 3, perichondrium; 4, submucosa; 5, insertion of the dilator of the tube; 6, safety tube; 7, lateral projection of the mucous membrane; 8, median projection of the mucous membrane; 9, accessory fissure.

patent, while others deny this. However, any observer with normal tubes will be able to notice that the tube opens, or at least widens, at every act of swallowing. If the nostrils are tightly held, air will be pumped out of the tympanum by the act of swallowing, and this air will be restored again to the ear-drum by swallowing with the nostrils free.

MUSCLES OF THE TUBE.

The muscular apparatus of the Eustachian tube also belong to the pharynx. Indeed, these parts are so

Fig. 46.—Section of the Middle Third of the Eustachian Tube (after Rüdinger). 1, 2, Cartilage; 3, dilator of the tube; 4, solds of mucous membrane under the cartilage hook; 3, folds of mucous membrane in the accessory fissure; 6, sub mucosa.

closely connected in all their structures that an affection of one part independent of the other can hardly be said to occur.

The muscles of the tube are:

1. *The Abductor or Dilator of the Tube.*—This muscle is also known as the spheno-salpingo staphylinus muscle, the circumflexus palati, or tensor palati mollis. It is probably the most important muscle of the tube.

It arises from the sphenoid bone and the cartilage of the tube. It is inserted on the blunt edge of the cartilaginous plate along the whole length of the canal. It passes forward, inward, and downward, and its fibres spread out along the edge of the soft palate, and on the side of the pharynx. It enlarges the calibre of the tube by drawing the hook of the cartilage forward and a little downward.

Rüdinger confirms the view expressed by Von Tröltsch and Mayer that the dilator of the tube passes directly into the tensor tympani muscle. This is true not only of the tendons but also of the muscular fibres.

Rüdinger compares the rolling of the muscle about the hamular process of the pterygoid plate of the sphenoid, to the pulley arrangement of the superior oblique muscle of the eye. This attachment is certainly a point of fixation in the movements of the muscle.

2. *The Levator Veli Palati.*—This muscle is not very intimately connected with the tube, and yet it plays an important part in its mechanism. It arises with a cylindrical tendon on the lower surface of the temporal bone, on the anterior border of the entrance to the carotid canal, and from the cartilaginous portion of the tube, to which it is fastened by connective tissue.

In the soft palate the muscles of the two sides are closely connected. From this point they separate, and each one runs upward, and is firmly attached, in the vicinity of the osseous tube, not only on the bone, but also to the cartilage and the mucous membrane of the tube. When this muscle contracts, by its becoming thicker, the membranous floor of the tube is pressed forward, and thus the long diameter of the tube is shortened, and the transverse diameter is enlarged, that is to say, it is made to gape very widely.[1] The salpingo-pharyngeus muscle also assists in this action.

3. *The Salpingo-Pharyngeus* (*Rüdinger*).—This is a thin muscular layer, that passes from the lower end of the tube obliquely downward and backward, and is connected to the lower end of the median cartilaginous plate, and to the mucous membrane. It is inserted in the posterior wall of the pharynx. Rüdinger considers this thin muscle to be a fixator of the median cartilaginous plate, in its various positions caused by the contraction of the constrictor of the pharynx and the *levator palati*.

The opening of the Eustachian tube is the result of a combination of muscular action. If the three muscles are innervated simultaneously, and their contractions occur at the same time, the hook-shaped cartilage is fixed by the dilator of the tube and drawn downward, the concave portion of the tube becomes a little less curved, and the semi-cylindrical gutter is widened. If the levator of the velum contract, the space of the tube at the pharyngeal orifice is enlarged more than three lines.

If the muscles cease to act, the elasticity of the cartilage comes into play, the canal becomes narrower, without being at its lower section completely closed,

[1] Rüdinger: *Beitrage zur vergleichenden Anatomie und Histologie de Ohrtrompete.*

however.[1] Respiratory movements of the membrana tympani have been often observed, and these occur through this gap in the tube, which cannot be said to be ever *firmly* closed. Any one who has often climbed high mountains and has become "out of breath" from exertion in reaching the top, must have observed in his own ears this continuation of respiration through the tube.

BLOOD-VESSELS.

1. The ascending pharyngeal artery, from the external carotid.

2. The internal maxillary, the larger of the two terminal branches of the external carotid, also supplies the Eustachian tube by its middle meningeal branch.

3. Branches of the internal carotid artery.

NERVES.

1. The internal pterygoid, a branch of the third division of the fifth nerve, sends a supply to the dilator of the tube.

2. The superior pharyngeal, a branch of the second division of the fifth nerve, sends branches to the pharyngeal orifice.

3. The glosso-pharyngeal supplies the mucous membrane.

4. The pneumogastric supplies the levator veli palati muscle.

PHYSIOLOGY OF THE MIDDLE EAR.

The waves of sound may reach the endolymph of the

[1] Rüdinger, *Beitrage zur vergleichenden Anatomie und Histologie de Ohrtrompete*, p. 7.

labyrinth, through the bones of the skull. It is with difficulty, however, that sonorous vibrations are transmitted from the air to solids and liquids. A special apparatus to secure their transmission is found in the middle ear, for, as we have seen, the external ear has a very small share in this function.

FUNCTIONS OF THE MEMBRANA TYMPANI.

The presence of the membrana tympani, in whole or in part, is not essential to fair hearing power. The membrana tympani is perhaps more properly considered as the outer expansion of the *ossicula auditus*, for it is so intimately connected with the malleus, as to be essentially a part of the chain of bones that conducts sound to the endolymph of the labyrinth. Very great thickening of the drum-head, that is to say, of its fibrous and mucous layers, must of necessity involve the insertion of the malleus which is in its layers, so that we can hardly speak of the functions of the membrana tympani without including those of the ossicles. Yet there are a few points in its physiology that may be mentioned by themselves. Wollaston[1] showed that if the membrana tympani be rendered very tense, the ear is rendered insensible to low sounds, but those of a high pitch are made more intense.

The peculiar formation of the membrana tympani, it being of the shape of a funnel with a depressed centre, surrounded by sides somewhat convex, make it, according to the physicists, peculiarly susceptible to sonorous vibrations, and it is easily thrown into corresponding movements when waves of sound enter the auditory

[1] Ibid., p. 306, 1820.

canal and strike upon it. The membrana tympani has a fundamental tone of its own. It has been shown experimentally to be E 4. It is thrown into vibrations by waves of a particular length more readily than by others.

It is probable that the membrana tympani can only be properly considered as a sound conductor in connection with the ossicles. It has one function entirely its own, however, which is of the highest importance. It is the protecting membrane of the tympanic cavity, although its complete destruction or great thickening of its layers, may not destroy the power of hearing. Even if a fair hearing of speech and music remain when it is removed, the tympanum is deprived of a covering which is essential to its continuation in health. As is seen in the study of chronic suppurations of the middle ear, when the membrana tympani is destroyed or even partially removed, the tympanum is exposed to a series of dangers, any one of which may be destructive not only to the hearing but to the life.

ACTION OF OSSICULA AUDITUS.

The action of the malleus and incus has excited considerable attention. Helmholtz[1] has shown, as has been already noticed, that when the malleus is carried inward, the incus also moves inward, and when the malleus returns to its position, the incus returns with it. Its saddle-shaped joint with cog-teeth permits this movement, while it prevents the stapes from being pulled back when the membrana tympani and the malleus are pushed out more than usual. The joint then separates, so that the malleus may be moved alone.

[1] *Die Tonenpfindungen, loc. cit.*

The ligaments also serve to keep the malleus in place. The bones conduct vibrations as a single solid lever, the fulcrum of which is situated at the attachment by ligament of the short process of the incus to the posterior wall of the tympanum.

Every movement of the membrana tympani is transferred through the ossicles to the membrane of the *fenestra ovalis*, and to the perilymph of the labyrinth. The vibrations are increased in intensity, but diminished in amplitude when they reach the perilymph. It is generally conceded that the ossicles have no independent vibrations that can be perceived, but that they act as a single solid body in conveying vibrations to the labyrinth.

ACTION OF TENSOR TYMPANI MUSCLE.

Even when the tensor tympani muscle is not in action it is of use in preventing the drum-head from being pushed out too far. When it contracts the membrane becomes more tense. It has been supposed to act either as a damper, lessening the vibration of the drum-head in the case of too powerful sounds, or as having an accommodative power in attuning the membrane to sounds which fall upon it.

ACTION OF STAPEDIUS MUSCLE.

The stapedius muscle is supposed to regulate the movements of the stapes, by preventing its foot-plate from being forced in upon the fenestra ovalis, during great or sudden movements of the drum-head.

Lucæ[1] found this contracted when the *orbicularis palpebrarum* muscle was strongly excited. He found with this a weakening of the power of hearing all

[1] *Loc cit.*, p. 65.

musical notes, but an increase in the capacity for hearing those of 10,000 and more vibrations.

Hensen, in one experiment, carried a needle through the tendon of the stapedius muscle. The point of the needle was in the facial nerve. As long as the tensor tympani was intact, the stapedius contracted energetically upon the reception of all tones, as Hensen believes, in consequence of a mechanical movement of the ossicle produced by the tensor. When the tendon of the tensor was divided, the needle in the stapedius moved only upon the production of higher tones, from about 7,000 vibrations and upward. In lower tones, the movements were indistinct, and the tones of the great and contra octaves did not produce any effect at all.

Budge, quoted by Hensen, has attempted to show that the stapedius muscle is of importance in maintaining the equilibrium of the body.

FUNCTIONS OF EUSTACHIAN TUBE.

This passage serves to maintain an equilibrium of pressure between the external air and the tympanum, and as a means of exit of the secretions of that cavity.

The tube is not constantly open. Its permeability varies in different persons. In some cases, even in quiet respiration, an interchange of air from the pharynx toward the tympanum takes place; in others the act of swallowing or a powerful expiration becomes necessary.

The tube is especially opened by the action of the muscles, during the action of swallowing. A difference in the pressure of the air is more easily equalized from the tympanum to the pharynx, than from the pharynx to the tympanum.

CHAPTER VII.

INJURIES OF THE MEMBRANA TYMPANI.

THE diseases of the membrana tympani usually occur either as a result of an inflammation of the external auditory canal, or of the middle ear. Independent or primary myringitis, or inflammation of the drum membrane, is rarely seen.

The anatomical structure of the membrana tympani is against an independent affection of this part of the ear. It is quite possible, however, that certain inflammations of the auditory canal and of the tympanic cavity have their origin in the drum-head. A draught of air blowing directly upon the membrane may cause an inflammation which almost immediately becomes one of the tympanic mucous membrane.

The vascular, nervous and lymphatic supplies of the partition wall between the auditory canal and the tympanum belong also to those parts which it separates. Neither the integumentary nor the mucous layer of the membrana tympani can be fully separated from it. These facts show that the drum-head has no independent existence. In the vast majority of instances the diseases of the membrana tympani are of a secondary character. There may be a primary inflammation of the membrana tympani when a draught of air blows directly upon the membrane, or from injury from an instrument or missile or from sea bathing when water forcibly enters the ear, as in diving. The origin of the inflammation will then be the drum membrane, so that a true myringitis is the initial lesion. Yet, in these cases, the inflammation, although it begins in the drum-head, advances rapidly to the contiguous tissue.

The drum-head is sometimes ruptured by the explosion of artillery or even of single guns near the ear. In the case of rupture from the firing of a single gun, the unexpectedness of the firing is usually described by the patient as a very great shock. In the explosion of artillery in battle, the concussion is not unexpected, and a certain preparation is made for it which lessens this.

The power of the muscles of the Eustachian tube, which act very quickly, and force, as it were, a current of air in upon the drum membrane from the inner side, is probably that which counterbalances the effect of a sudden condensation of air upon the outer side. The little chink, which normally exists in the calibre of the tube, is also a source of protection. Besides this, the structure of Shrapnell's membrane, made up as it is of fibres, much more loosely woven together than those of the remainder of the drum-head, assists it to yield to great waves of sound. Those persons who suffer a rupture of the drum-head from external concussions, probably have some catarrhal affection which prevents the air from freely circulating in the tubes and the cavity of the tympanum; for we can scarcely believe that so few would suffer this accident, were all drum membranes equally liable to it. During the heavy fighting of the civil war, both by sea and land, infantry soldiers in the trenches were in the habit of lying down, while the artillery behind fired over their heads; and yet, rupture of the membrana tympani was scarcely heard of, and this is true also in great firing at sea, although there is a small proportion of cases of tinnitus aurium resulting from the firing. Instructions are always given by the medical officers at sea as to how to lessen the trouble from great firing.

Gruber and Schmidekam's experiments on the cadaver show that the resisting power of the membrana tympani is greater in man than in the lower animals.[1] The same authors' observations in the German war of 1864 and 1866 show that the explosions of projectiles seldom cause a rupture of the drum-head. In the one case observed among a large number seen after the battle of Koniggratz, the soldier was knocked senseless by the explosion of a grenade that killed two near him. He suffered after he recovered consciousness from tinnitus aurium and deafness on one side. A perforation was found in the anterior and inferior segment of the membrana tympani. There was no evidence that he had previously suffered from aural disease.

In laying foundation, for deep water bridges the effects of compressed air upon the membrana tympani are observed. Dr. Andrew H. Smith observed one case of such rupture in the lock of the bridge then being built from Brooklyn to New York.

Dr. Smith believes that most of the men who suffered from aural trouble after having been in the caisson, had previously impairment of the permeability of the Eustachian tubes. The men under his care were "most strenuously" instructed not to enter the caisson unless they were able, when holding the nose and blowing forcibly, to feel the air enter both ears. Nevertheless, cases occurred in which this precaution was neglected, and the

[1] Gruber's *Lehrbuch*, p. 332.

individual was, in consequence, caught in the lock unable to " change his ears."

Dr. Smith says that the structures within the tympanic cavity not being acted upon by the increased pressure, " are placed relatively in the same position as the skin under a cupping glass," by the continued exposure to the effect of compressed air, when the Eustachian tube does not open, or rather, as we should say, when it does not act well, from swelling or thickening of its tissue. Then the intense congestion occurs, which may be followed by inflammation, finally resulting in perforation of the membrane, as happened in one case reported by Dr. Smith in his paper.

Politzer's method of inflating the ears, was found very useful in treating these cases of simple congestion, which, if they had not been treated, would have resulted in tympanic inflammation and perforation of the drumhead. As an effect of the use of this method of treatment, many of Dr. Smith's men were enabled to continue at their work who could not have otherwise done so without danger. The treatment became very popular among the men, so that as many as four or five of them would come at Dr. Smith's visit to have their " ears blown out."

The writer saw three or four of these cases of congestion of the tympanic cavity and was enabled to appreciate the great advantage of skilled medical advice to these men. Many ears would certainly have been permanently injured had not Politzer's method been employed at an early stage of the trouble.[1]

[1] Dr. Smith's paper on " The effects of High Atmospheric Pressure, including the Caisson Disease," received the prize of the Alumni Ass'n of the College of Physicians and Surgeons for 1873.

A gentleman who consulted the senior author in reference to what was an incurable chronic catarrh of the middle ear, which had resulted in thickening and sinking of the drum-head, afterwards came with a perforation of the membrane of one side and discharge of pus from the tympanum, which he stated was caused by a visit to the caisson. The perforation soon healed, and the hearing was rather worse than before the accident.

Dr. John Green,[1] of St. Louis, had previously to Dr. Smith made some observations upon the "physiology of the Eustachian tube, during a short exposure to an atmospheric pressure of sixty pounds to the square inch." Dr. Green's observations were made while bridge-piers were being sunk to the rock underlying the bed of the Mississippi River at St. Louis in 1869–70.

The entrance to the chamber of condensed air was "through an air-lock, or small chamber into which the condensed air could be admitted gradually, occupying for the higher degrees of pressure, from four to ten minutes. The exit occupied about the same time.

The accidents to the ears occurred, as in Dr. Smith's cases, while passing through this lock. Sudden chilling of the body from changes in temperature in the chamber were, according to Dr. Green, causes of catarrhs. This theory is rather more sufficient to explain the cases of tympanic congestion when the tube was not completely pervious, than the one of mechanical pressure, although undoubtedly both causes acted together in producing aural affections.

Dr. Green notices an interesting phenomenon observed in coming out of the lock, which Dr. Smith also observed. There was a spontaneous escape of air

[1] Transactions of the American Otological Society, 1870.

through the Eustachian tubes in a succession of puffs, succeeding each other at intervals of fifteen or twenty seconds, independently of respiration, and absolutely without the concurrence of any muscular action. The phenomenon suggested to Dr. Green "the action of a lightly resisting valve, necessitating a slight, but perceptive increase of pressure within the tympanic cavity, to open the passage to the pharnyx." Dr. Green observed several cases of rupture of the drum-head and acute catarrh occurring as a result of the unequal pressure and of the exposure to an uneven temperature.

Those persons who have occasion to be in the caisson of underground and under water work should ascertain the condition of their ears before doing so. Drum-heads that have once been ruptured and cicatrized are pretty sure to be ruptured again in the lock.

Magnus also investigated this subject and proved that it is pressure upon the membrana tympani that causes the pain. The membrane is actually pressed inward. Hermetical closure of the auditory canal is to be advised to workmen passing through the locks. A patient without a drum membrane had no pain in the lock.

The membrana tympani undoubtedly owes much of its insisting power, as Shrapnell pointed out, to the existence of a triangular membrane at its upper portion that is less tense and thick than the remainder of its structure, the so-called membrana flaccida, or Shrapnell's membrane, which yields when undue pressure is brought upon it. The membrane has, perhaps, some additional defence in its oblique position in the canal which causes a portion of it to be covered by the walls in such a way as not to receive the whole force of the column of compressed air.

The membrana tympani is perhaps more frequently injured by mechanical violence to the head or to the membrane itself. Many such cases are reported. A box on the ear is by no means a safe procedure; it may easily cause a rupture of the membrane especially if unexpected. A kiss upon the ear which was unexpected has been known to cause serious injury to the tympanum and vestibule, although not rupturing the membrane. (Roosa.)

Severe vomiting sometimes causes a rupture of the drum-head, as does strangulation by hanging. The cases of rupture that occur during whooping-cough, and sneezing or blowing the nose, are not properly to be considered in the present chapter; for when the membrana tympani is ruptured in such cases, there is usually some pre-existing catarrh of the Eustachian tube and tympanic cavity. Disease of the middle ear is usually to be traced as having preceded the breaking of the drum-head. The great accumulation of mucus caused by the catarrhal inflammation will be very apt to cause a rupture by mechanical pressure from within upon a distended mucous membrane and fibrous layer, unless the cavity be emptied by means of the catheter or Politzer's method.

In countries where punishment is meted out in exact proportion to the amount of personal injury done to the person assaulted, blows upon the side of the head which result in rupture of the membrana tympani are made the subject of careful medico-legal examination.[1]

[1] According to the Austrian criminal code, an injury is defined to be a severe one, when the person suffering it is deprived of his usual health, or kept from his occupation for a period of not less than twenty days.—POLITZER.

In order to determine the cause of a rupture of the membrana tympani, it must be seen within a few hours of the injury; for suppuration may occur soon after it has occurred, when it will be impossible to decide whether it had a traumatic or pathological origin.

Dr. C. H. Burnett[1] reported a case of evulsion of the membrana tympani, from the splashing of mud into the ear by a horse while the patient was crossing the street. The patient was thirty-nine years old, and consulted Dr. Burnett three days after the accident. He stated that his ear was sound until the mud came into it. Upon returning to his shop—he was a machinist—he was examined by some of his comrades, who said they saw foreign objects in the meatus, which they proceeded to extract with *chips and mechanics' small tools.* Several "little white pebbles" were taken out, which were probably the ossicles. Great impairment of the hearing of the ear followed. The patient was very pale, anxious and bathed in cold perspiration when he visited Dr. Burnett. A watch that should have been heard 40 inches was only heard 2 in. The tuning-fork placed on the vortex was heard very distinctly in the injured ear.

On examination Dr. Burnett found a small piece of mud adherent to the antero-superior quadrant of the periphery of the membrana tympani. The membrane was entirely destroyed except a very narrow border.

There were no ossicles visible. The inner wall of the tympanum was fully exposed to view. The mucous membrane was healthy, but slightly abraded on the promontory. Twenty days after, without treatment, patient was free from pain, and "ruddy and cheerful." The

[1] Transactions of the American Otological So., 1872.

border of the membrana tympani had become adherent to the promontory. Of course the hearing power was not improved, thanks to the care of his surgical comrade who so carefully removed the "white pebbles" from his ear.

Dr. J. Orne Green[1] reported a case where the explosion of a bag of gas near the ear caused a rupture of the membrana tympani. The patient, who was preparing for an exhibition in which an oxy-hydrogen light was to be used, was standing a few feet from the bag, and with his left side toward it at the time of the explosion. The immediate effect was some slight confusion of intellect, which soon passed off; but the next day the left ear began to be painful and on blowing the nose, air whistled through it. Dr. Green saw the patient twelve days after the accident, and found the membrana tympani red and swollen, and on the posterior segment just behind the umbo, a rupture $1\frac{1}{2}$ line long, nearly perpendicular, through which purulent matter could be forced by Valsalva's method of inflation. H. D. $\frac{6}{48}$. This patient had previously suffered from impaired hearing and mucous rales in his ears.

The assistant of the patient whose case has just been quoted, suffered at the same time from the explosion of a bag of gas, and also received rupture of the membrane, which resulted in a purulent inflammation of the tympanic cavity. In both of these cases the rupture healed perfectly, and the hearing power was partially restored. In Dr. Green's case it became $\frac{18}{48}$.

Dr. Green saw two other cases in which the patients suffered from the concussion of the same accident. It

[1] Transactions of the Amer. Otological Society.

caused a loud buzzing in the ear and confusion in the head. The patients consulted Dr. Green on account of the tinnitus which was caused in one case, but aggravated in the other, for the latter patient had previously suffered from disease of the middle ear. If a person be a sufferer from catarrh of the middle ear, the drum-head, as has already been intimated, is much more likely to be ruptured by blows, falls, exposure to the surf in bathing, or the like. In fact, it may be doubted if persons with well ventilated tympanic cavities and normally acting drum-heads ever suffer a rupture of the membrana tympani, except from very great violence.

The writer once saw a little boy who was thrown from his pony a few hours before. He struck upon his right side, and he had a free discharge from his right ear immediately afterward. His hearing distance was $\frac{1}{40}$ when examined, and he heard the tuning-fork better on the injured side. Blood was found on the walls of the auditory canal, and the membrana tympani was ruptured in the centre. The ear was let alone very carefully, and the drum-head soon healed. There remained, however, a depression in the centre at the side of the rupture. This little fellow had nasal and pharyngeal catarrh at the time he received the fall, He fell upon the lawn of a country place, and from a very small pony. In spite of the best of care from his family and from a distinguished expert in aural diseases, with whom the author occasionally saw him professionally, he has gone on with a catarrhal or proliferous inflammation in the middle ears until now, an active man, his hearing is very defective.

A young gentleman of nineteen consulted the author in regard to an injury to his left ear, of which he gave the following account: Two days before it was hit by the flat surface of a boxing-glove in the hands of his antagonist. He became dizzy and felt a sense of pressure upon the ear. He did nothing to relieve these symptoms and they passed away. But he stated that he had a feeling of tightness and pain in the ear, and noise causing discomfort. He once had a discharge from the ear after scarlet fever. His hearing distance was $\frac{8}{84}$ on the injured side, $\frac{40}{48}$ on the other. The tuning-fork is heard better in the affected ear. There was a red line through the anterior segment of the membrane beginning at the end of the malleus. The ear was inflated by Politzer's method, and this was repeated every few days. The ear gradually recovered its normal sensations.

It was formerly supposed that a severe and long-continued bleeding from the ear was positive proof of a lesion of one of the sinuses . But as Buck[1] has shown, a bleeding from the tympanic artery may cause this, without necessarily involving the sinuses. When an injury to the head is followed by bleeding from the ear, even if it be trivial, we may, as stated by Buck, diagnosticate a fracture of the temporal bone in the vicinity of Shrapnell's membrane, and probably in the line of the Glaserian fissure, but we cannot state that a deeper and a more extensive injury has occurred. A fracture of the temporal bone may occur, however, without hæmorrhage from the ear.

It is certain also, that patients recover from fractures of the tympanic portion of the temporal bone. A prominent physician of a neighboring city was attacked by

[1] *Diseases of the Ear*, p. 278, et seq.

ruffians one night a few years since, and severely beaten over the head, so that he was unconscious for a short time. A large hæmorrhage occurred from one ear, but he recovered perfectly, except that his hearing power was nearly destroyed upon that side. The membrana tympani a few months after the injury was without a cicatrix or other evidence of a rupture.

A profuse watery discharge from the ear occurring *immediately* after the injury is good evidence of a fracture of the petrous portion of the temporal bone, but a watery discharge may set in a short time after the accident, and be merely inflammatory in character and by no means be the cerebro-spinal fluid, even though it be excessive. The facial canal and the motor filaments of the fifth nerve may be injured in fracture of the temporal bone, and paralysis occur. Our knowledge of these cases would be greatly increased if a careful examination of the membrana tympani were made in each case of supposed fracture of the base of the skull.

Prognosis.—The prognosis of a fracture of the temporal bone with rupture of the membrana tympani is by no means unfavorable except as regards an impairment of the hearing. But each case must be considered by itself. No general prognosis can be given.

The prognosis in a case of rupture of the membrana tympani depends very much upon the nature of the injury that caused it. An accident of this kind, when produced by the concussion of a heavy explosion or of a severe blow upon the side of the head, is much more serious in its nature than an injury to a drum-head from the forcing through it of any sharp body, such as a knitting-needle, pen-holder, twig of a tree, a blade of straw or the like. The former class of injuries are apt to produce a fracture of the temporal bone, a concussion of the labyrinth, or a fracture or dislocation of the ossicles, as well as a rupture of the drum-head. Such a result, at once takes the affection away from the category of simple injuries, and renders it a very serious one, not only with reference to the hearing power but also as regards life. The tuning-fork becomes a valuable assistant to diagnosis in cases of rupture. Its vibrations will be heard more distinctly in the injured ear than the other, and the bone conduction will be better than the aerial, if the labyrinth be not injured. A simple rupture usually heals in a few days without great injury to the hearing. A suppurative process may result.

FRACTURE OF THE HANDLE OF THE MALLEUS.

This rare accident has been described by several authors. It is usually occasioned by the accidental thrusting of a delicate instrument like a pen-handle into the canal and upon the membrana tympani. Hyrtl, the anatomist, reported a case in which he found an ununited fracture of the malleus in the ear of a prairie dog, an animal which has a superficially situated membrana tympani. In a case reported by Weir, the accident occurred to a man who fell into an open area way a distance of about fifteen feet. His ear bled for a half hour afterward.

CHAPTER VIII.

DISEASES OF THE NOSE AND NASO-PHARYNX WHICH MAY AFFECT THE EAR.

In this chapter we shall discuss those diseases of the nose and pharynx which are particularly liable to cause aural disease or to influence the character of an aural lesion. The close connection between nasal lesion and aural disease has already been explained in the chapter describing Anterior Rhinoscopic Examination. In beginning the discussion we may first consider:

1. ACUTE CATARRHAL RHINITIS AND NASO-PHARYNGITIS.

This disease is characterized by a sudden onset of inflammation of the nose and naso-pharynx which runs a definite short course. The symptoms are those of inflammation, obstruction, and disturbance of secretion.

Causes.—This disease is caused by infection, mechanical or chemical irritation, or changes in physical condition. Among the infectious causes may be placed acute choryza when due to bacteria, Influenza, Measles, Scarlet Fever, and Syphilis; also the fumes of acids or chemical vapors, such as sulphurous acid and iodine. Sometimes the dust of drugs will provoke it, and conspicuous in this class are powdered ipecac and tobacco. The physical causes are mostly the result of sudden changes of temperature, and especially sudden changes of bodily temperature, particularly if they are local.

Appearance.—The mucous membrane of the nose is swollen, œdematous, and intensely red. Congestion of the blood-vessels and the venous sinuses is marked, and can be demonstrated by the use of cocaine and adrenalin solutions within the nose. This congestion varies within certain periods of the day and is generally worse at night. Sometimes the mucosa is so swollen from congestion that the nasal cavity is entirely occluded; at other times the nose is entirely free, or only partially obstructed. An increased secretion of mucous necessitates the constant use of the handkerchief, and such patients may soil six or eight handkerchiefs a day. An examination of the discharges shows it to be composed of water, considerable mucus, some leucocytes, and a considerable quantity of desquamated epithelium. Usually the entire membrane is not uniformly attacked, but is worse in distinct localities.

Symptoms.—Sneezing is generally present and may be constant or occur in attacks. It is usually worse when the opposite surfaces of the mucosa are swollen and lie in contact. Obstruction of the nose is always present, but may vary greatly. It is produced by a congestion of the blood-vessels and venous sinuses. Sometimes the nasal chamber may be wholly obstructed by this engorged tissue for periods of from fifteen minutes to an hour. The obstruction will then partially disappear for a long time, or entirely disappear for a short time. Many uncomfortable and subjective symptoms also are relieved when the obstruction subsides.

The secretion is marked and is apt to be scanty when the obstruction is greatest and most profuse when the obstruction is least. Frontal headache and a general feeling of heaviness about the head is present in most cases. This is explained by coincident inflammation in the accessory nasal sinuses. Besides these symptoms, there is loss of the sense of smell, poor appetite, physical exhaustion, and inability to concentrate the mind. Some slight febrile movement is commonly present. Occasionally pain on swallowing will develop after 48 hours.

After two days the symptoms subside, though some may persist for a week. The secretion is generally the last symptom to disappear. It gradually thickens and becomes stringy, the purulent elements disappear, and it takes on a mucoid character. Finally this also ceases.

Complications.—The accessory sinuses are generally —if not always—involved in this disease. The tympanum is often involved through the Eustachian tube, but the lesion rarely develops into more than an acute catarrhal otitis media. The larynx and trachea usually participate in the inflammation when it begins to subside, producing hoarseness, cough, and expectoration. Conjunctivitis of a catarrhal nature sometimes develops by extension of the inflammation through the lachrymal duct. Eczema of the nares is common and is produced by the constant use of the handkerchief as well as by the excoriating discharge.

Treatment.—At the inception of the disease if the patient is put in bed, in a room kept at an even temperature, and given diet of a fluid character, the disease will run a shorter course, than if he is allowed out of doors. At the onset of the disease 10 grains of quinine, followed by two tumblers of hot water, occasionally aborts the condition. After the disease is established this is useless and tends to prolong it. If the discharge is not profuse, small doses of wine of ipecac, one minim every hour, are useful. If there is a profuse discharge, it may be controlled by the use of rhinitis tablets. These should be given one each hour for six doses, after which one tablet should be given every three hours. The belladonna and camphor which these contain are the active agents in controlling the secretion. The local treatment of the disease consists in the use of a spray of 2 per cent solution of cocaine in a 1 to 10,000 adrenalin chloride solution. This solution will act as a physiological astringent. After the dilated venous sinuses have been emptied by the use of this remedy, a metallic astringent may be used—preferably a nitrate of silver solution, 2 grains to the ounce. Sometimes sulpho-carbolate of zinc is useful—3 grains to the ounce. If the secretion is very tenacious it may be washed away with hot normal salt solution used in a nasal douche or in a coarse spray. At home the patient should use a solution of

℞ Menthol	grains	2
Eucalyptol	"	2
Oil of cinnamon,	minims	2
Albolene	ounce	1

If this is used in a spray every two hours it will afford considerable relief. Occasionally if the nose is very tender and painful and a burning sensation is constantly experienced in certain localities within it, a salve composed of

℞ Cocain alkaloid	5 grains
Zinc oxide	10 "
Olive oil	½ ounce
Vaseline	½ "

is very useful to allay the irritation. When the secretion persists, a spray of tannic acid, 5 grains to the ounce may be used.

2. ACUTE PURULENT RHINITIS. (BLENNORRHŒA OF THE NOSE).

This disease is an acute infection of the nasal mucosa running a very severe course and involving the accessory nasal sinuses with the production of a profuse discharge almost entirely composed of pus. The disease does not often occur in adults, but is common in children when adenoids are present, and is very often produced by foreign bodies within the nasal chambers. It may also be caused by scarlet fever, diphtheria, and occasionally it develops during erysipelas in adults. It may also be produced by a streptococcus infection introduced by picking the nose with the finger-nail.

Symptoms.—There is a purulent discharge from the nares which, if the infection is marked, may be entirely of pus; or mixed with blood and mucus. As the discharge diminishes, it dries and scabs are formed. Other symptoms of rhinitis are present—obstruction from venous congestion, marked œdema of the mucosa, sneezing, heaviness in the head, loss of smell, poor appetite, and local pain. Fever is apt to be marked, sometimes reaching 102° or 103°, but usually only 101°. Chills are not ordinarily present.

Diagnosis.—A differential diagnosis in this disease must be made from nasal ulceration, foreign bodies, abscess of the perichondrium, and sinus disease. Careful anterior rhinoscopic examination, combined with the frequent use of the probe, will make the distinction.

In purulent rhinitis the ulcerations are small and superficial, and are formed only by denudation of the epithelium. Foreign bodies are detected by the probe, and a thorough search must be made for them in every case of purulent discharge. Purulent rhinitis is distinguished from abscess of the perichondrium by the quantity of the discharge and by the absence of local swelling or fistulæ through which pus exudes. Accessory sinus disease can only be distinguished from purulent rhinitis by observation of the source of discharge and the subsequent investigation of the suspected sinuses by probing and irrigation.

Complications.—This disease is very apt to produce acute or chronic suppuration of one or more of the accessory sinuses: acute suppurative otitis media is a frequent complication, and if the lesion is severe, perichondritis may arise.

Treatment.—The surgeon must search for the causes of this lesion, for unless they are removed the purulent discharge will continue indefinitely. This is especially true of cases caused by adenoids or foreign bodies. The local treatment of the disease consists of spraying the nose with a weak solution of cocaine to lessen the sensitiveness, after which the entire mucosa must be carefully cleaned. A spray of peroxide of hydrogen, 1 in 10, is useful to loosen and destroy the pus. A nasal douche of a warm saline solution, or a warm boric acid solution, should be used after the peroxide to cleanse the entire mucosa. If there is any objection, or danger from the douche is feared, a coarse spray may be substituted. If the discharge contains a large number of streptococci, spraying of the nose with a solution of permanganate of potash, 1 to 10,000, or with an iodine solution, 1 to 5,000, is effective as a germicide. The discharge is controlled by the use of powders. For this purpose xeroform 10 grains mixed with one ounce of compound oleostearate of zinc, is very useful. Another good powder is composed of iodoform 10 grains, bismuth sub-nitrate 20 grains, and pulv. acacia 20 grains.

3. CHRONIC CATARRHAL RHINITIS.

Definition.—A chronic catarrhal rhinitis is a nasal lesion of long duration, characterized by disturbances of circulation and of secretion, obstruction to nasal respiration, and alteration of the physiological function of the nose. A thickening or hypertrophy of the mucosa or a hyperostosis of the turbinate bodies are distinctive features.

Causes.—1. A continuous or a repeated irritation of the nasal mucous membrane is the most frequent cause of this disease in the Northern and Western parts of this country. Other active irritants are snuff, smoke, the air of poorly ventilated rooms, continuous damp atmosphere, and the constant inhalation of impure air. Thus the disease is common among cigar workers, millers, cement makers, cutlers, moulders, and workers in chemical laboratories.

2. Accessory sinus disease may produce this form of rhinitis, although the reverse is generally true and the sinus disease is produced from it.

3. Repeated attacks of acute catarrhal rhinitis finally result in the production of a chronic catarrhal condition. This is occasioned by the repeated congestions to which the mucosa is subjected, as well as by the stasis

of blood and the infiltration of the mucosa interspaces with exudate.

4. Sometimes this disease is a local expression of anæmia, rheumatism, scrofula, syphilis, or diseases accompanied by defective elimination.

5. Gastric conditions are not infrequently a cause, either by the gases which are expelled from the stomach and reach the nose, or by extended inflammation. It must be remembered that the nasal mucosa is morphologically and embryologically a continuation of the gastric mucosa.

6. This lesion is also produced by cardiac conditions, by chronic diffuse nephritis, and by chronic constipation.

Symptoms.—1. Obstruction is one of the most constant and persistent symptoms of this disease. It varies in degree in different patients, and at different times in the same patient. Both sides of the nose may be obstructed, so that nasal respiration is interfered with; or one side may be closed and the other remain free; or it may alternate from side to side. It is generally produced by an engorgement of the turbinate tissue or the mucosa of the septum. When the obstruction is purely congestive, variations in the degree are a marked feature, but as the disease progresses the congestion becomes constant, exudate appears in the mucosa, and the impediment which formerly occasionally disappeared now becomes constant. This insidious development of nasal obstruction is often not observed by patients but they sometimes notice that the periods of relief are fewer and the sensation of stuffiness within the nose is more constant as the thickening increases. The interference with respiration is apt to be worse at night, and is most marked in that side upon which the patient rests. Relief of the obstructed nostril may be obtained by changing the position to the other side, which will then slowly become occluded. The obstruction is aggravated by taking fresh colds, to which the patient is particularly susceptible, and this is repeated many times each winter, until finally the nostrils become so sensitive

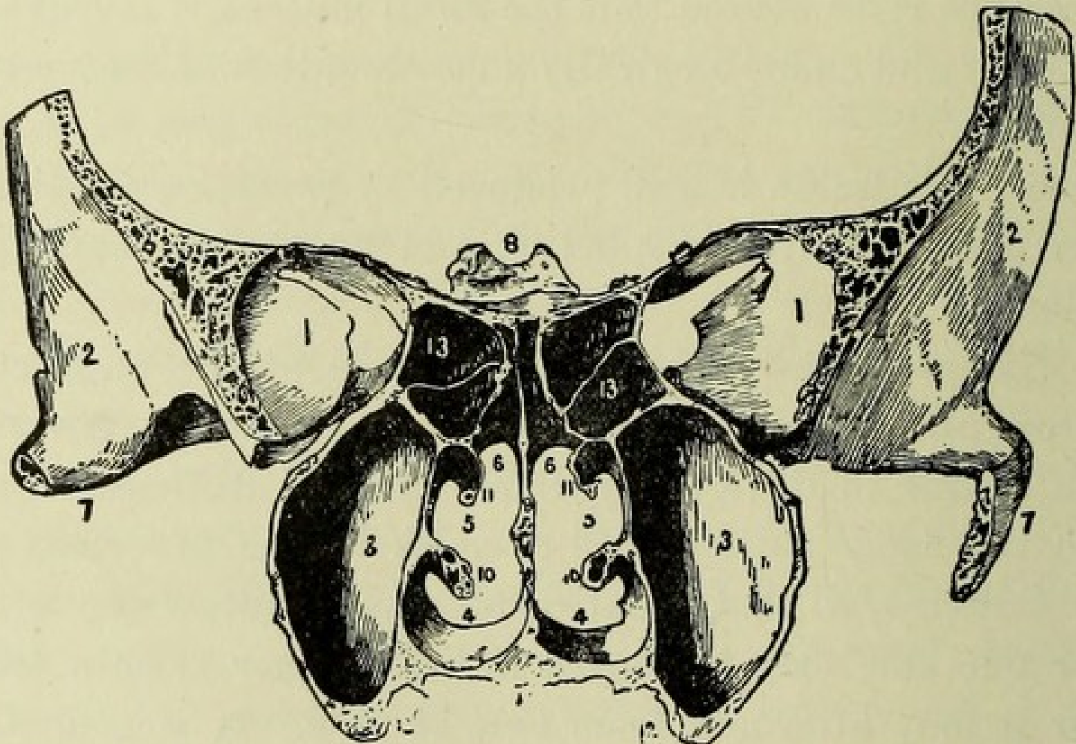

Fig. 47.--Vertical Section of Bones of Face (posterior half, two-thirds size. From Professor Darling's museum). 1, Orbit ; 2, temporal fossa ; 3, antrum ; 4, inferior meatus ; 5, middle meatus ; 6, superior meatus ; 7, zygomatic process ; 8 clinoid process of sphenoid bone ; 9, septum nasi ; 10, inferior turbinated bone ; 11, superior turbinated bone ; 12, alveolar process ; 13, ethmoid cells.

to slight changes of temperature that a condition of "cold" is present all the time. The obstruction gradually increases and the intervals of relief become fewer, until finally stenosis is permanent.

2. *Mouth Breathing.*—Mouth breathing is the result of the above nasal symptoms and bears a direct relation to the degrees of nasal stenosis. It is very detrimental

to the organism. As the result of mouth breathing, the mucus within the pharynx becomes dry and may collect as scabs. Cough is present and is aggravated by thickened or dried phlegm on the pharyngeal wall. Inflammation of the fauces and pharynx results from continued mouth breathing, but the more serious effects are seen in the patient's general condition. One of the most important functions of the nose is to supply to the inspired air a considerable quantity of water for the purpose of preserving the moist condition in the alveoli of the lungs and facilitating the exchange of gases. If the air does not receive moisture from the nose—where there are venous sinuses to furnish the supply—it will absorb that which covers the surfaces of the larynx, trachea, bronchii, and alveoli of the lungs. As these furnish an insufficient quantity to saturate the air, their surfaces are completely dried. It is a well established fact in physics, that the exchange of gases can only take place through a membrane if it is moist, therefore if the lung alveoli are dry the introduction of oxygen into the blood and the removal of carbonic acid gas from it are prevented, thus producing an oxygen starvation and a carbonic acid poisoning, with a long list of attendant woes and symptoms. This disturbance of the proper exchange of gases produces in the patient anæmia, uric acid conditions, lassitude, disturbance of mentality, loss of memory, inability to concentrate the mind, indigestion, chronic constipation, rheumatic pains, dyspnœa, bronchitis, catarrh of the apex of the lung, asthma, cardiac palpitations, predisposition to tuberculosis, neurasthenia, myasthenia, loss of weight, insomnia, and chronic headache.

3. Discharge.—The discharge from the nose is always increased. Under normal conditions the balance in the secretion of mucus is so nicely adjusted that the patient never needs to remove it, but in chronic catarrhal rhinitis the production is so increased that the patient either blows it from the nose or draws it back into the naso-pharynx. The character of the secretion is changed. It is usually viscid, sometimes starchy, and is often expectorated in little adhesive masses of very tenacious pearly particles. It is usually white, but may become yellow or green from time to time, or take a brownish or reddish tint by admixture with blood.

4. Coughing, hawking, and spitting are constant symptoms, present in varying grades of severity. In some patients they are mild, but in others they are very severe and cause considerable annoyance, and are often the symptoms for which the patient seeks relief.

5. *Anosmia.*—Disturbance of the sense of smell is usually present. The perception of odors may be diminished or may be altogether absent, or the discernment of certain odors only may be lacking. In a few cases the function may be altogether destroyed.

6. Pharyngeal irritation is usually present. It causes pain and a sense of thickening or stiffness in the throat, a sensation of dryness on the pharyngeal wall, and a desire to swallow.

7. Vomiting often occurs in the morning, and results from attempts on the part of the patient to remove the dried and thickened mucus within the nose and pharynx by hawking and spitting.

Examination.—The condition of the membrane may be studied by means of anterior rhinoscopy. The observer should first note the change in color, and the departure from normal of the anatomical relations within the nose. This presupposes a knowledge of the normal conditions. The membrane will be found hyperæmic and reddened in spots, and may show superficial ulcerations and a bleeding surface. It is generally swollen either from congestion, œdema, or hypertrophy of the mucosa. Congestion and hypertrophy areas may be distinguished by the application of a 4 per cent solution of cocaine in a 1 to 10,000 adrenalin chloride solution, applied to the nose upon pledgets of cotton. After this solution has remained in the nose for four or five minutes the pledgets are removed and a comparison made of the former and present appearances. If the nose is the seat of a congestion only, the membrane will be whitened and the swelling will have disappeared, while the anatomical relations are again normal. If hypertrophy is present, however, the membrane will be anæmic but the mucosa will not contract, and the hypertrophic areas appear as white boggy swellings which can be identified with the probe. This will indent them and show that the mass is not tensely contracted against the framework of the nose, but is loose and flabby. This is especially a characteristic of hypertrophied masses on the turbinate bodies.

Mucus or pus is usually detected lying upon the floor of the nose or covering the region of the middle turbinate body. If the secretion issues from any of the accessory sinuses it will be seen trickling down in the region adjacent to the drainage openings of the sinuses. When the discharge is mucoid it is yellowish, but if it contains many purulent elements it is white. An examination with the microscope shows that the discharge is made up of mucus, leucocytes, and epithelium, with a variety of bacteria—the pneumo-bacillus, (Friedlander,) staphyllococcus, streptococcus, pyogenes aureus, and non-pathogenic forms. The secretion is frequently distributed upon the naso-pharynx and over the pharyngeal wall, where it dries and adheres firmly. The examination may also disclose thickening of the mucosa. When these are present the disease is termed Rhinitis hypertrophica or Rhinitis hyperplastica. This form of the lesion is frequently described in text-books under a separate head, but there seems no reason to separate it from Chronic Catarrhal Rhinitis, of which it is a manifestation.

It is characterized by the development of an increased quantity of the tissue within the nose, and it is generally situated over the inferior turbinate region, either at the anterior end or along the lower border, and very frequently at the posterior end. Sometimes the bone becomes thickened as well as the mucosa. When the thickenings are upon the middle turbinate, the favorite locality is the anterior end, where it is generally accompanied by a thickening of the bone. Occasionally the posterior end of this turbinate is affected, and very frequently its inner side. When the thickenings are located within the tissue of the septum they occur only over a spur, or as a diffuse thickening of the mucosa and perichondrium, occasionally septal thickenings are limited to the posterior edge of the septum.

Appearance of the Hypertrophied Area.—The form of the hypertrophy varies according to its site. The mucosa may be *diffusely thickened* or it may be increased in size so as to present a rounded prominence; or it may be rounded with an irregular surface having a mulberry-like appearance. At other times the tissue becomes œdematous, and if the œdema is marked and a considerable amount of exudation takes place within the connective tissue interspaces, the hypertrophy becomes polypoid. When the mucosa is diffusely thickened the lumen of the nostril is partly occluded, the tissue is reddened, congested and swollen, contracts slightly under cocaine, and pits when pressed with a probe. The surface of the septum, instead of being perpendicular, presents rounded projections, and the turbinate surfaces instead of being flat are rounded.

With the development of *localized hypertrophied tissue* the appearance is somewhat different. There is some congestion and redness of the mucosa which disappears under the use of cocaine, but the anterior or posterior ends of the turbinate bodies, or their lower borders, still show a rounded swelling. This hypertrophic tissue indents when pressed with a probe and remains so for a few moments, after which it recovers its rotundity. Furthermore, the mucosa may be moved slightly over the bone with a probe in the same way that the tissue of the chin may be moved with the fingers. This movement of the mucosa occurs only in hypertrophic areas, for when the mucosa is normal it is closely adherent to the bony structure. These rounded thickenings ordinarily occur upon the anterior and posterior ends of the turbinates, where they are termed "hypertrophy of the tips." When the hypertrophic masses contain more newly formed connective tissue this has a tendency to corrugate the surface of the hypertrophy and produce a mulberry-like appearance. These are likewise found upon the tips of the turbinate bodies and are termed "mulberry hypertrophies." When the hypertrophied area either on the septum or the turbinate bodies is œdematous, it presents a glistening white appearance, shining through the thin pinkish surface. In this form the connective tissue spaces are filled with a mucoid exudate which causes the characteristic appearance. This form is distinguished from the preceding ones by its color. It is especially apt to occur in the regions of the accessory sinus openings, in the neighborhood of carious bone, and upon the lower border of the inferior turbinate body.

The *polypoid thickenings* are hypertrophic masses in which the œdema is more marked than in the former classes. In these the exudate has been poured out within the connective tissue interspaces so abundantly that these are markedly distended and the entire hypertrophic mass is stretched by the weight of its fluid contents. If the tissue thus filled with exudate has room in which to extend, the exudate settles in the lower part of the growth and forms a rounded swelling which by its weight stretches the elastic tissue above, thus forming a polyp with its pedicle. When there is no space into which the polypus may descend, it does not become pedunculated but is smaller and has a broad base. Such growths are termed "polypoid hypertrophies."

Diagnosis.—The diagnosis of chronic catarrhal rhinitis is made from the symptoms and by examination. The examination is aided by the use of a 4 per cent cocaine solution in a 1 to 10,000 adrenalin solution, which should be introduced within the nose upon pledgets of cotton. After remaining four or five minutes, these are removed and the investigation continued. The varying appearance of the membrane has already been described.

Treatment.—It is only since the discovery of cocaine that the treatment of this disease has been at all satisfactory. Previous to the use of cocaine as a local anæsthetic, laryngologists treated these conditions with medicinal agents and obtained only palliation of the symptoms. With this satisfactory local anæsthetic and improved methods of operation, a large percentage of cases are entirely cured. The galvano cautery was introduced subsequent to the discovery of cocaine and promised brilliant results, and for a long time was a favorite form of treatment, but has now fallen into disuse. This was occasioned by the use of the cautery in the hands of men who did not understand its proper application and who burned away an excessive amount of tissue. This resulted in the development of atrophic rhinitis, leaving the patient in a worse condition than before. The electro cautery, nevertheless, is a valuable agent in the cure of hypertrophic conditions if it is used with discrimination. Its application has been fully described in the chapter on *Nasal Stenosis.*

Operative measures furnish to-day the best results in the treatment of this disease. They are fully discussed in the chapter on *Nasal Stenosis* under the paragraphs dealing with *Septal Thickenings, the Surgical Treatment of Inflammatory Diseases,* and *Turbinectomy.*

While treatment by operative measure or by the use of the galvano cautery gives the best results in this disease, other therapeutic agents should not be neglected. Cleansing the nostril daily by means of a douche or coarse spray is an important adjunct. For douching or spraying the nose one may use warm normal salt solution or a half normal salt solution containing one drachm of bicarbonate of soda dissolved in it. Sometimes borax is substituted. The well-known Dobell solution, if diluted four times, is also a satisfactory irrigating fluid. If a nasal douche is used the water is delivered from a fountain bag to which is attached a well-fitting hard rubber olive-shaped nose-piece. A stream of water ¼ of an inch in diameter should be used under low pressure, the bag hanging not higher than six inches above the patient's head. The following essentials must be observed or water will enter the Eustachian tube or some of the accessory sinuses.

1. The pressure of water must not be greater than that which is obtained from hanging the bag six inches above the patient's head.

2. The nozzle must deliver a stream ¼ of an inch in diameter.

3. The nozzle must always be introduced into the more obstructed side, in order to prevent the blocking of the water within the nose and naso-pharynx.

4. The nares into which the nozzle is introduced must be higher than the other side. This is obtained by slightly tipping the patient's head.

5. The head must be well flexed upon the chest, and the shoulders bent forward.

6. The patient must not breathe through the nose, but may either hold the breath or proceed with quiet respiration through the widely opened mouth.

7. No attempt must be made to draw water from the nose into the pharynx, and no movement of swallowing should be made while the water is flowing.

8. After a few seconds of irrigation the flow should be stopped, the nozzle removed, and the patient allowed to blow the water from the nose without touching either nostril. This is called "blowing the nose by the open method."

If these details are carefully carried out there will be no great danger of the douche doing harm, although, as long since shown by the senior author, the nasal douche improperly used is likely to do great harm. It cannot be considered a safe means of treatment in careless or ignorant hands.

The spray is used in the ordinary way, but it does not cleanse the nose as well or furnish to it the heat which may be obtained from the douche. Weak solutions of silver nitrate—3 grains to the ounce, solutions of alumnol—3 grains to the ounce, zinc chloride—¼ grain to the ounce, are used in sprays. Their effect is to lessen the quantity of secretion and slowly change its character. Mandell's solution of iodine is sometimes used when there is much congestion, but care must be taken not to use it to produce irritation within the nostril. If it burns or smarts, produces sneezing or subsequent congestion, it should be used weaker. The formulæ for Mendel's solutions are as follows:

No. 1. ℞.	Iodine	5 grains
	Iodide of potash	10 grains
	Glycerine	3 drachms
	Water	3 drachms
No. 2. ℞.	Iodine	7 grains
	Iodide of potash	15 grains
	Glycerine	3 drachms
	Water	3 drachms.

No. 3. ℞.	Iodine	12 grains
	Iodide of potash	25 grains
	Glycerine	3 drachms
	Water	3 drachms.

Chemical Cauterizants may be used if the electro cautery cannot be obtained, but are inferior to it. They are applied with a cotton-covered probe. Chromic acid, monochlor-acetic acid, nitric acid, or orthoclorphenol may be used.

The *chronic pharyngitis* which usually occurs as a complication of chronic catarrhal rhinitis also requires treatment. Applications of nitrate of silver solution—5 or 10 grains to the ounce, or tannic acid and glycerine—20 grains to the ounce, or one of the Mandell solutions, are useful if there is dryness of the mucous membrane. Secretions and scabs should be removed by washing out the pharynx. If the lymphoid follicles on the posterior pharyngeal wall are enlarged they should be removed with a sharp spoon, or each follicle punctured with the galvano cautery. It is useless to treat chronic pharyngitis without at the same time giving proper attention to the disease of the nose.

Aural complications.—The aural complications which are apt to develop from this nasal lesion, are chronic otitis media catarrhalis, inflammation of the Eustachian tube, stricture of the Eustachian tube, and adhesive inflammation within the tympanum.

5. DISEASES OF THE ACCESSORY NASAL SINUSES.

Purulent discharge originating within any of the nasal sinuses may cause or influence a lesion within the ear, but the effect is usually indirect and results from the inflammation of the nasal mucous membrane, which itself is a complication of the sinus lesion extending into the Eustachian tube, and the tympanum. The only instance when sinus lesions directly produce an inflammation of the ear is when some of the pus is blown into the Eustachian tube and there acts as infective material. It will therefore not be necessary to discuss *in extenso* lesions of the accessory nasal sinuses.

The accessory sinuses of the nose are—The Frontal, Ethmoidal, Maxillary (antrum of Highmore), and Sphenoidal sinuses. The Ethmoidal sinuses are most frequently diseased, the Antrum next; the Frontal sinus and the Sphenoidal, less often than the others.

Symptoms. 1. *Pain.*—The location of pain varies according to the sinus involved.

A frontal pain with tenderness of the periosteum and pain on pressure at the inner part of the orbital roof, indicates lesion of the frontal sinus. If the ethmoid sinuses are diseased, the pain is boring in character and is located at the bridge of the nose, or at the inner surface of the orbit. Sometimes diffuse and constant dull headache is present. Disease of the maxillary sinus may produce a pain over the cheek, and occasionally, neuralgia in the teeth of the upper jaw. Sphenoidal disease produces a characteristic occipital headache, and occasionally a very severe pain at the base of the brain on a line between the ears.

2. *Discharge.*—Discharge of a purulent or mucopurulent character usually accompanies sinus disease. Unless the disease of the sinus is very severe and necrosis has taken place, the discharge appears in the neighborhood of the openings of the sinuses. It is

detected by examination after the nose has been thoroughly cocainized. The discharge from the frontal sinus appears on the outer wall of the nose, between it and the outer surface of the middle turbinate body. If the turbinate is displaced toward the septum, or if its anterior end is removed, the discharge may be seen within the *hiatus semilunaris* and may be traced upward to the naso-frontal duct. Discharge from the ethmoid sinus is found in two different localities; the anterior ethmoidal cells discharge their contents into the middle meatus of the nose through the *hiatus semilunaris*, while discharge from the posterior ethmoidal cells can be detected by posterior rhinoscopic examination issuing from the posterior ethmoidal cell opening, into the ethmoidal sulci. Sometimes pus from the posterior ethmoidal cells may be seen between the middle turbinate body and the nasal septum. The maxillary sinus discharges through the antral opening, or through one of its accessory openings into the lower part of the middle meatus, and appears running over the inferior turbinate body. Pus discharged from the sphenoidal sinuses is rarely seen except during posterior rhinoscopic examination. It appears in the superior meatus of the nose, and is apt to trickle down over the posterior pharyngeal wall.

3. *Cerebral symptoms.*—Diseases of the accessory sinuses usually produce cerebral symptoms which vary in severity. It is probable that lesion of the sinuses is always accompanies by some disturbance of circulation within the brain. At any rate, cerebral symptoms of a mild grade are present in all cases. These are—loss of memory, inability to concentrate the mind, lack of ap-

plication to work, inability for continuous work, lessened imagination, constant dull headache, and sometimes vertigo.

If the cerebral symptoms are more severe they are usually those of cerebral irritation, and are probably due to the development of a low grade of pachymeningitis. Infection of the brain with the development of septic meningitis or abscess, sometimes occurs in frontal, ethmoidal, or sphenoidal disease. Rigors, fever, slow pulse, headache, photophobia, nystagmus, contracted pupils, and tetanic condition of the muscles, or convulsions followed by paralytic conditions or paralysis, dulness of perception, stupor or coma—make up the characteristic picture.

4. *General symptoms.*—These are malaise, symptoms from anæmia, pains, muscular weakness, low febrile movement in the afternoon, loss of appetite, and symptoms from " catching cold," which is really a mild grade of sepsis.

5. *Diagnosis.*—The diagnosis of accessory sinus disease is made from the symptoms and by examination of the suspected sinus with a probe or by irrigation, or trans-illumination.

ATROPHIC RHINITIS.

This disease is characterized by an increased space within the nasal cavity which is obtained at the expense of the membrane covering the turbinate bodies, especially the inferior turbinate. In atrophic rhinitis the membrane is pale, deficient in blood supply, and the surfaces of the turbinates are flat. The mucous membrane, instead of being swollen and rounded, is shrunken and closely hugs the bone beneath. There is an insufficient secretion of water from the nose which results in drying of the entire mucous membrane. Crusts and scabs formed from dry discharges cover the surface of the mucosa. A foul odor is also usually present.

Causes.—Various conditions have been assigned as causes of this disease, but in the present state of our knowledge, it is impossible to state what is the most potent factor. It is certain, however, that this disease develops in patients who have suffered from adenoids. It also results from purulent rhinitis. Diseases of the accessory nasal sinuses produce a condition of the nasal membrane which resembles atrophic rhinitis and which gives all of the symptoms, but these disappear when the sinus disease is cured. This lesion may arise in poorly nourished individuals who have suffered for a long time from chronic hypertrophic rhinitis. This is especially true when there has been a constant production of new connective tissue in the mucosa, which subsequently undergoes contraction and strangulates the functional parts of the membrane. Constitutional conditions, such as scrofula, tuberculosis, and syphilis are also assigned a prominent causative influence. Bacteriologists have specified several germs as its cause, conspicuous among which are, the *coccus of Löwenberg, Frænkel's diplococcus,* and the *bacillus ozœna fœtidius.*

Symptoms.—A foul odor, which may be only slightly offensive or may be entirely unbearable, is one of the distinctive features. It is supposed to be caused by bacteriological processes going on beneath the scabs. The coccus pneumonii (Friedlander) produces exactly such an odor in a test tube, and as this is found in all atrophic rhinitis to it has been assigned the part of producing this foul smell.

The patient is constantly troubled with hawking and spitting, and experiences a stretched and dried sensation within the nose. Scabs are expelled—sometimes in small pieces, sometimes as entire casts of the nasal interior. The amount of fluid discharged is small, but is increased from time to time if an acute inflammation is superimposed upon the chronic condition. Inspection of the nose shows the membrane paler than normal and tightly drawn over the turbinate bodies, while the cavity of the nose is increased in size from this shrinking. Sometimes there is an absorption of the turbinate bodies, so that they are markedly decreased in size. This is especially true of the inferior turbinate body. Usually both sides of the nose are affected, but it is possible to have a unilateral atrophic condition, especially if the opposite side is stenosed. The greenish or silvery scabs are seen lying upon the mucosa. When these are removed minute superficial ulcerations are exposed. The sense of smell is usually destroyed so that the patient himself cannot perceive the foul odor which is so noticeable to others. Headache is frequently present, as well as symptoms arising from anæmia and gastric disturbances. The posterior wall of the pharynx is reddened, glazed, and dried, while the posterior faucial pillars are usually thickened. Examination of the naso-pharynx will reveal the same condition, covered by a number of scabs or quantities of stringy and very tenacious mucus.

Complications.—The complications of atrophic rhinitis are an atrophic pharyngitis or, as it is sometimes called, a *pharyngitis sicca.* The larynx also suffers and may be the seat of pacchyderma, or *laryngitis sicca* may develop. One or more of the accessory sinuses of the nose are generally involved. The ear rarely escapes and it usually develops an atrophic otitis media. The mucous membrane of the Eustachian tube is also atrophied.

Course.—Years usually elapse before all of the characteristic symptoms of this disease are established. It is rarely observed in children unless due to hereditary syphilis, is especially active between twelve and thirty-five years of age, and is less frequently seen after forty-five. It manifests itself in cycles. Even without treatment the symptoms will improve for a few weeks or months, and then begin another period of activity, this in turn being succeeded by a period of inactivity. In this feature the disease closely resembles tuberculosis.

Prognosis.—Without treatment the disease is never cured, although it becomes less active after the patient has reached the age of forty-five. Under treatment the patient improves readily, and sometimes will not require further attention for a long time. When accessory sinus disease complicates this condition its cure frequently results in a disappearance of all the symptoms of the atrophic rhinitis. Upon the whole, it may be said that the disease is incurable, but that the active symptoms may disappear over a long period of time, although the mucosa is never again normally functional.

Treatment.—The first essential in the treatment of this disease is absolute cleanliness. The patient must be taught to use the nasal douche safely, for from this method of treatment the best results are obtained. The douche should be used every day during the activity of the disease, and should be followed by an application of ichthyol salve, 4 per cent, within the nostril. It is immaterial what cleansing solution is used if it be one which does not irritate. A warm normal saline solution is perhaps best. If foul odor is present a small quantity of peroxide of hydrogen may be added to the douche; if the odor is extremely unpleasant, a solution of permanganate of potash $\frac{1}{20,000}$ or a Tiersch solution may be substituted. If the discharge is very tenacious, borax or soda added to the irrigation solution will aid in loosening the mucus. The patient should also be taught to remove the scabs gently with a cotton-wound applicator. Patients often become very expert in the management of their own cases, soon learn where the scabs are located, and dislodge them without producing the slightest nasal irritation. It is a good plan to loosen the scabs before douching as they are then more easily removed by the irrigation.

The removal of all scabs is necessary for the suppression of the odor, as well as to prepare for the subsequent medication. In the office treatment, the scabs should first be loosened with a cotton-covered probe. Every fold and furrow of the nasal mucosa must be searched for dried secretion, especially the outer nasal wall and the dome of the naso-pharynx. Frequently the odor will persist from a scab which has not been detached from the region of the Eustachian tubes. After the scabs are loosened, the nose should be irrigated or sprayed. The pharynx and naso-pharynx should be treated in the same way, and when these parts are entirely free from discharge they are ready for the application of medicines. If there are any superficial ulcerations present they may be detected by their tendency to bleed, and should be superficially cauterized, either with the galvano cautery—in which case their surfaces are merely touched—or by the use of nitrate of silver fused upon a probe. After this has been done a 5 per cent solution of ichthyol in glycerine, should be gently rubbed with a cotton-covered applicator over the entire nasal mucosa, and the mucous membrane of the naso-pharynx and pharynx. In this way a doubly beneficial effect is produced—one from the ichthyol and another from the massage. At first, these cases should be treated every day; subsequently, two times, and then three times a week. After a while the office treatment may be suspended, if the symptoms do not reappear, the patient returning from time to time for an occasional treatment and especially for examination. When he is relieved, if the symptoms do not immediately tend to return, he may be allowed to relax the regularity of the home treatment, but this must be resumed at their earliest appearance. In very severe cases of atrophic rhinitis, where speedy relief is desired, the patient should receive daily treatment at the hands of the physician, who after cleansing the nose and treating it with ichthyol and massage, should completely tampon one nostril with cotton pledgets soaked in ichthyol and glycerine. This should be removed the following day and the opposite nostril treated in the same manner—this to be continued until the symptoms are controlled, which generally does not require more than ten days.

The naso-pharynx and the pharynx must be treated coincidentally with the nasal treatment and in the same way. A moist climate, out-of-door life, and plenty of exercise, are important adjuncts.

DISEASES OF THE SEPTUM, INCLUDING EXOSTOSIS AND DEFLECTED SEPTUM.

Hematoma of the Nasal Septum.—Is an exudation of blood into the soft tissues of the septum usually as a result of direct traumatism. It is apt to accompany fractures and dislocations, and may sometimes occur in the course of infectious diseases. The nasal septum, on one or both sides, will be the seat of a swelling sufficiently prominent to obstruct the breathing. History of injury with obstruction immediately following is usually obtained. The tumor fluctuates on pressure, is blueish-red in appearance, while the surrounding mucosa is discolored from ecchymosis. The prognosis is good unless the hematoma involves the perichondrium and separates this from the underlying cartilage over a considerable area. In such cases the nutrition of the cartilage is interfered with and necrosis may result. For this reason and from the danger of infection, the hematoma should be incised without delay. After cocainization, a bistoury is introduced into the lower part of the tumor and the blood allowed to escape. Antiseptic irrigation follows, and drainage is secured by packing the cavity with a small piece of iodoform gauze. This should be changed daily after the cavity has been irrigated.

Abscess of the Nasal Septum may result from an infected hematoma, but more often by direct infection from the finger used to remove scabs from the septum.

These abscesses produce pain and swelling. The diagnosis is made from the presence of an actively inflamed area on one or both sides of the septum, with a fluctuating swelling and nasal obstruction. The condition is apt to resemble dislocation or fracture of the septum, or the formation of a new growth, and is to be differentiated from these by the history and the presence of fluctuation. A hypodermic needle introduced into the swelling will remove pus and confirms the diagnosis. Abscess of the septum must be immediately incised and drainage secured, otherwise perforation is apt to result. It should be treated like an hematoma. The best results have been secured by using hydrogen peroxide to wipe out the infected cavity after the incision. Drainage is secured by packing the cavity with iodoform gauze. At the time of the incision a probe should be introduced as far as the cartilage is bared to ascertain if it is necrotic. If the cartilage has sloughed it must be removed at the time of the first incision. Perforation of the septum as a result of abscess formation rarely occurs if the abscess is incised freely and without delay.

Hypertrophy of the Septal Mucous Membrane.—Examination of the nasal septum in cases where nasal discharge and obstruction are complained of, will frequently show localized areas of thickened mucous membrane without increase of the bone or the cartilage. This condition is apt to occur in the region of the tuberculum septi and the upper anterior third of the septal surface. Such thickenings are also found on the septum if the middle turbinate body lies in contact with it. The posterior end of the septum frequently shows the same hypertrophic thickenings. It is also possible that the mucous membrane of the septum is found diffusely thickened throughout its entire area. This thickening is characterized by partial shrinking under cocaine and suprarenal and by the indentation of its surface from a probe. The pathological condition includes an hypertrophy of the mucous membrane with deposits of fibrous tissue in the sub-mucosa. There is always some œdema in the immediate neighborhood of these thickenings. When the tissue of the septum is in this condition it does not require treatment unless it causes obstruction or is active as an element in the production of some reflex condition. It is of greater importance to recognize and remove the cause than to destroy the septal thickening itself. Sometimes the obstruction is sufficient to produce considerable respiratory discomfort, particularly when located anteriorly. They should then be treated by the galvano cautery or the knife.

Treatment.—The knife gives better results than the cautery. After thorough cocainization, a narrow bladed knife is introduced into the thickening at its anterior edge and pushed directly backward along the septum to the posterior margin of the thickening. The instrument is then carried through it above and then below until the tissue is entirely removed. Less reaction is produced by the knife than from galvano cautery. When the cautery is used the parts are not cut through, but long incisions are made with the heated platinum cautery point in the tissue one-eighth of an inch apart, the depth being determined by the extent of the thickening. The disadvantages of the cautery are that periostitis is more apt to be developed

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while the wound heals slowly, and the dangers of sepsis are not diminished. The reaction from the use of so much heat in the nose is also a disadvantage, since it is likely to produce infiltration of the surrounding tissue, with constitutional disturbances—headache, fever, prostration. The single advantage from the cautery is that the cauterized area does not bleed.

Ecchondroses and Exostoses of the Nasal Septum are protrusions from the surface of the nasal septum. These cartilaginous or bony thickenings of the nasal septum cannot be considered as a pathological result, since anatomical malformation is largely responsible for their existence. Where the triangular cartilage joins the upper edge of the vomer, we are apt to have a cartilaginous thickening develop, termed an ecchondrosis; and more posteriorly, where the septal plate of the ethmoid joins the vomer, thickening of a bony nature develops called exostosis. These thickenings occur at no other part of the septum. Because the articulation of the vomer with the septal plate of the ethmoid is higher behind than in front, the exostoses are more posterior and higher from the nasal floor, than the ecchondroses.

The exact manner in which these thickenings are developed has never been satisfactorily explained, it is presumed that one or both sides of the thin Y-shaped upper border of the vomer, together with the triangular cartilage and the septal plate of the ethmoid suffer a slight deflection and then become thickened and hypertrophied. Such an outgrowth from the nasal septum may vary from one-quarter of an inch in length to about two and a half inches. Such a one extends the entire length of the upper border of the vomer. One thickening may be present in the anterior part of the articulation, and another in the posterior part, with an intervening space uninvolved. In this way two spurs on the same side are formed. They may also vary in shape; some are thin in front having an edge like that of a plow, while behind they are wider and thicker. Others are wide and thick, having a rounded surface. As a rule, spurs are more apt to be thicker and wider behind than in front, and they generally terminate one half an inch in front of the posterior margin of the septum.

They give rise to definite symptoms and lead to pathological conditions in the nose, besides producing nasal obstruction and interfering with respiration. If they are wide enough to touch the turbinate at any point, they cause inflammation with interference of circulation in the turbinate with secondary results of disturbance of nasal function and abnormal secretion. When they have remained for a long time in persistent contact with the turbinate, abrasion of the surfaces of each may take place, with the subsequent formation between the turbinate and the spur of a cicatricial band known as synechia. This leads to further pathological developments.

When the spur extends posteriorly, it is apt to receive upon its upper border the lower edge of the middle turbinate body, while its sharp edge impinges upon the posterior end of the inferior turbinate body. Such a condition of affairs may cause adhesion of these three parts, give rise to other nasal inflammatory conditions, or produce diseases in the adjacent accessory sinuses, as well as disturbance of the physiological balance of the pharynx and larynx. Chronic headache is frequently caused by these spurs.

Spurs of the nasal septum are apt to be associated with deformities of deflections of the septum. Such complications will be considered later.

Diagnosis.—Spurs are very difficult to recognize when the turbinate tissue is swollen, or in narrow or aquiline noses. They may be recognized as projections from the septum having a sharp thin edge, or as a diffuse rounded thickening projecting from the perpendicular septal wall. The diagnosis of a posterior spur when invisible, can best be made by the resistance which the probe meets in its passage from below upward along the surface of the septum.

For the diagnosis of septal ecchondroses and exostoses it is necessary that the turbinate tissue be lessened in size by application of a 4 per cent solution of cocaine in a 1 to 10,000 solution of adrenalin chloride. This should be applied on pledgets of cotton. The congested and œdematous tissue of the septum in the neighborhood of the spur is also shrunken in the same way to make the relative protrusion of the spur more prominent.

Probing for spurs.—A curved probe passed into the nose will disclose the presence of a spur, even when it is not visible, by the resistance offered by this projecting part to the passage of the probe from the floor to the roof, along the septal surface. The spur will either entirely block the probe in its upward movement, or else it will make a considerable excursion outward toward the external wall on its way over the spur.

TREATMENT.

Preparation for operation.—The nose is washed out with a sterile douche. This may be a normal salt solution containing a small quantity of bicarbonate of soda, generally a drachm to a quart of the solution. If the nose contains purulent matter it may receive preliminary treatment with hydrogen peroxide, 1 to 10, and may afterwards be douched with a sterile solution. It is then cocainized with a 4 to 8 per cent solution of cocaine—first sprayed into the nostril in small quantities to produce slight general anæsthesis, and afterward directly applied to the field of operation on cotton pledgets. It is always necessary to cocainize both sides of the septum. At the end of five minutes the cotton pledgets may be removed and a sterile solution of suprarenal gland introduced on cotton. For this purpose one may use 1 to 10,000 adrenalin chloride, Armour's sterile suprarenal solution 1 per cent or powdered suprarenal gland 6 per cent mixed with water and filtered. The required percentage of cocaine may be dissolved directly in a sterile solution of adrenalin chloride, 1 to 10,000, and both remedies applied simultaneously to the nose by spraying or upon cotton pledgets. This method is preferable and lessens the toxic effect of the cocaine, while it in no way interferes with the anæsthetization. Five minutes after the application of the solutions the mucous membrane will be blanched as well as anæsthetized, and it is possible to do a painless and bloodless operation.

Small ecchondroses, when located anteriorly, may be successfully treated with the galvano cautery, linear incisions being made through the mucous membrane and the thickened cartilage, extending from behind forward through entire thickness and length. Large cartilaginous or bony spurs should not be treated with

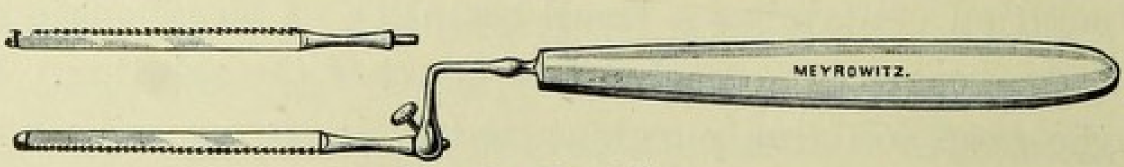

Fig. 48.—Nasal Saw.

the cautery. An ulcer is produced over the burned area. It does not heal readily and is apt to form synechiæ. The saw is the best instrument for the removal. As a rule, a " cross cut " saw should be used,

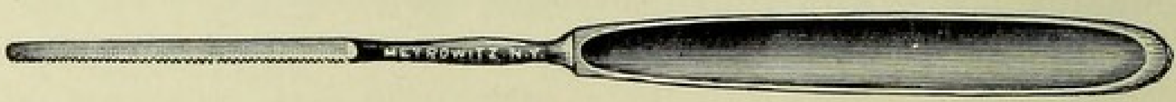

Fig. 49.

although some operators prefer either a saw which cuts on the draw or the push. These, however, are matters of individual preference, and may be left to the operator to determine for himself.

Spurs are also sawed from below upward. As the

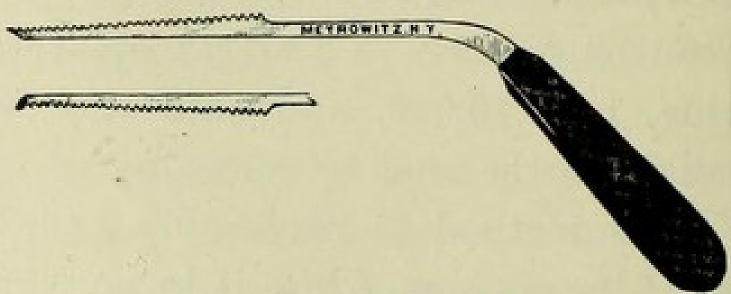

Fig. 50.—Nasal Saw.

first tissue to be cut is mucous membrane, it is well to begin with a fine-toothed saw or a knife. After a groove has been made in the cartilage a large toothed saw can be used. When the spur has been severed the mucous membrane is again reached on its upper side, the fine toothed saw is again used. It is always necessary to cut at first horizontally into the septum so that when the saw is turned upward the surface will correspond to the perpendicular plane of a normal septum. It is the purpose of this operation to leave the septal surface perpendicular. There are two reasons why the sawing is begun under the obstruction. Any blood flowing below the instrument does not obscure the field of operation, and the saw will lacerate less before it enters the hard part of the spur. If it first engages the exostosis from above, it does so with more or less tearing of the mucosa. After sawing through the anterior part it will reach the posterior parts of the spur. The sawing must be continued until the entire growth is removed. Often the posterior part of the exostosis will remain attached while the anterior is completely removed by the instrument. This is apt to occur with inexperienced operators, but it is better to do away with the entire exostosis at once and persevere in the sawing until the whole is removed. Care must be taken not to perforate the septum in this operation. This leaves an oval perforation the edges of which heal slowly, ulcerate readily, and cause annoyance afterwards. Perforation is guarded against by occasionally looking into the side of the nose not being operated upon, where the first tendency of the saw to go through can be easily detected.

There is one kind of excrescence from the septum which is not an exostosis and yet resembles one very closely. It is a sharp deflection of the nasal septum to one side, containing a deep furrow in its concavity of the opposite side. The mucous membrane in this concavity hypertrophies and fills the hollow, so that except with the probe it is impossible to recognize it. If this deformity is removed under the impression that it is a spur, the result is an ugly long perforation of the septum.

Another difficulty which the beginner is apt to encounter, is the removal of the cut-off spur when it remains attached posteriorly by a shred of mucous membrane. This must be severed by the scissors after the bony spur has been cut through. If an attempt is made to remove the spur by pulling it while still attached, there is danger of tearing away a large area of the mucous membrane.

Formerly spurs of the nasal septum were removed by the dental burr, the drill, or chisel. These methods have now fallen into disuse except in the hands of a few operators.

After-Treatment.—Usually there is neither pain nor bleeding during the operation, but both may make their appearance after the completion of the operation. Sepsis may also develop.

Pain.—The pain may be treated by the application of iced cloths or absorbent cotton to the nose or forehead, and by administration of one of the coal-tar preparations. A favorite one is:

℞.	Acetanilid	grains 2
	Caffein cit.	grains ¼
	Caf. monobromate	grains ⅛
	Salol	grains 2

Ft. in one tablet.

One of these tablets may be used every half hour until relief is afforded. Occasionally morphine may be required.

Hæmorrhage.—No nasal spur operation should be left without packing the nasal cavity. Congestion naturally follows the disappearance of the ischæmic condition produced by the suprarenal solution, and shows anywhere from two to forty-eight hours after the operation. The secondary hæmorrhage is at times serious. It is not at all necessary that the operated side should be tightly packed, but it is advisable to place some pressure against the operated area. Nothing is more satisfactory than small strips of plain sterile or iodoform gauze *packed lightly* against the field of operation, unless it is a Simpson-Bernay's nasal tampon. The packing is always removed after forty-eight hours. Repacking is only done for hæmorrhage.

Sepsis.—Sepsis after spur operations may develop even where care has been exercised to maintain sterile conditions. The infection comes through the inspired air. The early symptoms are malaise, pain in the back or through the body, severe headache, nasal obstruction, rise of temperature, and chilly sensations. These may appear soon after the operation, when they are undoubtedly associated with nervous shock, and are most likely to occur within the first forty-eight hours. Enlargement of the cervical and submaxillary glands, may be present. Drainage in the nose is generally so good that sepsis subsides readily. Upon the earliest occurrence of septic symptoms the packing should be removed and the nose irrigated, when the sepsis quickly disappears, if ordinary surgical cleanliness is observed.

Granulation Tissue Formation may defeat the purpose of the spur operation. When large areas have been denuded by the saw, they are slow to form granulation tissue, and the parts may remain unhealed for a long time. Or granulations may suddenly spring up and fill the entire space previously occupied by the spur, develop synechiæ by pressure against the turbinate, and defeat a good result from the operation. In other cases exuberant granulation tissue is apt to develop on any uneven surface of bone which may remain. Sometimes granulation tissue remains normal and healing is not delayed. In cases where it tends to be exuberant, treatment by the application of nitrate of silver fused on a probe is useful. Sometimes a plate of celluloid or rubber tissue, or even a thin strip of aluminum, is required to keep the two opposing surfaces apart until they no longer swell and touch each other. When such plates are used they must be removed daily, the nostrils cleansed, and the granulated surface occasionally cauterized. The plate must be reintroduced after smearing it with sterile or antiseptic salve, and the tissue surfaces covered with a weak antiseptic powder of iodoform and compound stearate of zinc. No operated area within the nose can be considered safe from exuberant granulation tissue formation until the cicatrices are fully formed. Until then there is always a danger of a reappearance of the obstruction from exuberant granulation, or from the formation of adhesions.

Deflections of the Nasal Septum.—Deflection of the nasal septum is of frequent occurrence. The majority of septa are somewhat deflected, but theoretically the septum is placed exactly in the median line and divides the nasal cavity into two equal chambers. Practically, however, unless the nasal septum is markedly deflected, so as to produce a marked diminution in the area of one cavity, it is not important.

Causes of Deflection.—Traumatism is undoubtedly the most constant and active factor. It is not necessary that it should be recent. The nutritive changes following an injury, produce a deflection after the immediate effects of the injury have ceased. A traumatism may have occurred years before the deflection is noticed, but slowly developing tissue changes exaggerate the septal deformity and produce thickening which increase the obstructions. Pressure upon the septum from the opposite side may be the cause of a deflection; this is observed most often from pressure of the middle turbinate. When this body enlarges it presses against the septum, and if this is continued for a long time the septum yields and is forced to the opposite side. When these two factors are not present, nutritive changes alone may account for the deflection. If the septum develops more rapidly than the external parts, a deformity must result from overgrowth.

Forms.—Deflections may be either of the cartilaginous or the bony septum, or both; or it may consist of a dislocation of the cartilaginous portion from the bony spine of the superior maxillary bone. Bony deflections are not so frequent as those of the cartilaginous septum. The bony septum is probably never deflected at its posterior third. When it is deflected, usually the edge of the septal plate of the ethmoid and the upper part of the vomer are the parts involved. Deflections of the bony and cartilaginous septum may be classified under the following types:

1. *Bowed Septa* are those in which the deflection is

more or less regularly convex, without any marked ridges or lines of deflection, and in which the septum is of equal thickness throughout its whole extent. This is perhaps the most common form of deflection, and is the form frequently seen in children.

2. *A Rigid Deflection* is one in which a ridge forms as a result of bending of the septum. This ridge is usually single and indicates a former line of fracture. The ridge, if compound, is joined by other ridges, also representing lines of fracture. The ridged septum is next in frequency to the bowed variety, and to the inexperienced eye it has many of the appearances of a spur. The unobstructed side of the septum is concave, the depression corresponding to the ridge in the obstructed nostril.

3. *A Bowed Septum with Thickening* is formed by an inflammatory deposit in the mucous membrane and perichondrium around the point of greatest convexity. A considerable amount of fibrous tissue deposit produces a thickening at this point, thus increasing the obstruction. The ridge form may also be thickened in the same way.

4. *A Sigmoid Septum* is one in which the deflection exists on both sides, making the septum S-shaped. This form is often found. It may present a double-bowed, or doubled-ridged form. A septum at one time simply bowed or ridged may subsequently become sigmoid through a second injury.

5. *Dislocated Septum.*—In this condition the obstruction is almost entirely at the floor of the nose. The deformity is produced by a dislocation of the cartilaginous septum from the upper border of the vomer, and is

generally accompanied with some displacement of the anterior part of the vomer or of the superior maxillary spine. It is apt to be overlooked unless the floor of the nose is examined carefully.

The Symptoms of Deflection are obstruction and discharge. Obstruction may be very moderate or complete. It is unilateral and constant, but increases from congestion if the patient is recumbent. Pressure upon adjacent parts may produce reflex conditions, such as hay fever, asthma, headache. Discharge is produced by catarrhal inflammation accompanying the deflection. This in turn results in the production of fibrous tissue and hypertrophy, by which the obstruction is increased. Chronic congestion or hypertrophy of the turbinate tissue frequently accompanies these changes. The symptoms vary more or less with the different forms of deflection. Bowed septa will produce obstruction on one side, while frequently the mucous membrane of the other side will be found in a condition of atrophy from overwork. If the bowed septum is accompanied by thickening, catarrhal symptoms with hypertrophy or chronic congestion may supervene. Loss of the sense of smell is apt to occur in this variety.

A rigid septum produces results similar to those of spurs, and is likely to cause chronic congestion and inflammation of the inferior turbinate bodies, with the accompanying symptoms.

A sigmoid septum may obstruct one side and give indications of pressure on the other, particularly if the middle turbinate is severely pressed upon by the deflected septum. In such cases headache appears, interference with mentality occurs, cerebral hyperæmia is established, and chronic inflammation of the accessory nasal sinuses is apt to follow.

A dislocated septum tends to produce obstruction of the nose in its anterior part. In such cases patients experience relief from pulling aside the alae of the nose. They are apt to do this incessantly. All such dislocations produce chronic congestion of the nasal mucous membrane, followed by hypertrophic rhinitis, from which again develops a long list of other symptoms coincident with the establishment of chronic catarrhal inflammation.

Diagnosis.—The operator must recognize the form of the nasal deflection, and it is important to observe each line of deviation from the median line. It is also necessary to recognize where the septum is thickened as well as displaced. As an example of the importance of a careful examination, a specific instance may be cited. There is one form of rigid deflection in which a prominent projecting ridge, like an exostosis, is formed on the obstructed side. The deception is heightened by the concavity in the opposite nostril being filled with hypertrophied mucous membrane. The hollow is obliterated and the septal wall is perpendicular, as in exostosis cases. This form is often mistaken for an exostosis and removed with a saw. A large perforation invariably results. This form may be recognized by inspection of the unobstructed side of the nostril with a probe introduced on a level with the ridge in the other side. It will enter a deep slit-like furrow in the mucous membrane, which usually escapes detection by sight. Beginners are very liable to overlook this form of deflection.

The diagnosis of septal deflection is made by inspection and palpation. In order to accomplish this the septum must be thoroughly cocainized with a 4 per cent cocaine solution in 1 to 10,000 adrenalin chloride solution. After inspection with a nasal speculum, a probe is used to discover the extent of the deflection. A good idea of the varying thickness of the nasal septum may be obtained by using two probes, one in each side. In this way thickened parts are recognized which require preliminary removal with the knife. The little finger should also be introduced into both sides as far as possible, and the irregularities of the septum studied by touch. Much information regarding the character of the deflection may be obtained from the examining finger. After examination of the unobstructed side, the finger should be introduced into the obstructed side and an attempt made to gently force the cartilaginous septum toward the opposite side. If this is possible, the lines of deflection will be easily made out.

Treatment.—These cases may be treated in two ways. First, by removal of all thickenings which may be present, by means of a knife and saw, leaving the septum still deflected; or second, by an operation to replace the septum in the median line and restore its perpendicularity. *In cases requiring correction of the entire septal plane, it is also necessary that thickenings be previously destroyed by the use of the saw or knife.*

Cases will be found where the middle or inferior turbinates of the opposite side are enormously enlarged. Such require removal prior to the operation for deflection, otherwise when the septum has been replaced in the median line it will lie against the enlarged turbinate and obstruction will result, thus transferring the obstruction from one side to the other.

In correcting a deflection of the nasal septum, a general anæsthetic is sometimes required but usually cocaine anæsthesia is satisfactory. The choice of anæsthetics depends upon the age of the patient, and the custom of the operator. Complete anæthesia may be obtained by local means, but ether is frequently required in nervous individuals, and used by operators who are not expert. The disadvantages of ether narcosis are the position of the patient, the increased amount of hæmorrhage, and the length of time required. The advantages of local anæsthesia are absence of hæmorrhage, the sitting posture, the coöperation of the patient, together with the fact that the operator is able to get a better view of the field of operation. The sensation of pain is completely abolished in local anæsthesia.

Local anæsthesia of the nasal septum may be obtained by infiltration or local application. In each instance the entire nasal mucous membrane must be previously anæsthetized by a 6 or 8 per cent solution of cocaine by means of a spray. If the infiltration method is used, the solution is injected at various points into the mucous membrane. When properly anæsthetized the parts remain insensitive for nearly forty minutes. The solution should be sterile, and is made according to the following formula:

℞.	Cocaine muriate,	grains 1.
	Eucaine,	grains 4.
	Solution adrenaline chloride (1 : 1000)	drachm ½
	Sterile Saline Solution q.s. ad.	ounce 1.

Altogether about 60 or 80 minims of this solution may be used before beginning the operation. More injections are used subsequently, if necessary. The chief difficulty in local anæsthesia is to abolish sensation in the lower and anterior nasal septal parts. This is aided by injecting the tissue about the superior maxillary spine through the under surface of the upper lip. If it is not desired to use the infiltration method, the nasal mucous membrane is sufficiently anæsthetized by means of an 8 per cent solution of cocaine, in a solution of adrenalin chloride, 1 to 10,000, applied on cotton pledgets to both sides of the septum, and allowed to remain in position for five minutes. This will render the mucous membrane thoroughly insensitive and ischæmic. Constitutional symptoms from the cocaine may be prevented by the administration of solutions of nitro-glycerine, minims 2 ; strychnia, grains 1/60 to 1/30 ; or whiskey, 1 ounce, ten minutes before the cocaine is used.

The Operation.—Exostoses and ecchondroses must be removed before the faulty position of the septum is corrected. Furthermore, all thickenings over the deflections must be removed. This preliminary operation should be performed two or three weeks before the other one, in order to allow the parts to partly heal. Sometimes it is necessary to remove the exostoses or ecchondroses, or other septal thickening just before the deflection operation, but this plan is to be avoided if possible. It is also necessary to remove from the obstructed side any condition of the turbinated tissues which would form an obstruction to this side after the septum is replaced. Before the patient is anæsthetized, the nose should be douched with a warm salt solution. A small quantity of peroxide of hydrogen (1/50) in the douche is useful.

After the anæsthetization, the finger is well oiled and introduced into the nares. The examination by means of the finger will show the lines *where the septum has been previously bent, or where fracture has taken place.* The finger should detect the ridges which may exist, and should determine whether there are one or more deflections, and whether these join each other or are separated. Cases are seen of apparently simple deflection consisting of a horizontal ridge, where the finger discovered another ridge leading upward and backward, which was as much a cause of obstruction as the one seen by the eye. A careful examination of these ridges or convexities forming the deflection will indicate the plan of operation which is to *perforate the septum at the point of greatest convexity and cut along the lines of deflection in whichever direction they may extend.* It is of great importance that the examining finger, while searching for the deflection, should ascertain whether the triangular cartilage joins the superior maxillary spine, or has been deflected or displaced from this ridge. Having determined carefully the location of the lines of deflection, the spear knife is introduced into the obstructed side and is carried to the point of greatest convexity. If the deflection is out of the line of vision, the little finger which has been placed in the free side will easily determine when the spear knife is on the deflection, for it can be felt through the thickness of the septum. The point of the knife is then turned inward and pressed through the septum, thus buttonholing the deflection at its greatest convexity. The point is felt as it perforates, by the finger in the opposite nostril. An incision about $\frac{3}{4}$ of an inch long is then made following the line of deflection, and the knife is withdrawn. The object of the spear knife is merely to perforate the septum enough to allow the introduction of a blunt pointed bistoury. This second knife is introduced on the obstructed side into the incision made by the spear knife, the finger in the free nostril again acting as a guide. It first cuts forward, then backward, and the incision is continued along the ridge of the convexity until the entire deflection is incised. It is usually necessary to cut forward to the skin at the vestibule of the nose, and as far posterior as the bony septum. The blunt point on the instrument prevents any wounding of the turbinated tissue. If the examining finger discovers deflections joining this main deflection, the bistoury should be reintroduced and these ridges incised along their most prominent edge, until the entire length of each deflection is cut. When this has been accomplished, the septum will present one or more cuts along the line of deflection, and entirely through the substance of the cartilage. This leaves the septum in a thoroughly divided condition along the lines of the deflection.

Ascertain next whether the deflection from the superior maxillary ridge exists. If it does, it should be treated in one of two ways: if the deflection at the floor of the nose consists of a displacement of both the *bony ridge* and the *cartilage,* an attempt should be made to break the bone free from its improper attachment with the forceps. If the bony ridge is not deflected with the cartilage, but what is more frequently the case, *the cartilage has slipped from its articulation* and obstructs near the floor of the nose, it should be incised and liberated from its adhesion. To do this, the knife is introduced at the junction of the cartilage with the vomer and drawn forward horizontally to the epithelial border. The septum presents at this stage of the operation one or more incisions, each corresponding to a deflection. The incisions allow the cartilage to be pushed to either side with great freedom.

The next step is the destruction of any elastic bands which may exist in the sub-mucosa as the result of the inflammatory action accompanying the deflection. These adhesions should be thoroughly broken up by introducing the forceps on either side of the septum

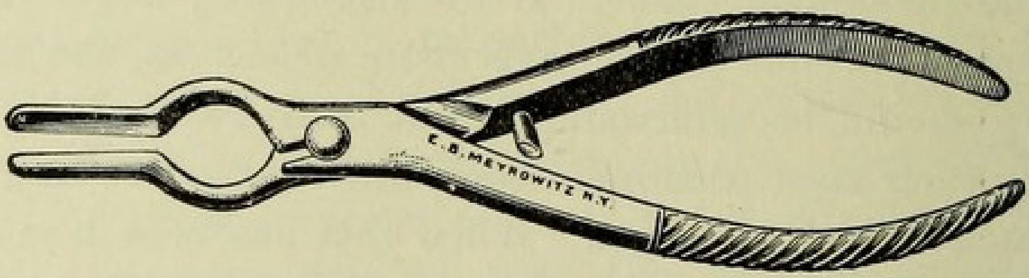

Fig. 51.—" Septum Forceps."

and quite forcibly twisting the septum with a rocking or rolling motion, until all adhesions are thoroughly destroyed and the cartilaginous septum is freely movable.

The following step is to bend the septum *away from the side which has been obstructed.* This causes a very slight overlapping of the cut edges toward the free side. The overlapping is accomplished by introducing the finger into the obstructed side, thus displacing the edges of the incision and producing the overlap on the concave side. The bony septum should now be explored, and if there are prominent deflections these should be broken by the forceps or removed by the chisel. A splint is then introduced into each nostril, the largest splint being worn in the previously obstructed side, producing just enough pressure to force the septum somewhat past the perpendicular, but care must be taken not to press too far over. The second splint, in the opposite nostril, will assist the first to maintain a correct position of the septum.

The After Treatment is important. Unfavorable results are almost unknown if the splints fit properly and are not uncomfortable. The splints should not be removed for forty-eight hours unless there is pain, headache, swelling of the nose, or retained secretions that cannot be removed by washing. The first day the nose should not be irrigated. The second day, it should be cleansed with a hot normal sal solution. At the first removal of the splints on the third day, the septum should be examined. If it bulges to either side, it can be replaced by means of a nasal periosteal elevator. Very satisfactory splints are the Simpson nasal tampon, made of Berney's cotton sponges. These are used as substitutes for the hollow form of metal or rubber splint. The exact degree of desired pressure may be obtained in each nostril, and the pressure may be nicely balanced. The compressed cotton of which these tampons are made swells from absorption of fluids in the nose. The tampons are easy of introduction, give good support, are readily removed, absorb pus and serum, and prevent the growth of exuberant granulation tissue. Fresh and sterile ones should be introduced into each or both nostrils, as required, every forty-eight hours. While the splint is out the nostril should be irrigated. After two to four days, the splint in the unobstructed side may be dispensed with, leaving the one in the formerly obstructed side. This should be removed each forty-eight hours for the first week, afterwards each third day in order to permit of the cleansing and antiseptic irrigation of the nose. This splint should be worn for two weeks and may then be dispensed with. Briefly, this operation consists of four steps:

1. Buttonhole the septum at the point of greatest obstruction, and incise obstructing ridges or convexities along the lines of the convexity.
2. With the septal forceps break all fibrous bands, and separate the cartilage from the superior maxillary spine at the floor of the nose.
3. Overlap cut edges and introduce splints.
4. Treat antiseptically for two weeks.

Treatment of Inflammatory Diseases of the Nose; Cauterization, Electrolysis, and Turbinectomy; Treatment of Contacts and Synechia.—These operations are usually done to relieve nasal obstruction or its attendant evils. The treatment of lesions of the nasal septum will not be described here, for this has already been described under "Treatment of the Nasal Septum." Nasal obstruction is very generally produced by lesions of the turbinate bodies. The most common is chronic congestion (see Chronic Catarrhal Rhinitis). This condition is more frequently found in the inferior than in the middle turbinate, and is disclosed by inspection. The turbinate surfaces, instead of being fairly flat, are rounded, bulbous, irregular, and soft. The mucous membrane pits upon pressure with a probe, and shrinks when cocaine and suprarenal solutions are applied. When these conditions exist, the diagnosis of chronic congestion of the turbinates may be made. The electric cautery, or electrolysis, corrects the difficulty.

Cauterization of the Turbinate Tissue.—When the cautery is used, the congested tissues are first anæsthetized with a 4 per cent solution of cocaine. A certain advantage is gained by the use of eucaine, for it contracts less, but as its anæsthetic action is uncertain, cocaine is preferable. After anæsthetization the turbinates are cauterized by using a flat nasal electrode attached to a proper electric apparatus. Usually two incisions are burned upon its median surface from the posterior to the anterior end of the turbinate, parallel with its lower border and through the entire thickness of the mucosa. If a point electrode is used to puncture the mucous membrane, no line of cauterization is made. Instead of this, several places are punctured and burned along the turbinate surface. The point is inserted a sufficient number of times to destroy the thickened turbinate tissue. In the opinion of the writers, it is unwise to use the electro-cautery upon the middle turbinate excepting on its anterior tip, and even this is not without danger of serious sequellæ. It is safe to cauterize the inferior turbinate body if care is taken not to destroy too much mucous membrane.

The dangers from the cautery are thrombosis and cellulitis, leading possibly to meningitis. Another danger is secondary inflammation of the bone. Atrophic rhinitis frequently results from destruction of the functionally important mucous membrane of the turbinate. Exuberant granulation tissue forms during the healing, and frequently produces synechia. The best effects of the electro-cautery are seen in the purely congested turbinate where the cautery acts to bind down the over-distended venous sinuses and destroy a number of them, in this way relieving the obstruction. After cauterization the nose should not be irrigated for 72 hours. During this time a soothing salve should be introduced within the cauterized nostril three times a day. Such a salve may be made from the following formulæ.

℞. Cocaine alkaloid			grains x.
Zinc oxide			grains x.
Aristol			grains x.
Ol. olivae			ounce ss.
Vaseline	q.s.	ad	ounce i.

or,

℞. Ichthyol	grains x.
Bismuth subnitrate	grains x.
Vaseline	ounce 1.

After 72 hours the slough will loosen, and a douche of saline solution or a spray of Dobell's solution removes it. The use of the salve should be continued until healing is complete. Exuberant granulation tissue should be cauterized every fourth day with silver nitrate or orthochlorphenol, until it is controlled.

Electrolysis.—When electrolysis is employed to reduce venous congestion, a double pointed electrolysis needle is necessary with a galvanic current of five or six milliamperes. The electrode is made in such a way that the two needles shall be about $\frac{1}{16}$ of an inch apart. After cocainization, they are introduced into the congested area and the current turned on. A current of five or six milliamperes is sufficient to produce destruction of the tissue between the poles, and for a limited area around them. The chemical disintegration taking place is indicated by the bubbles of oxygen and hydrogen escaping at the points of introduction of the needles. After three or four minutes the current may be turned off, the electrode removed, and reintroduced at another point. It is well to make four or five introductions at one sitting. This can be done without producing too much destruction of tissue. Care should be taken to introduce the needle beneath the epithelial surface in order to avoid superficial destruction and subsequent ulceration. The advantage of electrolysis over the cautery are that the deeper structures only are obliterated, leaving the surface intact. Reaction shown by headache, nasal pain and obstruction, fever, prostration, and malaise—is much less apt to develop than when the cautery is used.

After the operation the parts should be dressed with an antiseptic powder. Five or six days after the application of electrolysis the parts are ready for a second treatment, if required. No sloughing follows this process.

Destruction of the Venous Sinuses by means of a fine scalpel has been suggested by Bryson Delavan. This is a satisfactory method in many cases. It consists in the introduction, after cocainization, of a small knife into the congested area. The knife is forced between the bone and soft structures, in this way severing the venous sinuses from their communicating vessels. The resulting submucous cicatrix obliterates some of the vessels. The after treatment is conducted on general surgical principles.

Operative Treatment of Hypertrophy of the Turbinate Bodies.—This is at present a disputed subject. Some rhinologists believe that hypertrophic tissue is best reduced by cauterization; others, that it should be excised. The present writers' belief is that hypertrophic tissue of the inferior turbinate bodies may frequently be reduced satisfactorily by cauterization, but that in many cases subsequent removal of the mass will be required. They also believes that the middle turbinate body should very rarely be cauterized, and then only upon its anterior tip. Excision of this turbinate is preferred.

Hypertrophic conditions of the turbinate bodies may be classified under six heads.

1. Hypertrophy of the mucous membrane with chronic congestion.

2. Hypertrophy of the mucous membrane with chronic congestion and hyperostosis; that is, a hypertrophic inflammation of the bone associated with the soft tissue thickening.

3. Hyperostosis without hypertrophy of the mucous membrane.

4. Nasal polypi and polypoid hypertrophies.

5. Bony cysts in the middle turbinate without hypertrophy of the mucous membrane. (Not a pathological product.)

6. Cysts of the middle turbinate with hypertrophy of the mucous membrane.

When the turbinate tissue shows the presence of hypertrophy and chronic congestion, the proper treatment is by the electro-cautery, the galvano-cautery, electrolysis, or by removal of the mass. This applies only to the inferior turbinate body. When there is hypertrophy with chronic congestion and hyperostosis, it is advisable to reduce the first two conditions by electrolysis or the galvano-cautery. The hyperostosis can then be treated by amputation if obstructive symptoms continue. This also applies only to the inferior turbinate body, for the reader will remember that it is inadvisable to cauterize the middle turbinate body. Under conditions of hypertrophy of this body, the treatment is always by surgical removal of the hypertrophied mass. When hyperostosis is present without hypertrophy, it is amenable only to excision. The condition known as cystic turbinates, with or without hypertrophy of the mucous membrane, can only be reduced by surgical measures. The methods of employing electrolysis and the galvano-cautery have already been considered.

The operations for removal of parts of the turbinate tissue may be classified as follows:

1. The snare operation for removal of hypertrophied tissue, including the removal of the posterior ends of the turbinate bodies.

2. Operation for removal of the anterior tip of the inferior turbinate.

3. Removal of its lower border when pressing upon the nasal floor.

4. Removal of the anterior tip of the middle turbinate body.

5. Removal of the lower border of the middle turbinate body.

1. *The Snare Operation.*—The simple snare operation in the nose may be used for small masses of hypertrophy occurring on the middle and inferior turbinates. It is to be preferred whenever it is possible to engage the hypertrophic mass in the snare. The posterior tips of the inferior and middle turbinates, when hypertrophied, are also best removed in this way.

After thorough cocainization of the nasal tissues, the snare—best when made of steel and pistol-shaped, carrying a loop of piano wire No. 4 or 5,—is introduced into the nostril. The wire loop should be about 1/2 or 3/4 of an inch in diameter. Aided by good illumination in a well dilated nostril, the wire loop is carried over any projecting hypertrophic mass, and then the snare wire tightened slowly as it cuts its way through the growth. If the hypertrophy is on the bodies of the turbinates, no particular precaution is necessary regarding hæmorrhage, but if the posterior tip of the inferior or middle turbinate is engaged, it is always better to remove the mass more slowly. The operation occupies five to ten minutes. This lessens the danger of secondary hæmorrhage. It is a safe rule to cut through any turbinate tissue which engages in the snare wire, even if the growth so secured cannot be seen, for it is not possible that a large mass will be thus fastened unless it is hypertrophied.

After the snare has cut through the tissue and is removed it sometimes brings with it the amputated part. Frequently, however, this piece is left in the nose and must be removed with the forceps. It generally drops to the floor of the nose, frequently near the lower border of the inferior turbinate, and can be recognized by its whitish appearance. If it is not completely loosened, the snare must be reintroduced over it and the attaching shred cut through. It is dangerous to pull the partly detached piece away, for it may bring with it a quantity of mucous membrane and cause serious hæmorrhage or subsequent atrophy. In using the snare care must be exercised to keep it from moving about in the nose, otherwise it wounds the epithelium of the septum or some other part of the nasal interior, which in healing may produce an excess of granulation tissue which might form synechiæ. The snare may be used several times during one sitting to remove at each introduction a mass of hypertrophied tissue. After the snare operation the nose must be lightly packed with either Bernay's sponge or iodoform gauze, which should be removed at the end of twenty-four hours. It is better not to irrigate the nostril until the end of the third day, on account of the danger of removing an unorganized clot and starting secondary hæmorrhage.

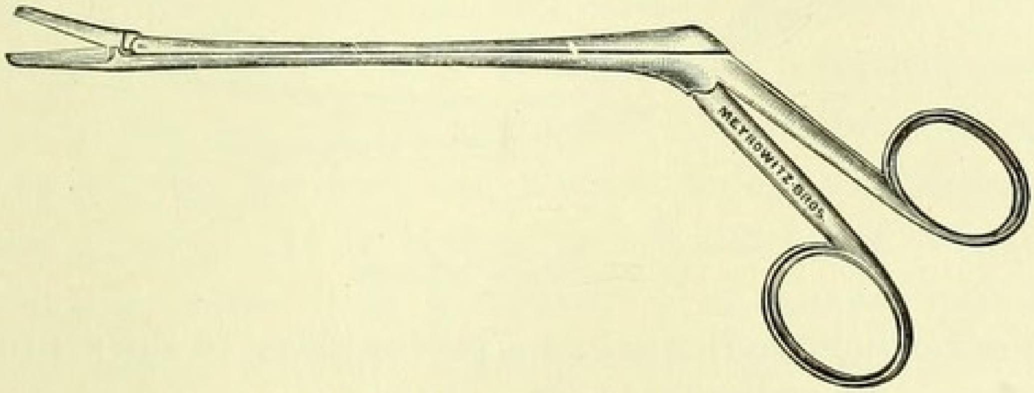

Fig. 52.—Alligator Cutting Forceps.

Anterior Inferior Turbinectomy consists in the removal of the anterior end of the inferior turbinate body. If this end is very pendulous it may be caught in the loop of the snare and removed as described under snare operation. More often, however, it is necessary to remove a portion of the bone with the mucous membrane. A pair of scissors is introduced, the blades separated, across the anterior end of the turbinate body at the point where it joins the outer nasal wall, and a scissors incision made backward for a quarter or a half inch. The scissors-points may then be pressed downward and the operation continued by cutting through the turbinate body at the lower border, or a snare wire may be introduced into the incision while the snare tube is carried along the floor of the nose to a point about a quarter of an inch posterior to the end of the incision. The remainder of the operation may then be completed by cutting the tissue engaged within the tightening wire. Anterior inferior turbinectomy is done to improve lachrymal drainage, for hypertrophic rhinitis, for septal contacts, and contacts of the turbinate with the floor of the nose producing interference with the drainage. It is

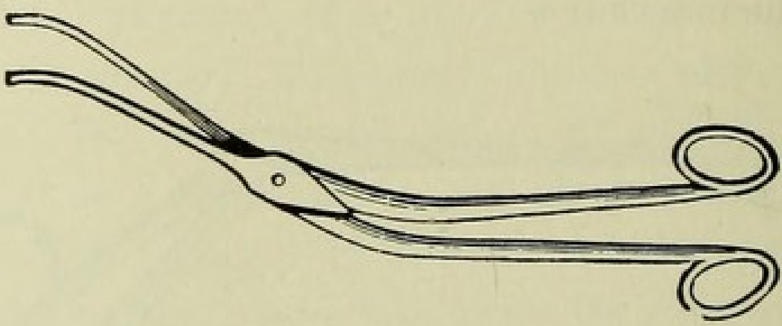

Fig. 53.—Nasal Scissors.

also sometimes indicated as a preliminary to the septum operation in deflection.

After the parts have been amputated the freshly cut surfaces should be protected against hæmorrhage and infection by a light packing of iodoform gauze against the cut surface, or by small rectangular strips of Bernay's sponge.

Amputation of the Lower Border of the Inferior Turbinate is frequently done when the turbinate is hypertrophied and lies on the floor of the nose. It is best performed with scissors. A sufficiently long and very strong pair of scissors is introduced into the nostril, the blades crossing the anterior tip of the turbinate body at its point of junction with the lateral nasal wall, and an incision is made backward and downward through the turbinate body. The incision is then continued backward, above and parallel with the lower border of the turbinate, for one and a half inches. The tendency of the scissors is to cut higher behind than in front. This must be guarded against by pressing the instrument downward toward the floor of the nose. If attention is not given to this point the entire posterior part of the turbinate body will be removed. The lower border of the inferior turbinate body is particularly rich in venous sinuses which bleed furiously after this operation unless pressure is made against the cut surfaces. Such pressure is obtained by iodoform gauze, or pieces of Bernay's sponge laid along the floor of the nose. These must be placed far enough back to make pressure upon the posterior part of the incision. The packing should not be removed for forty-eight hours unless symptoms of sepsis develop. It is better left in place for seventy-two hours, when it is saturated with mucus and detached easily without tearing away granulations or opening the ends of the newly closed sinuses.

The after treatment of operations on the turbinate consists of antiseptic cleansing, removal of the packing, and blowing upon the granulating surface a powder composed of 20 grains of aristol to 2 drachms of bismuth subnitrate. If granulation tissue springs up, its surface should be burned with chromic acid, nitrate of silver, or the cautery. Healing should be complete in ten days.

Anterior Middle Turbinectomy or the amputation of the anterior end of the middle turbinate body, is perhaps one of the most important operations in nasal surgery. In the immediate vicinity of this end of the turbinate lies the drainage openings of the frontal sinus, the anterior ethmoid cells, and of the antrum of Highmore. When enlarged it presses upon the lateral nasal wall or the nasal septum, and if enlarged downward, upon the inferior turbinate body, thus blocking both the lower nasal cavity and middle meatus. Enlargement of this tip is also a factor in deflection of the nasal septum. It frequently produces chronic headache, is often the cause of obstruction to nasal drainage, and is the site

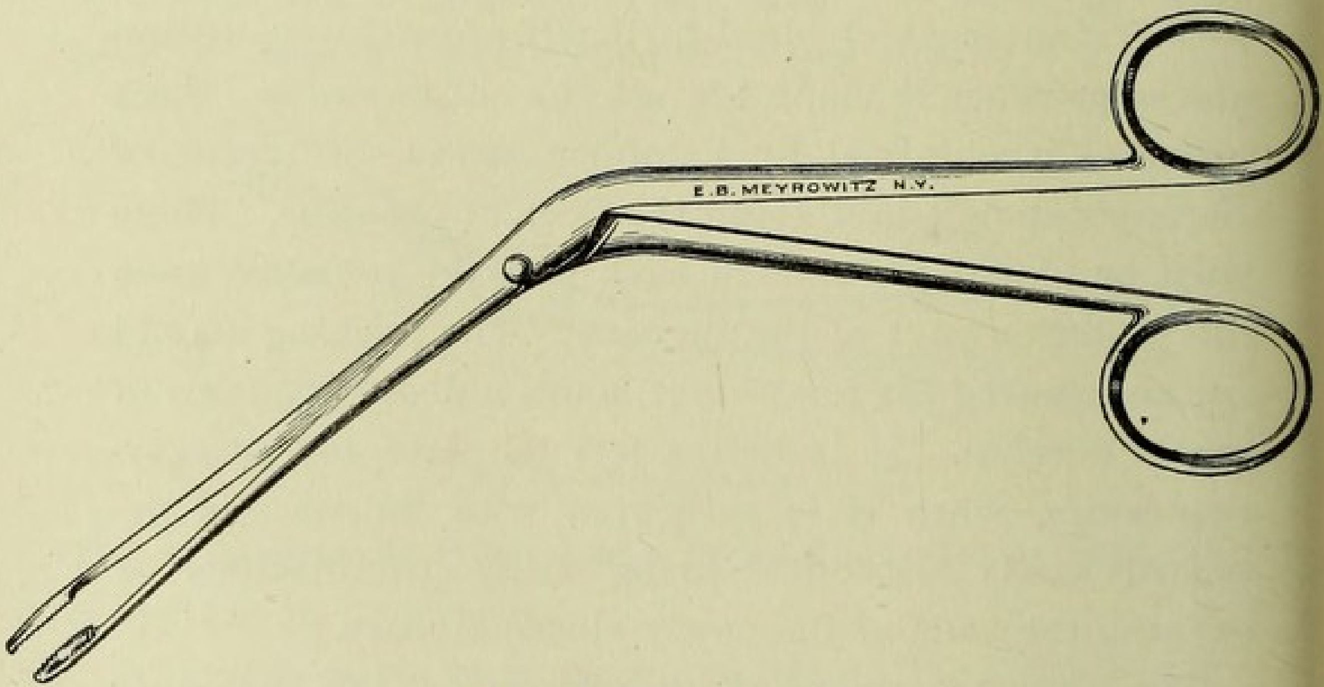

Fig. 54.—Nasal Forceps.

from which polypi most often arise. It is abnormal either anatomically or pathologically when it lies in contact with any other part, whether septum, lateral nasal wall, or inferior turbinate body.

The operation for this condition may occasionally be done with the snare, but this is impossible if there are contacts or adhesions present. In the simple snare operation, a snare is passed over the anterior end and removes it as above described. This is a favorite operation with some specialists. A better method consists in thoroughly cocainizing the turbinate region and using the scissors. These are placed with separate blades across the turbinate where it joins the lateral nasal wall, and make an incision backward and slightly upward about half an inch long. Before the instrument is removed, the partially severed anterior tip should be pressed with the scissors-blade slightly downward and toward the septum, making the incision more apparent. Into this incision the end of the snare wire is placed and retained. The rest of the loop with the snare tube is then pressed backward *under* the lower border of the middle turbinate. The end of the turbinate is thus surrounded and included in the wire loop. The wire is then drawn through the snare tube and in so doing amputates all the engaged tissues. When the tip is cut it falls into the inferior meatus and is withdrawn by the forceps. It is recognized by its anæmic appearance. If slight synechiæ exist between the turbinate and the septum, they are severed before adjusting the snare wire.

In case the turbinate is very much twisted upon itself, or if it lies firmly in contact with the inferior turbinate, it is often impossible to pass the snare wire backward over it. It then becomes necessary to use cutting forceps in order to remove the anterior tip. This operation should never be performed if it is possible to use the snare or scissors, for it invariably results in fracture of the bone, leaving jagged pieces and shreds of mucous membrane, and the irregular surface thus produced is liable to be the seat of sepsis; or granulation tissue produced will give much trouble during healing. In a few cases it is possible to remove the anterior tip with a strong pair of scissors, when care should be taken that the scissors do not break into the anterior ethmoidal cells. After completion of the operation the treatment is the same as described under Inferior Turbinectomy.

Amputation of the Lower Border of the Middle Turbinate becomes necessary when it interferes with drainage from the maxillary antrum, or when by pressure downward causes congestion and hypertrophy of the inferior turbinate body. It is removed by an operation similar to that for removal of the lower border of the inferior turbinate.

Treatment of contact of one part with the other.—In an absolutely normal nose the inferior turbinate body should not press upon the floor or the septum, nor should the middle turbinate body impinge on the inferior turbinate or touch the septum. When any part of the nasal mucous membrane permanently impinges upon another part, it is called a contact. This contact may be the result of abnormal anatomical development or of pathological charges. Anatomical contacts often produce certain obstructive symptoms, while those due to pathological changes are accompanied by general systemic disturbances and local catarrhal manifestations. It may be said that when such a contact interferes with drainage or produces nasal obstruction it should be relieved. Sometimes contacts result in permanent adhesions known as synechiæ.

Synechiæ are the result of the adhesion and subsequent organization of two masses of granulation tissue. They may result from traumatism, from the use of instruments, or from chronic inflammatory contacts of nasal tissue. A contact may produce superficial epithelial necrosis from pressure. A superficial ulcer is thus formed, which nature attempts to heal by producing granulation tissue, and this tissue on the surface of the ulcers which lie in contact grows together causing a diffuse adhesion, which when it undergoes contraction forms a band or synechia uniting the two surfaces.

Treatment of a Contact and Synechiæ.—Oftentimes in permanent contacts it is necessary to resort to turbinectomy. In other cases where the contact is intermittent but occasioned by swelling, the parts in contact may be removed by the cutting forceps or scissors. After removal it is necessary to keep the cut surfaces apart until cicatrization has occurred. This is accomplished by the introduction of Bernay's sponge, a thin plate of vulcanite or celluloid, rubber tissue, or any material dense enough to prevent granulations growing into it. Annular areas of granulation tissue, such as sometimes form at the nasal orifice, are more difficult to treat in order to prevent the formation of stenotic bands across the nostril. The best results are obtained by free cauterization of the granulation tissue and subsequent introduction of a hard rubber nasal splint to keep the parts separated.

Treatment of Nasal Polypi and Polypoid Hypertrophies.—While these conditions represent more or less chronic forms of inflammation of nasal mucous membrane, they are best treated under separate heads, since they are more often recognized as polypi than as a form of nasal hypertrophy. The diagnosis of nasal polypi is not difficult. Permanent obstruction of the nose, catarrhal discharge, headache, pharyngitis, and diseases of the accessory nasal sinuses, are constantly associated with the presence of polypi. Upon inspection milky-white tumors are visible blocking the nasal chamber. The typical nasal polypus usually begins in the mucous membrane of the middle turbinate and lies in the middle meatus, or the middle nasal cavity. They most frequently develop from the anterior tip of the middle turbinate body. Polypoid hypertrophy of the mucous membrane is seen quite frequently both in the region of the middle and along the lower border of the inferior turbinate bodies. Histologically identical with polypi, they are restricted in their growth by the limited space in which they develop and are not so œdematous as polypi.

The removal of a polypus is an easy matter, and is most effectively accomplished with a polypus snare—the pistol grip snare being preferred. A rather large loop is used, and the polypus is cut through with the snare wire. Others are then surrounded with the snare wire by carrying it as far upward toward the bases of the growths upon the middle turbinate body as possible. Hæmorrhage is generally slight and the pain is not severe. After the polypi are removed the parts are dusted with an antiseptic powder of aristol and bismuth. It must be remembered that as polypoid hypertrophy affects the entire thickness of the mucous membrane, as well as the periosteum covering the turbinate bodies, its removal with the snare does not prevent recurrence. The operation for the removal of nasal polypi is never complete until the mucous membrane of the region from which they develop has been very thoroughly cauterized or curetted, or amputated by one of the turbinectomy operations already described.

The operator must always remember the possible association with sinus disease, and after the polypi are removed the sinuses should be investigated. Polypoid hypertrophies—that is, masses of hypertrophy with sufficient œdema to form small tumors with broad bases—must be treated by the removal of the mucous membrane and part of the bony tissue, after one of the methods of turbinectomy already described. The rapid recurrence of nasal polypi in the absence of accessory sinus disease leads to the suspicion of malignancy.

8. DISEASES OF THE NASO-PHARYNX.

Congenital Closure of the Posterior Nasal Opening.—This rare occurrence may involve one or both sides. If unilateral, it frequently escapes detection, the patient respiring through the free side. If bilateral it is diagnosed earlier. The closure may be complete or partial. It may be suspected in infants who are mouth breathers, when no adenoids are found and the cause of obstruction is not revealed by anterior examination. In young adults the rhinoscopic mirror reveals the closure. The diagnosis is also made by passing a sound into the nose, or by blowing into the nostril with a Politzer bag. The finger introduced into the posterior choanæ will discover the stenosed area. This condition must be suspected in children who are unable to breathe through the nose after adenoids have been removed. It will be confirmed by the examining finger placed in the naso-pharynx and forced forward toward the choanæ.

Treatment.—This consists in breaking down the partition, if bony, with a chisel or drill; if soft tissue, by any perforating instrument. When the stenosis is membranous it may be broken down with a knife or galvano-cautery. A rubber tube of the largest calibre which will enter the nostril should be inserted, and worn until complete cicatrization occurs. It should be removed daily and cleansed, and the nostril douched and covered with an antiseptic powder. The tube must be placed at the location of the former stricture to prevent it from re-forming.

Acute Inflammation of the Naso-pharynx.—Acute catarrhal inflammation of the naso-pharynx often accompanies rhinitis but may exist as an independent condition. The swelling affects the adenoid tissue, and the entire mucous membrane of the naso-pharynx. This catarrhal condition subsides very readily under the use of nitrate of silver, 5 grains to the ounce, or tannic acid, 10 grains to the ounce. It runs a self-limited course and is of no importance unless there is a tendency to inflammation of the Eustachian tube.

Abscess of the Naso-Pharynx.—Purulent inflammation of the naso-pharynx is not of frequent occurrence. When present, it involves the entire mucous membrane of the naso-pharynx. The inflammation may be caused by streptococcic infection.

The symptoms are fever, chill, nasal obstruction, swelling, intense redness, and oedema of the naso-pharynx. There is frequently a discharge which may dry and form scabs. The abscess will either rupture spontaneously and discharge through the nose or pharynx, or it will burrow between the mucous membrane and the fibrous tissue of the neck and appear in the lower part of the pharynx. Sometimes it produces an oedema of the larynx.

Treatment.—As soon as the diagnosis has been made the abscess should be incised and the pus evacuated. Ice should be applied to the neck, the patient put on liquid diet, and the general symptoms combated by tonic treatment and alcohol stimulation.

Erysipelas is occasionally seen in the naso-pharynx. The diagnosis is not generally made till after the lesion has spread to the mouth of the nose. It appears on one side and slowly extends, involving the soft palate, pharyngeal walls, nose, mucous membrane of the mouth, and sometimes the larynx and finally the skin of the face. The treatment is symptomatic and stimulating. (See Erysipelas of the Auricle.)

Chronic Inflammation of the Naso-pharynx.—This is almost always associated with the same condition in the nose, or follows hypertrophic or atrophic lesions of that organ. The symptoms are difficulty in prolonged speaking, and pain or soreness in swallowing. The pharynx is very dry and is covered with secretion or scabs. Sometimes the mucous follicles of the naso-pharynx are hypertrophied and appear as minute papillary enlargements on the mucous membrane. In atrophic forms the mucous membrane is dry, dilated blood-vessels course over its surface, and in places it is devoid of epithelium. Attempts to remove the scabs by hawking frequently result in vomiting. Cough is a frequent and persistent symptom.

Treatment.—This disease will generally be found associated with atrophic and hypertrophic conditions of the nasal mucous membrane, and attention should be directed to the nasal condition. If this is neglected no result may be expected. Treatment of the catarrhal naso-pharyngitis is absolutely useless unless the nose is restored to a fairly normal physiological condition. Tannin and glycerine solutions, nitrate of silver, 4 or 6 per cent and iodine and glycerine used as Mandel's solution, are useful to relieve the symptoms, but are not curative. If the mucous follicles are enlarged, the galvano-cautery will reduce them. In atrophic naso-pharyngitis the atrophic nasal condition should receive attention, and the naso-pharynx be treated with applications of ichthyol and glycerine.

Chronic Inflammation of Luschka's Crypt.—This disease was first described by Tornwaldt, and has since been observed by many others. It is an inflammation of the pharyngeal bursa which lies beneath the adenoid tonsil at the roof of the naso-pharynx. The symptoms are the discharge of quantities of mucus or muco-purulent secretion from the mouth of the crypt, located in the median line of the naso-pharynx. If a probe is introduced into the crypt, either from the nose or the pharynx, it will enter $\frac{1}{4}$ or $\frac{3}{4}$ of an inch, will move about in the crypt cavity freely, and will dislodge any secretion retained there. The symptoms are similar to those of chronic naso-pharyngitis, of which this is only a form. Occipital headache is also frequently present.

Treatment.—The electro-cautery may be used to destroy the secreting lining of the crypt, or it may be removed by a sharp curette. Solutions of the mineral astringents—silver nitrate, 3 grains to the ounce; chloride of zinc, 3 grains to the ounce—may be applied until the parts thoroughly granulate and cicatrize.

Tuberculosis of the Naso-Pharynx.—The naso-pharynx is more often infected by tuberculosis than the nose, and less often than the pharynx. It is generally associated with pharyngeal ulceration of a tubercular nature, and is never diagnosed before the ulcerative stage. The tuberculous ulcer in this locality has the same characteristics as elsewhere. It is often single, the edges are irregular and broken down, and it is covered with purulent secretion.

The Symptoms are pain in the ear, which is increased by swallowing; sometimes occipital pain is present; and there is hæmorrhage from the ulcerated surface. The other symptoms are those of general tuberculosis. The ulcers are treated by curettage, application of the electric cautery, of creosote, of fused nitrate of silver, or lactic acid, c. p. The general condition is also treated by the usual methods.

Syphilis of the Naso-Pharynx may express itself as an initial lesion, in which case it is usually due to infected instruments, especially Eustachian catheters. Secondary syphilis is sometimes seen in this region. Tertiary syphilis is the most frequent form. The place of election of the tertiary syphilitic ulcer is the upper surface of the soft palate and the roof of the naso-pharynx near the posterior edge of the nasal septum. The ulcer may exist as a tertiary ulceration, or follow the breaking down of a gumma. Perforation of the soft palate often results, and in some cases the roof or posterior surface of the naso-pharynx may ulcerate so deeply that bone is exposed.

Diagnosis.—When an ulceration is seen in the naso-pharynx—fairly superficial in character—in patients who are not tuberculous, the diagnosis of syphilis should be made and the patient put on the test treatment. It is impossible to describe a characteristic ulceration, since syphilis in this position manifests itself in many forms. The test treatment consists in the administration of mercury or potassium iodide in increasing doses to the point of toleration, or until the ulcer disappears. Treatment should be continued for a long time if the diagnosis is confirmed.

Local Treatment.—This consists in keeping the ulcer clean with one of the alkaline antiseptic solutions, after which the cautery, nitrate of silver, or a solution of acid nitrate of mercury, or carbolic acid c. p. may be applied. Iodoform in solution or as a powder stimulates healing. The process of healing of syphilitic ulcers frequently results in adhesions of the soft palate and pharyngeal wall, resulting in disturbances in the Eustachian tube, interference with nasal breathing and alteration of the voice.

Rhinoscleroma of the Naso-Pharnyx is a condition rarely found in this country, but observed in Russia and Austria. Its lesion is similar to the tertiary syphilis. The diagnosis can only be made from syphilis by microscopical examination of pieces of removed tissue, the demonstration of the bacillus of Rhinoscleroma, its slow extension, and its resistance to syphilitic treatment.

Hypertrophy of the Pharyngeal Tonsil; Adenoids in the Naso-Pharynx.—In the naso-pharynx there exists from birth a lymphoid tissue similar in structure to the faucial tonsils, and called adenoid tissue. This is apt to hypertrophy in early life upon the least irritation and causes characteristic symptoms. Adenoid tissue is located in the roof of the pharynx, just posterior to the fibrous band separating the nose and naso-pharynx. In front of this line it never develops although when enlarged the mass may push forward beyond this point. It may develop downward on the pharynx wall, and is sometimes continuous with a lymphoid hypertrophy along the lateral wall of the pharynx, extending to the oral tonsils. It may enlarge laterally and block the openings of the Eustachian tube. There are two forms: (1) masses of soft pinkish tissue completely or partially filling the naso-pharynx—if large, they may be seen through the nose or behind the uvula. (2) Enlargement of single adenoid follicles scattered over the naso-pharyngeal wall, and extending down on the pharynx wall. Adenoid tissue is most common in childhood. It occurs most often between the fifth and tenth years; from ten to sixteen years it is observed less frequently and after the sixteenth year it is seldom seen, although it has been observed in adults as late as the forty-fifth year. Spontaneous disappearance occurs through cessation of round-celled proliferation, and by shrinking of fibrous connective tissue. In cases of spontaneous cure adhesions always result. These resemble the chordæ tendinae of the heart and are formed near the nasal septum and around the Eustachian tube.

Cause.—Enlargement of the adenoid tissue is caused by any irritation which may affect the naso-pharynx, and conditions undermining the health, such as scrofula, anæmia, measles, scarlet fever, whooping-cough, diphtheria, and exposure to cold.

Symptoms.—There is a discharge of a considerable quantity of mucus, with frequent nasal hæmorrhage, some debility, and interference with general nutrition.

The location of the growth produces nasal obstruction, mouth breathing, and snoring. The most important symptom is interference with the functions of the middle ear, for the growth may produce obstruction of the Eustachian tube and inflammation of the middle ear. Difficulty in hearing is present in a large percentage of cases. These symptoms are apt to decrease when the growth is not especially congested, and become aggravated if congestion reappears. Remote symptoms from adenoids are gastric disturbances due to swallowing large quantities of mucus, bronchitis, asthma, aphonia, and laryngitis, restlessness, insomnia, sweating, and frequent micturation. Disturbances of mental development often result. Deformities of the hard palate, irregular development of the teeth in the upper jaw, a symmetrical development of the bones of the face and of the internal nose are also caused by this condition.

Diagnosis.—Adenoids may be diagnosticated in children, without posterior examination. If there is nasal obstruction without any visible cause on anterior examination, no enlargement of the tonsils or obstruction of the pharynx, then the only locality where the obstruction can exist is in the naso-pharynx. Here obstruction in childhood can only result from a sarcoma,—which is extremely rare,—foreign bodies, or adenoids. In nine hundred and ninety-nine cases out of a thousand a child suffering over an extended period from mouth breathing, restlessness at night, and discharge from the nose—where there are no enlarged tonsils or apparent nasal lesion—has adenoids. All that is required to establish the diagnosis is to pass the finger behind the uvula into the nose pharynx. Here it will encounter the soft protuberant mass more or less filling the naso-pharyngeal space. Adenoids may exist as scattered follicles or as a large mass extending to the choana. In some patients it is possible to see the end of the growth with a mirror by posterior rhinoscopy, or without the mirror when the adenoids extend far down into the pharynx; they may also be seen by anterior rhinoscopy in case the turbinates are atrophied. Palpation, however, is the surest method of diagnosis.

The operator should introduce the mouth gag before the finger enters the mouth, otherwise the child may bite it. In cases of frightened nervous children, it is better to make the diagnosis by exclusion, without examination, or to make the examination under anæsthesia, using nitrous oxide.

Treatment.—The only satisfactory treatment is operative removal.

Operation for the Removal of Adenoid Tissue; Preparation of the Patient.—The mouth should be washed with an antiseptic solution, the pharynx cleansed by a gargle or with the douche, and the nose washed out, to render the field of operation as clean as possible. This should be done an hour before the operation. A weak solution of Listerine, borolyptol, boric acid, or normal salt solution may be used for cleansing. The operation should never be undertaken without proper aseptic preparation, as cases of sepsis, tuberculosis, and syphilis have been recorded, resulting from improperly cleaned instruments.

No operation for adenoids should be undertaken without complete narcosis, unless there is some direct contraindication to its use. This is not always the rule in hospital and dispensary practice, but without general anæsthesis such operations cannot be properly performed. An exception may be made in the case of grown persons, where satisfactory operations may be performed under cocaine. Recurrences are more apt to take place when an anæsthetic is not used. The preparation of the patient for the anæsthetic has been fully described on page 471. Nitrous oxide is undoubtedly the most satisfactory anæsthetic, the unconscious period lasting long enough for a quick and skillful operator to do his work. Ether can be used when more time is required. Just before operation, the adenoids should

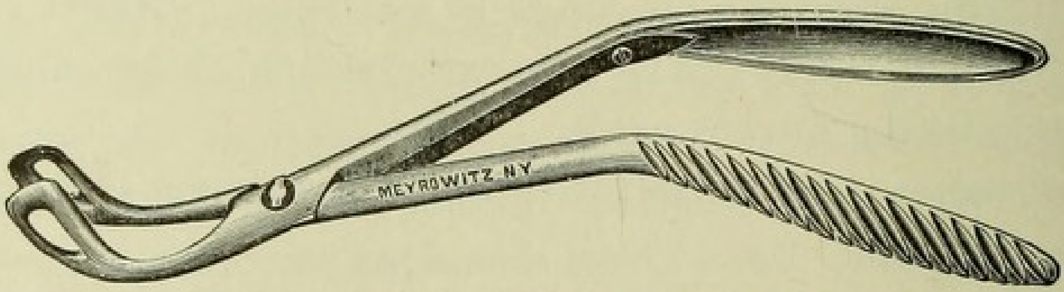

Fig. 55.—Brandagee Adenoid Currette.

be painted or injected with a 1 to 1000 solution of adrenalin chloride in order to lessen the hæmorrhage at operation.

Operation.—The patient being anæsthetized and in the recumbent or sitting posture, the growth may be removed either by the forceps or curette, or by the use of both.

Forceps Operation.—There are many forceps for this purpose. The authors prefer the Brandagee, and next the Jurasz form. The head may either hang over the table—claimed by some operators preferable—or rest on a low pillow. The mouth is opened and an O'Dwyer mouth gag inserted. If enlarged tonsils are present they should be removed. The forceps with the blades closed are then introduced through the mouth as far as the posterior pharyngeal wall. Then the finger should draw forward the soft palate and the blades of the forceps are placed behind the uvula and pressed upward to the roof of the naso-pharynx. In this position they should be opened and *not closed until the handle of the instrument is placed against the upper teeth.* This rotates the blades away from the nasal septum and avoids wounding it. The forceps may now be closed upon the growth and a few firm twists—first to one side and then to the other—will free the adenoids. The forceps may be introduced in the same way several times until no more growth engages in the instrument.

Dangers of the Adenoid Forceps.—In the hands of practised operators there is no danger of catching the posterior end of the septum. In the hands of the beginner, there is an added danger of catching the soft palate. In the haste and excitement incident to operation, the beginner not infrequently catches the soft palate and thinking it is the adenoid tissue brings away more or less of the structure. We have seen in consultation cases in which three-fourths of the soft palate was removed, and several other cases where perforation of the palate resulted. This unfortunate accident may be avoided by not closing the blades till the operator has satisfied himself by careful digital examination, and by elevating the handles of the instrument against the upper teeth, that he has only the growth between the blades. Sometimes even experienced operators will seize the posterior end of the nasal septum and tear away the posterior edge of the vomer. This is not such a serious matter, but may be guarded against as follows: After the forceps are introduced and the uvula freed, the blades should be opened and allowed to enter the adenoid growth by pushing the open blades upward. In this position the handles of the instrument lie against the lower teeth. The instrument is not closed in this position, *but the blades are rotated posteriorly by raising the handles till they rest against the upper teeth.* By this rotation the nasal septum, if previously engaged, is freed, and when the blades are in this position they may be closed.

Operation with the Curette.—The original Gottstein model, of which there are four different sizes, is for the beginner the best and safest instrument with which to remove these growths. The dangers of the forceps operation are not present here. The curette may be used to remove the entire growth, but most often is used as an adjunct to the forceps. The patient is prepared and placed in the same position as for the forceps operation. The curette is passed behind the uvula and its handle should lie against the lower teeth. In this position it should be pressed upward and backward with a pressure equal to that required to move a weight of ten pounds. Then with a strong sweep of the curette backward and downward along the dome and posterior wall of the naso-pharynx a large mass of the adenoid tissue will be removed. Care must be taken that this tissue is not inspired by the patient. The curette should then be reintroduced and the entire surface of the naso-pharynx scraped. The hæmorrhage is sometimes quite marked in this operation, but is easily controlled by a syringeful of equal parts of hydrogen peroxide and water, injected through the nose.

Accidents may arise during the operation from difficulty with the anæsthetic, inspiration of tissue or blood, and from hæmorrhage. The dangers from the anæsthetic are increased in adenoid cases. The mouth should always be propped open with a gag to facilitate breathing, or the tongue pulled well forward. Inspired bits of tissue or blood are dangerous, and sometimes prove immediately fatal. A tracheotomy tube should always be at hand. Clots and bits of tissue drawn into the respiratory tubes may set up a septic inflammation, septic pneumonia, or gangrene of the lung. This may be prevented by allowing the head to hang over the edge of the table, although this position increases the danger of hæmorrhage to such an extent that it is of doubtful benefit. In case clots of blood are inhaled, it is necessary to stop operating immediately and clear the trachea and larynx. This is best accomplished by the method known as "stripping the larynx." It consists of grasping the trachea between the fingers near the sterum and pressing upon it so as to force its contents into the larynx by a continuous stripping motion upward. This should be continued after the foreign body has reached the larynx, when by compression at this point the body will often be forcibly expelled into the mouth. In case this is not immediately successful, the patient should be raised by the heels, the head pendant, and jolted while an assistant strips the larynx. If this fails, tracheotomy must be performed.

The danger from hæmorrhage is considerable. In all cases where the operation is properly done there is much loss of blood. Considerable blood is swallowed during the operation, even with the head hanging over the table, and after operation patients are apt to vomit more or less dark-colored, partly digested blood. The excessive loss of blood is preceded by symptoms of shock and cardiac depression. The danger of hæmorrhage immediately after operation is great. If children are left lying upon the back they constantly swallow blood unobserved until they suddenly develop evidences of acute anæmia and collapse, or else they will vomit large quantities of blood. This should be guarded against by laying the child, after operation, upon its face, when any escaping blood will make its appearance on the pillow. When hæmorrhage after operation persists, the nose and throat may be filled with hydrogen peroxide solution, which will usually control it. When this is not successful, the naso-pharynx should be packed with a cotton plug by the method known as "posterior nasal plugging."

The dangers after operation are hæmorrhage, sepsis and tubercular or syphilitic infection. In a few cases death from hæmorrhage has been reported, but such cases were not properly watched, or were in children of hæmorrhagic diathesis. The methods of avoiding and treating the hæmorrhage have been described above. In addition to the modes above mentioned, adrenalin chloride, 1 to 1,000, may be employed. In cases of hæmorrhagic diathesis it is sometimes difficult to check the hæmorrhage even with the posterior plug. If the patient has become so exsanguinated as to produce symptoms of acute anæmia, rectal injections of saline solution, or even transfusion, should be employed, and the heart sustained with whisky and strychnine. In a few cases, secondary hæmorrhage may appear two or three days after operation. In such cases it is almost always produced by sloughing of the soft parts. This should be regarded as a septic complication. Removal of the sloughing or hæmorrhagic area by gentle curettage will check the hæmorrhage.

Sepsis rarely develops after adenoid operation if care is observed in the sterilization of instruments and the field of operation. The drainage in this locality is perfect, and this alone is a sufficient safeguard against sepsis. In a few instances where infection occurs it produces fever and chilly sensations with soreness of the posterior pharyngeal wall, and occasionally enlargement of the cervical glands. A more serious complication is the extension of sepsis to the Eustachian tube causing suppurative middle ear inflammation. Increase in temperature following an adenoid operation need not always be regarded as septic, since malaria very often affects patients after this operation. In such instances malarial treatment will cure the febrile condition. The diagnosis is made by the temperature curve. Cases where the end of the bony septum has been lacerated will sometimes be followed by sepsis. This subsides in a few days without serious consequences.

Cases of tubercular and syphilitic infection have been reported, and they occur with sufficient frequency to call for the greatest care in regard to sterilization. The follicular tonsillitis which sometimes occurs several days after the operation is to be looked upon as septic, and the tonsil should be treated with a strong solution of silver nitrate, the throat being irrigated with saline solution.

Hypertrophy of the Faucial Tonsils.—This very common affection of the throat is so well known and so easily distinguished that a description of its features seems superfluous. It is usually associated with hypertrophy of other parts of the lymphoid ring. In young children it is associated with adenoids; in adults, with hypertrophy of the lingual tonsil, while in late childhood and young adult life it frequently exists as an independent lesion. It exerts a detrimental influence upon the ear indirectly by interference with proper pharyngeal circulation. This produces a chronic congestion of the tube; and by interference with ventilation in the middle ear sooner or later establishes a chronic otitis media.

Diagnosis.—The detection of this condition is so easy that the diagnosis is often made by members of the family who consult the physician for enlarged tonsils. There is only one class of cases in which the diagnosis is not so simple. Usually the enlarged tonsils project into the pharyngeal space from behind the pillars of the fauces as bilateral smooth rounded swellings. Sometimes they are so enlarged as to meet in the median line; at other times they project only slightly from the pillars of the fauces. There is, however, a form of hypertrophy of the tonsil which is not evident. This occurs when the anterior pillar becomes adherent to the tonsillar surface, and as the tonsil enlarges it drags the pillar with it toward the median line. Thus the enlarged tonsil continues hidden behind the stretched pillar and escapes observation unless during the examination the patient makes a movement of swallowing. Then the lateral pharyngeal walls press the tonsil toward the median line and reveal the hypertrophy.

Treatment.—When the tonsils are an element in the production of aural disturbance they must be removed. The best method of treatment is undoubtedly amputation. This is performed with any of the well-known tonsillotomes, of which the Mattieu is perhaps the best form. The tonsil is cocainized, or a general anæsthetic is administered, the tongue is depressed and the ring of the circular knife placed over the hypertrophied tonsil, care being taken to include within it that part of the tonsil nearest the tongue. The instrument is then firmly pressed against the lateral pharyngeal walls, while counter pressure is made by an assistant under the angle of the growth. When the knife completely surrounds the growth the tonsil is cut through. This is repeated on the other side if necessary.

Dangers.—There is danger that the amputated mass may be drawn into the larynx by the patient if it slips from the prongs of the instrument. Should this occur, the finger is introduced into the pharynx and the loosened piece thrown forward over the tongue, when it can be easily secured and removed. Excessive hæmorrhage is feared by many operators, but as a matter of fact it rarely occurs, and then is easily controlled by proper methods. If the tonsillar artery is spurting it should be seized with a pair of long arterial clamps, which should include beside the vessel a small part of the tonsillar tissue. If the instrument is then twisted the vessel will be closed and the instrument may be removed, after a few moments. If capillary hæmorrhage persists for hours after the tonsil has been removed, steps should be taken to control it. The bleeding surface should be carefully sought and dried. It should then be cauterized with the galvano-cautery. If this does not control the bleeding, it will be necessary to pass a properly shaped needle threaded with silk through the posterior faucial pillar, through the base of the tonsil, and then through the anterior faucial pillar. Two or three such sutures should be used. When they are tied, the cut surface of the tonsil will fold upon itself so that the hæmorrhage will be checked by the pressure of its own surface.

Cautery.—The hypertrophied tonsil may be reduced with the electro-cautery when it is deemed inadvisable to amputate it. After thorough cocainization the tongue is depressed and the surface of the tonsil is exposed. Three deep horizontal furrows are then burned into the tonsillar surface. The sloughing which subsequently results destroys the greater part of the mass of the tonsil. If necessary, the cauterization may be repeated. By this treatment, all danger of hæmorrhage is avoided, but the healing is slow and there is often considerable reaction.

CHAPTER IX.

ACUTE CATARRHAL INFLAMMATION OF THE MIDDLE EAR.

ACUTE catarrh of the middle ear is a very common disease in the northern part of this country, and in all climates with severe winters. Examination shows that there is rarely a grown person who has not, at one time or another, suffered from what is called *earache*. Earache generally means acute catarrh of the middle ear. Sometimes, it is true, pain in the ear is of a purely neuralgic character, dependent upon neuritis, diseased teeth, or the like, and occasionally, furuncle of the auditory canal occurs and when it does it generally causes severe pain. But, as has been stated, an acute catarrh of the middle ear is the usual cause of severe earache.

The reports of aural institutions show that comparatively few cases of aural disease reach the clinics during the acute stage. The general public, although somewhat awake to the subject of the importance of aural disease, does not, as yet, consider earache as one of the things that require the prompt attention of a physician, and very often, what is called " home treatment," is adopted, —a treatment which is very inadequate—until the disease has advanced to be a dangerous affection, in other words, acute suppuration. Indeed, when a general practitioner is visiting a family, some of the members of which are ill, it is sometimes incidentally mentioned that one of the children has had a severe earache all night, and that there has been great difficulty in quieting the pain. In some quarters, at least, even if the pain is not then subdued, and the family have exhausted the means at their disposal for relieving it—taught by tradition and experience—they do not expect anything from the physician, although they immediately seek his aid for pains very much less severe, occurring in other parts of the body.

Practitioners of medicine should labor in the direction of instructing their patients as to the danger of acute *otitis catarrhalis media,* and not stand helplessly by, and allow it to go on to purulent infection, with periostitis of the mastoid, meningitis or infection of a venous sinus and death. The means for the treatment and relief of this affection are ample, and when properly employed, they have, what may almost be termed, a brilliant effect. At the outset of this discussion we desire to impress the fact upon the minds of our readers, that the often neglected earache, so familiar in a household with children, is actually an acute infection of the middle ear.

Symptoms.—First, pain, referred to the depth of the ear, or of a neuralgic and slightly intermittent character, passing from the throat to the ear.

Second, a sense of fulness in the ear.

Third, tinnitus aurium.

Fourth, an unnaturally hollow sound of one's own voice (autophony).

Objective.—First, vascular injection of the drumhead.

Second, bulging outward of this membrane.

Third, impairment of hearing.

Fourth, catarrh of the naso-pharynx.

Fifth, increase of the general temperature of the body.

Pain is very often the first symptom that is observed. Children old enough to speak awake from sleep crying, "My ear, my ear." Adults find themselves without warning, attacked by a pain which may cause the most intense agony—a pain which forces the strongest men to shriek and tremble, while children affected with such a disease soon cause the attendants to believe that the brain must be the seat of the trouble. Sometimes, however, patients with good habits of observation notice that the pharynx feels thickened and full, and that the throat is sore, a short time before the pain in the ear begins. Most patients are aware of what, for the want of a better name, may be termed a thickness of hearing, a fulness in the ears, before the attack of pain occurs. This pain is described by some patients as beginning in the throat and crawling along the Eustachian tube. It is a disease, however, which may be said to be sudden in its origin, and one which jumps at a bound to its height. It will pass over the acme, in most cases, unless at once arrested, into acute suppuration of the middle ear; a disease which some practitioners seem to invite, judging from the expression formerly very often heard. "It is a gathering of the ear, from which we shall get no relief until suppuration is established." This is certainly an erroneous and mischievous view of a serious disease.

The sensation of fulness, the noises in the ear in acute inflammation, are very distressing. The latter symptom, the technical *tinnitus aurium*, usually lessens and changes its character with a cessation of the pain. It changes from a puffing sound, like the puff of a miniature steam-engine, to a ringing or buzzing sensation. The feeling of fulness usually lasts for some days after the pain has passed away.

The early diagnosis of this disease is often difficult in young children, because they are unable to locate the seat of the pain in words. If, however, we watch a child carefully who is suffering from pain, we can usually narrow it down to the region of the head. Then by means of pressure upon the tragus, observing if the child winces at this, we can generally form a conclusion as to the origin of the pain. The disease with which infantile catarrh of the middle ear is apt to be confounded is an affection of the membranes of the brain. When we remember the anatomy of the ear, especially that of the tympanic cavity, we can readily appreciate the fact that an acute inflammation of the middle ear may easily cause hyperæmia of the membranes of the brain through the roof of the tympanic cavity, or of the labyrinth, through the fenestræ of the thin wall separating the tympanum from the cochlea and semicircular canals. When we also consider, as shown by Politzer, that the vascular communication is direct, through vessels situated in this partition, we are not surprised that a congestion or inflammation of the middle ear, especially in infants and young children, may cause very serious head symptoms. The physiological process of teething, is often credited with a great deal of pain, which more properly belongs to the ear. The diagnosis of difficult dentition, is often sufficient to cover a multitude of painful symptoms. Accordingly, gums are needlessly lanced, and dangerous delays are allowed, until a discharge of pus through the drum-head makes the diagnosis for the little sufferer.

Pouring warm water into the auditory canal will usually temporarily relieve an infantile earache; and in this procedure we have a means of diagnosis which is always at hand. Children who are crying with pain from inflammation of the middle ear will go to sleep in a few moments after warm water has been poured into the canal, or from breathing into the meatus. Sometimes, however, this latter procedure will fail to give relief, but the free use of hot water usually will. If not a paracentesis of the drum-head should be performed.

Catarrhal Inflammation Mistaken for Neuralgia.—Adults sometimes mistake the pain from inflammation of the lining membrane of the middle ear, for what is termed neuralgia. Cases are seen where an anti-neuralgic treatment by means of quinine and opium, had been tried in vain for a disease which was really an inflammation of the mucous membrane; but adults usually locate the seat of trouble with exactness and accuracy. The pain is indeed neuralgic, and a moment's consideration of the rich supply of nerves to the cavity of the tympanum, will give the reason for the fact that the pain follows the course of the fifth nerve. This mistake in diagnosis is very similar to the one made when acute glaucoma is thought to be neuralgia. Neuralgia of the tympanic cavity is a very rare affection. When it does occur, the absence of the symptoms of inflammation will indicate the true diagnosis.

The objective symptoms are chiefly to be sought in the membrana tympani. There is sometimes a pinkish hue to the whole membrane, again the vascular injection is around the periphery of the drum-head, and along the handle of the malleus, while the other parts of the membrane remain normal in color. An acute inflammation occurring in a drum membrane rigid, thickened, and opaque from former inflammation, is more apt to show localized redness than the diffuse pinkish tint that is seen when inflammation occurs in a membrane that has been previously healthy. At other times the redness is so intense as almost to prevent any recognition of the drum-head, except as an evenly red surface in which no vessels can be traced. There is always an increased vascularity of this membrane, in every case of acute inflammation of the lining of the tube and the cavity of the tympanum, so that we may find in this symptom the deciding point in doubtful cases, even in an infant. The membrane has, however, at times the appearance of glass that has been breathed upon, without any evident increase in vascularity, even where there is acute inflammation going on in the middle ear.

The Hearing.—The impairment of hearing is not always marked in the stage of pain. The hearing power may even be augmented and be painfully acute during the first stage of the disease. In cases of chronic aural catarrh, in which an acute inflammation had supervened, many instances are known where the acuteness of hearing was found on accurate examination to be markedly increased. It may be increased also in acute cases occurring in persons whose ears had been previously healthy; that is to say, sounds may seem very loud to them. In such cases there may be hyperæmia of the vestibule or cochlea, besides that of the tympanum.

Bulging of Membrana Tympani.—Bulging outward of the membrana tympani is a symptom that may often be observed after the first forty-eight hours of an attack of acute catarrh. If the disease continue longer in an acute form, spontaneous perforation is apt to, but does not always occur. This bulging outward is most frequently observed in the posterior and inferior quadrant, but it is also found in Shrapnell's membrane, and usually in the posterior portion of this membrane. It is sufficiently marked to be detected by any one who is at all familiar with the examination of the normal membrane. In rare cases the imperforate membrana tympani will be found to pulsate synchronously with the pulsation of the heart. As is well known, it is quite common to observe a pulsation of the vessels of the cavity of the tympanum in cases of acute and chronic suppuration of this part, but pulsation of the imperforate membrana tympani is a rare symptom. There must be great increase of the tension of the membrane from the pressure of the blood column or of mucus behind it when this occurs. Increased secretion from the pharynx and region of the posterior nares is almost always observed in cases of acute catarrh; but it requires but a mere mention at this point.

The Temperature.—The temperature is usually considerably increased in a severe case, so that the general aspect of the patient, suffering from severe local pain, impairment of hearing, and a dry, heated skin, is one of intense suffering. Yet this is the disease which is often allowed to run its course, without any of the antiphlogistic treatment that would at once be resorted to were any other organ of the body similarly attacked. In completing this description, it should also be said, that there are cases of acute catarrh of the middle ear in adults as well as in children, where while the symptoms of impairment of hearing, a sense of stuffiness in the head, redness and bulging of the drum-head, a peculiar hollow sound of one's own voice, are marked, there is no considerable pain, or if there has been, it has passed away before the physician has reached the patient. These, however, are exceptional cases.

Causes.—The causes of this disease are manifold. Any undue exposure to the influence of cold may produce acute catarrh of the middle ear. Getting the feet wet, the surface of the body chilled by standing or walking in the cold, are frequent causes of earache. A draught of air blowing, for instance, through the window of a railway carriage in rapid motion, is sometimes a cause of acute catarrh. Ducking the head under water, and allowing the water that enters the auditory canal to remain there, is another cause.

Surf-bathing, especially in those people who habitually suffer from catarrh of the nares and pharynx, thus may become a cause of acute inflammation of the middle ear, as well as of the auditory canal. The salt-water may enter the nostrils and Eustachian tube and cause the disease, or a wave may deluge the auditory canal and injure the drum-head, and thus affect the middle ear. Yet, considering the great extent to which surf-bathing is practised in our country, the number of cases of inflammation of the ear caused by it is very small. The cases of disease of the ear caused by it, occur chiefly among careless and ignorant bathers, or in those who already suffer from chronic aural or naso-pharyngeal disease. Prolonged bathing and diving in still water, are much more apt to cause congestion of the middle ear than surf-bathing. Many cases of aural disease are said by those who suffer from them to have originated in the following way. "I got my ears full of water and never could get it out," is the fanciful statement of patients who mistake the feeling of fulness in an inflamed middle ear, for that from water remaining in it. Surf-bathing is of such value as a tonic to many debilitated systems that it may be advised even to patients with aural disease, under proper precautions. These are:

1. Take a bath of not more than five or ten minutes in duration.
2. If the ears are affected by chronic suppuration, close the meatus with cotton.
3. Never allow a wave to strike the side of the head.
4. Indulge very sparingly, if at all, in swimming or diving through the breakers.

Constitutional diseases, such as small-pox, scarlet fever, and measles, in which the pharynx is affected, are very common sources of acute aural catarrh. Pneumonia and bronchitis very often have this affection as a complication. Coryza or cold in the head, however caused, very often gives rise to acute inflammation of the ear. It arises in the course of syphilitic affections of the pharynx and posterior nares; but, contrary to what has been said by some authors, no pathognomonic evidences of syphilis are seen in the character of the pain or the appearance of the membrana tympani in such cases. Cerebro-spinal meningitis is also a frequent source of acute inflammation of the middle ear.

The origin of acute catarrh is chiefly to be sought for in the faucial extremity of the Eustachian tube, and not in the auditory canal. This explains the fact, that it is much more important for patients liable to aural disease, to protect the external surface of the body and the extremities from the cold, than the meatus and auricle.

Yet it is not to be denied, that inflammation of the middle ear does occasionally extend from the canal, through the membrana tympani, and not through the Eustachian tube, for a draught of air upon the side of the head will produce acute aural catarrh, and if cold water enter the ear through the meatus externus, and remain for a considerable time, it may also produce acute catarrh of the middle ear. The use of the nasal douche for the treatment of naso-pharyngeal catarrh, may also produce acute inflammation of the ear, as was shown by the senior author of this volume.[1] His experience has since been confirmed by many other observers. Operations upon the nose are sometimes followed by an otitis media.

The occurrence of acute catarrh of the ear, in scarlatina, measles, naso-pharyngeal catarrh, and pneumonia, is favored by the formerly common practice of giving large, or comparatively large, doses of sulphate of quinine in these cases. This invaluable remedy should be given with great caution in these diseases, since the disposition to extension of the inflammation to the middle ear, exists strongly in all these constitutional

[1] *Archives of Ophthalmology and Otology*, vol. i, No. 1.

affections. Quinine is quite sure to aggravate aural symptoms, if they already exist, and in young children it may excite them. The writers have several times seen children suffering from acute aural catarrh, in whose ears the administration of quinine had, from the very first dose, steadily aggravated the pain, until the discharge of pus from the tympanic cavity explained the high temperature, which should have been combated by local antiphlogistic remedies, instead of by an *antipyretic.* What has been said of quinine refers also with equal force to the various drugs for reducing temperature—antipyrine, phenacetin, and so forth. Wintergreen and salicylic acid should be used with caution in cases with sensitive ears. Since influenza, *grippe,* has become so prevalent it has become a prolific cause of acute catarrh of the middle ear, with a decided tendency to a violent form of the disease.

Treatment.—The proper treatment of acute aural catarrh is predominantly an antiphlogistic one. The disease is an inflammation of the severest form, and can only be successfully combated by such means as local blood-letting, quiet, warmth, and opium. As has been said, a neuralgia of the middle ear, that is to say, pain without other symptoms of inflammation, is extremely rare, yet an inflammation of the middle ear is very often treated as would be a case of facial neuralgia; or we might even say, that the ordinary treatment for acute aural inflammation is preëminently empirical and without reason. From the time of the ancients down to our own day, all kinds of decoctions and mixtures have been poured into the ears to relieve earache. Some of these agents are of negative or slight value; many of them are of a positively harmful nature. To the former class belong such applications as sweet-oil and laudanum, glycerine, molasses, and so on. To the latter class belong Haarlem oil, Cologne water, ether, and all stimulating applications. Poultices are remedies often used; but while they sometimes quiet aural pain, their application is so dangerous to the integrity of the drum membrane, especially if they be used for many hours in succession, that the practitioner will do well to avoid them. The chief thing to be done in this disease is to decrease the heat, swelling, and vascularity of the parts. Applications of a stimulating nature, made to the membrana tympani, certainly cannot do this; and mere emollients, such as sweet-oil, have a very transitory effect.

Leeches.—Local blood-letting is the chief and first remedy in acute aural catarrh, in grown children or adults. This blood-letting should be performed by means of leeches applied to the tragus, and not to the mastoid process. Wilde and Tröltsch taught the profession years ago that this is the best point for the application of leeches in inflammation of the ears, and the reason therefor. At this point, the blood is most easily drawn from the cavity of the tympanum—the vessels supplying it, and the drum membrane, inosculating here. The application of from one to four leeches, according to the severity of the disease and the age of the patient, will usually be sufficient to quiet the most severe pain in the ear, and to check the intensest form of catarrhal inflammation. Almost magical effects occur from their use. A striking case is the following: The writer was called on a very severe winter's day to see a young gentleman in a neighboring city, who had been suffering for two days from acute pain referred to the ear. The symptoms of acute aural catarrh were found in a reddened but intact drum membrane, congested pharynx, and so forth. The patient seemed to be in a mortal agony. He said that he had not slept for forty-eight hours, and his anxious countenance verified his assertion. Leeches were obtained and one was applied to each ear, and before they had dropped from the tragus the patient was asleep, and went rapidly on to perfect recovery. Such cases might be multiplied, for they are of frequent occurrence in hospital and private practice, where leeches are used at an early stage. This is a condition for which paracentesis of the membrana tympani is often unnecessarily performed.

Leeches, are, however, a troublesome remedy, and in country districts they are not always to be had, although it is easy for any practitioner or druggist to keep them on hand. In their absence the use of warm water is next in efficiency. This should be poured continuously into the ear, and not used by means of a piston syringe, as patients sometimes adopt this method when told to pour warm water into the ear. The fountain syringe is the best means for applying warm water to the ear. Sometimes the warm water is unpleasant, instead of grateful, to the patient, and then if the patient does not soon become accustomed to it, the vapor of water or the smoke from a cigar or pipe may be conducted into the ear. Children may sometimes be relieved in the beginning of an attack of acute aural catarrh, by breathing into the affected ear for a very few minutes. If leeches cannot be had, and the use of warm water or of steam does not subdue the pain, cups—wet or dry—applied around the auricle, are sometimes of use, as well as blisters, or an artificial leech may be used. (Bacon.)

If the patient or his friends are told to apply leeches, the exact spot upon which they are to be placed should be marked with ink, or they will be put on the lobe, or on the neck, or in some other position where their use will

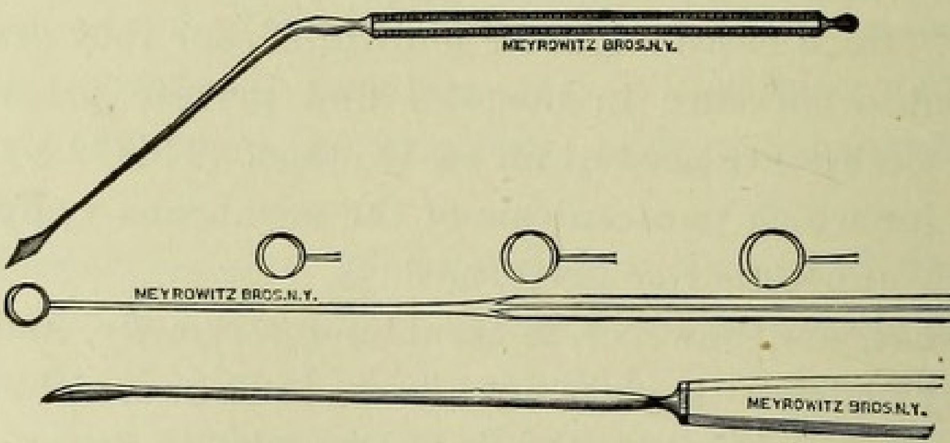

Fig. 56.—Paracentesis needles and Curette.

do no good. A neglect to state just where the leeches should be applied, sometimes causes the efforts to relieve pain to be of no value. The bleeding should usually be encouraged, by the use of warm compresses, for an hour after the leech has dropped from the ear.

Scarification of the drum-head, as recommended by Blake, is also of service in mild cases. It requires a much more practised hand for its performance, however, than a paracentesis. Paracentesis of the drum membrane is a very efficient remedy when there is bulging of the drum-head, and we see that perforation is imminent; or even in cases of prolonged pain without bulging of the membrane, when the leeches have been used at too late a period, or have proved ineffectual.

Schwartze taught us the value of this means of treatment in acute cases, and it is of great value. A cataract knife may be passed through the posterior portion of the membrana tympani, in any case, whether bulging was seen or not, when the use of leeches did not markedly diminish the severe pain within a few hours. Yet leeches and hot water, if properly used, will usually check the progress of even the severest case. Very often, however, we are not called until the disease has advanced so far as to involve every part of the middle ear, when periostitis of the mastoid has occurred, and suppuration seems to be inevitable.

Paracentesis of the membrana tympani should be performed while the head of the patient is well supported, and a good light is thrown upon the membrane by means of the otoscope attached to a forehead band. A needle, such as shown on the next page, may be used. An ordinary sharp cataract knife does very well. The point of opening should be determined by the seat of the greatest amount of bulging, which is generally in Shrapnell's membrane, or in the posterior and inferior quadrant of the membrane.

The instruments with an angular handle, are much less easily managed than the straight handled ones. This facility in use much more than completely balances any value from not shutting off the light from the canal, said to belong to the other instruments. A good electric light such as can be usually obtained in homes in large cities forms an excellent light for this operation. The operation when required causes so little pain and it is so brief, that this element does not enter into the consideration of the surgeon. The light of a candle is a good convenient source of illumination, when the operation is to be done in a sick-room, and the patient is in bed, or even better, one of the numerous electric headlights, or a 32 candle electric lamp. For acute cases a thorough incision, through which the blood, mucus, or pus can escape, is an opening large enough to relieve pain. The operation is seldom required in cases where the severity of the pain has passed.

The condition of the pharyngeal mucous membrane should at the same time be attended to, by means of gargles and external applications. A saturated solution of chlorate of potash forms one of the best of applications to the pharynx, while the neck should be enveloped in saturated solution of Acetico-tartrate of alum.

The Eustachian catheter and Politzer's method or the new method (with the double bag) of inflating the middle ear should be used as soon as the acute symptoms have subsided, say in forty-eight hours. If employed with gentleness, there need be no fear of aggravating the subdued inflammation into a relapse. Indeed, inflation often relieves pain by emptying and ventilating the tympanum. The dangers of infection of the tympanum by inflation are largely mythical.

We cannot be too much impressed with the fact that a neglected acute aural inflammation may lead, through suppuration of the middle ear, with all its consequences of caries, polypi, meningitis, cerebral abscess, pyæmia, to the most deplorable results. Better would it be for a child suffering from scarlet fever or measles to die from the disease, than to recover from the constitutional affection only to succumb, with great misery, to the effects of the neglected inflammation of the middle ear.

All cases of acute inflammation of the middle ear are serious. If the patients cannot provide an intelligent attendant in their own homes, they should be treated in a hospital. In the private family of the well-to-do, the services of a trained nurse should be secured.

A distinguished surgeon of New York, in a discussion upon the effects of scarlet fever and measles upon the ear, stated that while writers on aural surgery said much about the neglect of diseases of the ear, occurring during the course of the exanthemata, he had found no means of doing anything to prevent the breaking out of such disease while the measles or scarlet fever were going on, and he did not know, after all the warnings, that there was anything really to be done. Now, in answer to this, it may be said that it is not claimed that *otitis media* may be always averted in the course of scarlatina or rubeola, but sometimes, if the physician be on the lookout for it, it may be aborted, so to speak. If a child begin to toss its head about as if in pain, or if it becomes hard of hearing, the tragus may be at once examined to see if pressure upon it cause or increase pain, the drum-head may be looked at and a diagnosis made. If there be congestion of the ear, the warm douche will often relieve it at once. If not, we have blisters, leeches, and paracentesis of the membrana tympani. If, however, the attack cannot be aborted and goes on, certainly we may by these same means alleviate or stop the pain, and modify the course of the disease, so that recovery of the ear will usually go on step by step with the general convalescence, and the patient will not barely recover from the first, to suffer the horrors of the other. In cases of acute inflammation of the middle ear occurring in the course of the exanthemata, it is necessary that they receive the same treatment that is given when it occurs as a local affection.

The course of a case of acute catarrh, promptly treated in the manner that has been outlined, usually ends in complete recovery, with integrity of the structure and function of the ear. In less favorable cases suppuration occurs; but this is usually tractable, and even then the organ may be restored to complete usefulness. It is unfortunately true, however, that an acute catarrhal inflammation of the middle ear, even under judicious management, may in very rare instances go on to be a suppurative one, from which death may occur from extension of the inflammation to the brain. More will be said of this, however, in the chapter upon acute suppuration.

It is sometimes stated that the treatment as described in the preceding pages, is too heroic, and that milder means than leeches, paracentesis, may be employed, not only with safety, but with benefit to the patient. The use of leeches has been especially objected to, on account of the local irritation and even inflammation they are said to frequently cause. Paracentesis of the drum-head, it is said, is a dangerous operation, and often performed unnecessarily, and so forth. To all this, it may be said that *acute* catarrh, or acute suppuration of the middle ear, are serious and rapidly progressing diseases that admit of no temporizing, of no delays in active antiphlogistic treatment. We are not speaking of subacute inflammatory affections, of neuroses in hysterical and anæmic subjects, but of acute inflammation, with its pain and its possibilities of rapid advance from the tympanic cavity to the membranes of the brain, to the general circulation, or when its progress takes a more favorable turn, to the membrana tympani. To combat this disease, only local antiphlogistic treatment will be of avail. Those who wish to arrest pain quickly, to prevent dangerous consequences from an extension of an inflammatory process, will find the active treatment that has been here described will not disappoint their expectations. Some of the arguments against the means now in vogue among modern otologists have been based on the incorrect assumption that they are employed in mild cases when less active means will be more agreeable, and equally efficacious. But we have been careful, however, to show that local blood-letting, paracentesis, with confinement to a room, are to be employed in acute cases only. That an acute inflammation of the middle ear is a severe case, certainly no one will deny who has been called to treat it, or who has unfortunately experienced it.

While the treatment of Mastoiditis with all its consequences and sequences, has advanced materially in the last decade, the knowledge of the necessity of prompt and thorough-going treatment of acute aural catarrh has not kept pace with this progress. There are text-books with elaborate and correct descriptions of the method of operations upon the ear, that have no such description of the disease now under consideration as to form a guide for the general practitioner.

There is undoubtedly a natural course of diseases, which it is often better not to attempt to check; we believe in the *vis medicatrix naturae;* in the danger of doing too much for some cases, but the disease now under consideration is one which we believe can only be successfully combated by what are known as local antiphlogistic means, among which leeches and the warm douche, the so-called irrigation of the ear, take the first position.

SUBACUTE CATARRH OF THE MIDDLE EAR.

There is a variety of catarrh of the middle ear, very common in young persons and in children, although it also occurs in adults, which differs in so many respects from the ordinary type of acute catarrh, that it seems to require a more extended notice than the references that have been made to it in discussing the latter named affection. This affection may be termed *subacute catarrh of the middle ear.* It has many of the symptoms of the truly acute form. The absence of pain is the chief distinguishing mark by which it is separated from the latter form. Some authors, judging from their statistics, have classified it under the head of chronic aural catarrh. Others classify it among acute affections. While the former view may not be strictly incorrect—for the affection may last for months, and run into the strictly chronic form—it has more of the characteristics of acute catarrh in its nature, and in its readiness to yield to treatment, than of chronic inflammation.

We may justly draw a distinction between an acute and a subacute affection. If we do so, we shall be less likely to fall into the error of treating all recent cases of catarrh of the middle ear as vigorously as we do those that only differ from them in being attended by great pain and injection of the drum-head. Acute catarrh demands vigorous treatment, while the subacute form will get on very well with mild measures.

Symptoms.—The subjective symptoms of subacute catarrh of the middle ear may be stated as follows: It is observed that the patient, without suffering from pain in the ear, or if so, from pain that is not long continued, is very often so hard of hearing as not to hear ordinary conversation. Very little is thought of this by the friends of the patient, or perhaps by the medical adviser; but the trouble recurs, the attacks become more frequent, and the period of impairment of hearing more prolonged, so that school-life is seriously interrupted. The general health may, or may not, be impaired. Such cases may be seen in boys and girls in excellent general health, as well as in the delicate and strumous.

The objective symptoms are as follows: the pharynx is usually in a thickened or granular condition, the normal secretion is excessive, and it may be changed in quality, and be decidedly muco-purulent. The tonsils may or may not be hypertrophied. Adenoid growths in the naso-pharyngeal space are frequently found in this class of cases. The membrana tympani has lost its normal neutral gray color, and is of a pinkish hue. The vessels are not usually to be traced upon any part of it. It may be exceedingly brilliant. The light spot is usually absent, or is smaller than usual; a fact which shows that the drum-head is sunken inward. The hearing, as tested by the watch, is found to be very much impaired, and only such conversation as is addressed to the patient, with his face toward the speaker, is heard.

This impairment of hearing in children is very often attributed to "absent-mindedness" by parents, and to "stupidity" by teachers. Children are not usually absent-minded, and when they are stupid, there is always a cause, which should be traced out, and the poor child not treated as if it were responsible for the disease that has rendered it so. Again and again, will the practitioner find that he is obliged to correct the false ideas of parents and teachers, who do not know that children always prefer to hear, if they can. Malingering as to deafness is a deception which children rarely understand, and which they can never successfully maintain. A child that does not habitually answer at once when addressed, should be at once carefully examined as to its hearing power, before it is scolded for absent-mindedness.

Treatment.—It is often found to be the case, that proper hygienic rules have not been observed in the management of such young patients. They have been allowed to eat and drink food improper for growing persons; for example, tea and coffee, pastry, sweets, and so forth, to the greater or less exclusion of simpler and more nutritious substances, and thus a capricious state of the appetite has been induced. In the case of boys, frequent and prolonged bathing or swimming, of which ducking the head under water forms the chief part, is sometimes found to cause or increase the impairment of hearing. The regulation of the diet of such patients, the wearing of flannel next the skin, the abstaining from any habits which may be recognized as predisposing to inflammation of delicate structures, building up of the system by a proper therapeutic course, such as the exhibition of cod-liver oil and iron, with proper attention by the use of gargles to the mucous membrane of the pharynx are important means; but the impairment of hearing, which is the most striking and most troublesome symptom, will be the last relieved, and it may not be relieved at all, and the patient grows up to be permanently hard of hearing. We have at our hands, however, in Politzer's mode of inflating the ears—a means of instantly improving the hearing, and thus of removing the most embarrassing symptoms in an instant.

The wonder and joy depicted on a little patient's face when the world of sound opens to him again, after the air has once entered the Eustachian tubes and tympanic cavities, is something very pleasant to see. In the absence of the air-bag, a bit of india-rubber tubing inserted in one nostril, the other being closed, through which air is blown from the lungs of the surgeon, will do very well. Indeed, where the subjects are very young, this method is to be preferred.

The pathological changes in these cases, which cause the impairment of hearing, are probably in some cases simply plugging of the faucial orifice of the Eustachian tube, in others of the calibre of the tube and the tympanic cavity by mucus. Structural changes, such as thickening of the mucous membrane, adhesive bands, rigidity of the ligaments of the ossicles, and so forth, have not occurred. Hence these cases should not be classed among those of chronic catarrhal inflammation.

It is probable that the mobility of the ossicles is interfered with in some cases by the accumulated mucus as well as by the swelling of the articulations. The restoration of the normal vibrations of the chain of bones, and the removal of the mucus explains the sudden increase of hearing power by inflation.

Such cases require the most thorough consideration as to hypertrophy of the tonsils, and adenoid growths. Should these conditions exist the tonsils and the adenoid growths should be removed, while inflation of the ear is not neglected. The use of the catheter when the patients will submit to it, and nearly all but infants will do so, causes the action of Politzer's method to be more powerful. It probably excites the muscles of the tube to more vigorous contraction. When children are too young to swallow on the signal, we may still employ Politzer's method, by putting the tube in one nostril, closing the other with the finger and rapidly forcing in the air in spite of the child's screams, which are not those of pain. During the swallowing motion that the little one involuntarily makes, air will enter the tube. Infants sometimes suffer from subacute catarrh, which if not relieved by local treatment passes on to a chronic process, which ends in deaf-muteism. Where any doubt exists, the little patient should have the benefit of it, by the use of Politzer's method, which can do no harm, and may do a vast deal of good. The existence of naso-pharyngeal catarrh in an infant, should be carefully considered by the attending physician, lest it result in one of the tympanic cavity, and there cause changes which must leave permanent impairment of hearing. The evil consequences of neglected colds in the head are not always sufficiently appreciated. It is from the children who suffer frequently from this affection, that the large class of persons, whose hearing is greatly and permanently impaired, is annually recruited. It is of the utmost importance that all cases of impairment of hearing, should be under early supervision, lest a permanent defect occur. Inflation of the ear, attention to adenoid growths and enlarged tonsils, with general hygienic means, will generally relieve these cases promptly.

HÆMORRHAGIC INFLAMMATION OF THE MIDDLE EAR.

The senior author of this volume was the first to report [1] cases of acute aural catarrh which had an unusual course and termination—that is to say, cases in which the course was very acute and terminated rapidly in perforation of the membrana tympani without suppuration but with quite an abundant hæmorrhage through the drum-head. It is well established that hæmorrhage into the middle ear may occur in the course of kidney disease, just as from the vessels of the retina; but the two cases which are about to be described certainly do not come under the classification of hæmorrhage from blood-vessels made atheromatous by renal disease. They are to be considered as cases of acute inflammation of the lining membrane of the middle ear, in which the morbid process has an annually rapid and violent course, so that not merely an exudation through the walls of the vessels, but an actual breaking down of the walls themselves, occurs; there is then such an accumulation of the blood in the cavity of the tympanum

[1] *Transactions of the American Otological Society,* 1872.

that the rupture of the drum-head almost necessarily follows. It has been often observed that in many cases of paracentesis of the membrane, for the relief of inflammation of the lining membrane of the drum cavity, blood is the only product that escapes. These cases are analogous to those just described.

A gentleman in his eighty-fourth year, under the observation of the writer, suffered simultaneously from hæmorrhagic retinitis and hæmorrhage into the middle ear. Absorption of the blood in the tympanic cavity and the drum-head was followed by great improvement to the hearing. Hæmorrhage into the drum-head, after the escape of fluid into the tympanum while gargling has been observed. This latter case, however, is hardly like a true hæmorrhagic inflammation of the middle ear. Not only have cases of otitis media hæmorrhagica been reported by eminent authorities,[1] but in one hospital[2] 19 cases have been observed in thirteen years. Hæmorrhagic inflammation of the middle ear is usually a very tractable inflammation whose violence is spent with the hæmorrhage. The history of such cases, especially with regard to the abatement of the pain as soon as the hæmorrhage occurs, furnishes another argument for an early perforation of the drum-head, when great pain is experienced and the drum-head bulges.

Vascular Tumors of the Membrana Tympani. Cases of alarming hæmorrhage from the depth of the auditory canal, from the puncture of a small swelling, hid by the *membrana tympani*, have been published. These cases occur in those who have previously suffered from sup-

[1] *Guide to the study of Ear Disease,* by T. McBride, M.D., p. 50, Edinburgh, 1884.

[2] *Brooklyn Eye and Ear Hospital Report,* 1883.

puration of the tympana. The proper treatment is to check the hæmorrhage for the time by a tampon, and at the first opportunity, after the alarming hæmorrhage has ceased, to make a thorough examination, under ether, to discover the exact origin of the vascular growth.

Vascular Growths on the Drum-Head, have also been observed. The indications for treatment are to remove them by incision and the use of the scissors, tracing up, where necessary, the conditions that give rise to them.

Aural Hæmorrhage in Bright's Disease.—Aural hæmorrhage may occur in the course of Bright's Disease. Such a case was first reported by Schwartze. The patient was twenty-five years of age, and he had at the same time, retinal hæmorrhages. There was also enlargement of the liver and spleen, and infiltration of the lungs. Like all patients who have retinal hæmorrhages, this patient died in a short time after the hæmorrhages in the ear. They indicate the very last stages of Bright's Disease, almost without exception.

Acute Aural Disease In Cerebro-Spinal Meningitis. The statistics of examination of deaf-mutes, shows that quite a proportion of them become deaf while suffering from cerebro-spinal meningitis. We believe that the chief site of the lesion, in a majority of these cases, is not in the cochlea or auditory nerve, but in the middle ear. The lesion in the eye is choroiditis, and not usually optic neuritis, and by analogy, we may conclude that the tympanum is the principal source of attack. The aurist is seldom called to see acute cerebro-spinal meningitis, but when so, he should use leeches, and the in-

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ternal administration of mercury or pilocarpine to combat the exudative process going on in the ear.

As yet, the prognosis, in general, in these cases, is very bad, because the labyrinth is apt to be secondarily attacked. The subject has not been very carefully studied by the Otologist chiefly from want of opportunity. He does not see the cases until their course is run.

CHAPTER X.

ACUTE SUPPURATION OF THE MIDDLE EAR.

ACUTE suppuration of the middle ear commonly occurs as a direct and immediate consequence of an acute catarrh of the same part. A catarrhal process is unchecked and passes on to a suppurative one. In some cases the catarrhal inflammation is unobserved—we cannot, however, say that it does not occur—and the first intimation of any morbid action given by the ear is a discharge of pus from the auditory canal. An examination of the ear in such cases always reveals a perforation of the membrana tympani. We probably never see a discharge of pus from the surface of the auditory canal, without previous intimation, by pain or swelling, that an inflammation of the part had occurred, although this may occur from the tympanum. Cases of sudden and painless perforation of the membrana tympani are nearly always preceded by some premonitory symptoms, such as pharyngitis, feelings of fulness in the ear, impairment of hearing, and so forth. The failure to notice them is usually to be attributed to carelessness in observation.

Then again, there are cases where pain is felt long before the pus is discharged, but where it is mistakenly referred to some other part of the body, or to a neuralgia, instead of an inflammation.

It is not to be denied, however, that there are cases of acute suppuration of the middle ear, where the initial symptoms of swelling of the lining membrane of the Eustachian tube and cavity of the tympanum, are so quickly passed over, in a few hours, or even minutes, as to be practically unrecognizable. Such a course of the disease is frequently observed in pulmonary tuberculosis where a membrana tympani will sometimes break down from an accumulation of mucus behind it, and go on to suppuration without a trace of pain.

The usual onset of acute suppuration is violent. The severe pain of acute catarrh is unrelieved, pus is formed in the cavity of the tympanum, the lining of the mastoid cells is very much distended, the outer surface of the process may become red, tender and painful, the head throbs, high temperature occurs, and the whole system is seriously disturbed. In young persons there may be delirium, and in all subjects, who have acute suppuration of the middle ear, there is considerable fever, and the condition of the patient is one of intense suffering. There is probably no more severe pain to which the human system is liable, than that due to the distention of the cavity of the tympanum by mucus, serum or pus.

Symptoms.—The symptoms, then, of this disease are usually pain in the ear and head, increased temperature, with impairment of hearing and tinnitus. The membrana tympani also exhibits marked changes in appearance. But the pain may be entirely absent, as we have seen, and yet the inflammatory process, because it is sudden in its origin, be fairly entitled to the adjective *acute.* The cases of the painless form of acute inflammation in persons suffering from phthisis pulmonalis before alluded to, are not as amenable to treatment as the more acute cases.

The membrana tympani has usually lost its naturally transparent appearance in a case of acute suppuration. It has a boggy, sodden, or swelled appearance, and has none of its normal distinguishing marks—the light spot and the handle of the malleus. Yet this is not always the case. Cases occur where the transparency of the drum membrane is almost unimpaired, and the accumulated pus and mucus which is bulging it out may be seen through it. Pus is found not only in the cavity of the tympanum in rare instances but also between the mucous and fibrous layer of the drum-head.

It is possible that some cases of so-called abscesses of the membrana tympani should be regarded as examples of limited suppuration in the tympanic cavity. An abscess confined to the layers of the drum-head without any communication with the cavity of the tympanum or the external auditory canal, is extremely rare. It should be added that the osseous portion of the bony canal is often involved in conjunction with the symptoms in the membrana tympani, the cavity of the tympanum and the mastoid cells. It is often impossible to draw the line between the affections of the three parts of the ear. Their anatomical connections show that infections must of necessity run into each other, however distinctly they may be separated in their origin. It is rather a predominance than an exclusive localization of symptoms in a part, that gives rise to an exact classification of disease. For example, an *otitis media,* in a young child, may very readily and rapidly pass on to an *otitis interna,* or to inflammation of the labyrinth, *panotitis,* and give us much difficulty in deciding which was the original affection.

Causes.—The causes of acute suppuration of the middle ear are the same as those that have been enumerated in the chapter on "Acute Catarrh." The important ones are comprised in exposure to wet, draughts, and cold, influenza—infection of the naso-pharyngeal mucous membrane being the usual starting-point.

The violent use of the posterior nasal syringe in an acute or subacute catarrh, will also in very rare cases set up acute suppuration in the tympanic cavity, as may any vigorous treatment of the pharynx. As has already

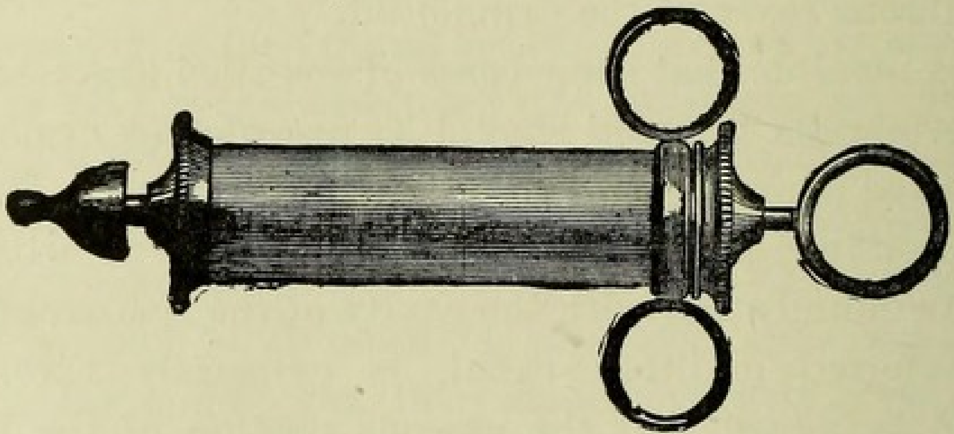

Fig. 57.—Aural Syringe.

been mentioned, sea-bathing sometimes becomes a cause of acute catarrh. In the same manner, want of caution in protecting the side of the head from the force of the waves, or the canal, or nostrils and Eustachian tube from the entrance of water, may produce acute suppuration.

Scarlet fever, measles, diptheria, tonsillitis, bronchitis, pneumonia, typhoid fever, whooping-cough, influenza and cerebro-spinal meningitis, play an important part in the production of acute aural disease, and usually, except in pneumonia and cerebro-spinal meningitis, the suppurative form is the one first recognized, although as has been said, there is probably almost always an unobserved stage of the milder variety of inflammation.

Injuries of the side of the head, and of the membrana tympani, are causes of acute suppuration of the middle ear of a very severe nature. This subject has, however, been discussed in the chapter on "Injuries of the Membrana Tympani."

Course.—The course of acute suppuration is usually violent until perforation of the drum-membrane occurs; when it gives way—at times with quite a loud explosion—and relief to the severe pain is usually experienced. If no measures are taken to remove the accumulated pus, and to check its formation, the impairment of hearing will continue, although the pain and tinnitus may be relieved and we shall soon have a case of chronic suppuration of the middle ear, and the patient be liable to all the fearful consequences of this disease. In rare cases, pus may escape into the Eustachian tube, and the case go on to resolution with no perforation of the drum-head. This is more apt to occur in children than in adults.

In the worst event of all, suppuration may extend into the brain or the blood vessels. It may pass through the thin and sometimes porous lamella of bone which forms the roof of the cavity of the tympanum, or it may go behind into the sinuses, and thus produce blood-poisoning. It may also extend to the labyrinth.

The mastoid process is of course always more or less involved in acute suppuration, or even in acute catarrh. Its cells form an integral part of the middle ear. There are probably but few, if any, cases of suppuration that are limited to the tympanum. Severe disease of the mastoid process is also a dangerous complication; but for a full discussion of the subject, the reader is referred to the chapter upon consequences of chronic suppuration. Under appropriate treatment, however, the secretion of pus usually soon ceases, the membrane closes up, the hearing is restored, and scarcely a trace is seen, either in the anatomical structure or the functions of the organ, of the disease which has raged so violently.

Our aim should always be to prevent or limit suppuration in the ear, but if it does occur, and even if a large portion of the drum-head be swept away, we may usually, if the ossicula be left, by prompt, energetic and patient treatment, restore it, and with it, the hearing power.

Diffuse inflammation of the external auditory canal is often a troublesome complication in the course of an acute aural suppuration with perforation. It is probably caused by the irritation of the pus in the auditory canal, and perhaps in some cases by the excessive manipulation for the purpose of cleansing the ear. Such a complication is sometimes embarrassing and distressing, for it protracts the duration of the disease very much.

Acute catarrh and acute suppuration of the middle ear are exceedingly amenable to judicious treatment. There are no important parts of the body which more certainly in the large majority of cases recover from serious inflammation than those that make up the middle ear. Acute catarrh and acute suppuration very often run their entire course, and end in perfect recovery with no especial treatment. Any one who is in the habit of hearing the histories of patients and of examining the membrana tympani, soon convinces himself that young children often recover from acute suppuration of the middle ear under very crude but not meddlesome treatment, received from nurses and parents. This becomes an important consideration in the physician's treatment of acute inflammation of the ear, for it will lead him to a wise conservatism in certain cases, and a healthy skepticism as to the value of drugs which therapeutic enthusiasts praise so highly and with which they claim to avert a suppurative process. There are, however, painful exceptions to the rule that acute suppuration of the middle ear is, under proper guidance, usually a tractable and not fatal disease.

Treatment.—An acute catarrh or suppuration of the middle ear should never be lightly estimated. A case seen early in its course will usually prove very tractable and respond readily to treatment, but if left to itself it may be a serious one. The first step in the treatment is to insure quiet and freedom from care for the patient, if an adult. Patients with acute suppuration should usually be confined to their rooms. If adults, absolute freedom from business or domestic employment should be insisted upon.

Each case should be watched as forming a possible starting-point for cerebral meningitis, or infection through the sinuses. In the large majority of cases such deplorable consequences will not occur, but it would be much less frequently observed were each patient with acute suppuration carefully guarded from the exciting causes of cerebral hyperæmia, from the beginning of the aural disease until he is fairly convalescing. The room, or ward in which such a patient is, should be kept free from visitors. Prolonged conversation, bright light, noise should not be allowed, and an attempt should be made to secure physical and mental quiet. To underrate the gravity of an acute suppuration, or even an acute catarrh of the middle ear, is to invite peril to life. Cases have been seen where the life was lost, because the patients insisted that a painful ear and a tender mastoid process, were not sufficient causes to keep them away from business and from active social life.

If the case be seen in the earlier stages—that is, when the pain is still present, and the membrana tympani is intact—two or more leeches should be at once applied, and if the appearance of the membrana tympani indicate that it is about to rupture, or if the pain be not quickly subdued by the use of the leeches, a paracentesis of the membrana tympani should be at once performed in the most bulging portion of the membrane. If the mastoid be red, tender, and swelled it should be treated by wet applications such as acetico-tartrate of alum in saturated solutions, thoroughly and well. If the mastoid process be simply red and tender, but not swelled, the use of leeches and fomentations will probably subdue the inflammation without an opening.

The ear should be douched very often, say every half hour, with lukewarm or hot water, by means of a fountain syringe, the temperature of the water being determined by the patient's feelings. This procedure the patient will usually find very grateful. In case of the absence of a douche, warm water may be dropped into the ear from the sponge, a procedure as old as the time of Hippocrates. A douche may be extemporized by the syphon arrangement of a bit of rubber tubing in any kind of a vessel that will contain water. At the same time, especially if the weather be cold, the patient should be kept in bed, while pediluvia and diaphoretics are employed. If the membrana tympani has ruptured, the pus should be removed at least twice a day, generally oftener, by careful but thorough syringing.

The quantity of pus discharged is sometimes enormous. At the same time Politzer's method of inflating the ear should be practised. This latter procedure gives no pain when carefully done, that is when the bulb is not too vigorously pressed. It at once improves the hearing, helps to cleanse the ear, and prevents the formation of adhesions in the cavity of the tympanum, and gives the patient hope and confidence.

The throat should be kept free of secretion by a gargle. The chlorate of potash in a saturated solution is excellent. Hot sterilized water is often an adequate gargle. In cases of scarlet fever the pharynx will require the most careful and energetic treatment. The neck should be kept warm by wet applications, and the pharynx be very often cleansed by the use of a nebulizer, chlorate of potash in powder, placed upon the tongue, and so forth.

Relapses of pain should be combated by leeches, warm water, and the internal administration of opium, or morphia, chloral, and bromide of sodium combined; but opium has very little power in subduing the pain from acute aural suppuration, if used without the local treatment. The administration of calomel or other mercurials, the application of blisters, will not be required. The former kind of treatment is useless, while the latter aggravates the suffering of the patient. Blisters are more applicable to chronic aural disease, but in the absence of leeches they are useful.

If the case go on well, a physician who does not see much of this form of disease, will be astonished at the rapidity with which the suppuration is checked, and the membrana tympani restored. The impairment of hearing will be the last symptom to be fully relieved. The hearing power should be often accurately tested by the watch and tuning-fork, in the course of the disease, in order that if possible we may not dismiss the patient until the cure is complete.

A good astringent in acute suppuration is a solution of sulphate of zinc, which is poured into the ear once or twice a day, after syringing. The solution should be previously warmed. Should the suppuration continue unduly, the nitrate of silver may be applied in strong solutions, say from 40 to 80 grains to the ounce. This solution is brushed over the drum-head and in the edges of the perforation. In some cases it may be necessary to drop the solution into the ear, afterward neutralizing it by syringing with a warm solution of salt and water. Argyrol in 10–20 per cent solution may replace the nitrate of silver. It should be said once for all, that, except in very rare and exceptional cases, cold fluids should not be dropped into the ear.

Solutions of bichloride of mercury are not to be used at all. They are irritating and useless. The use of astringents in the treatment of acute suppuration should not be begun until it is believed by careful trial that the cleansing of the ear is not of itself sufficient to cause the purulent discharge to cease. *In many cases an astrin-*

gent is never required, but the curative influence of nature, impediments to her action being removed, proves to be sufficient.

As was said by the late Dr. Edward T. Ely, "great labor has been required to lead physicians and laymen to consider acute suppuration of the middle ear, as of any importance, and it is natural that many practitioners having thus been laboriously awakened to its importance should hold exaggerated ideas as to the rem edies required for its cure."

THE USE OF HOT WATER FOR CLEANSING THE EAR.

It is not at all necessary that anything should be dissolved in sterilized water, before applying it to the ear. Water used for this purpose should be filtered, if it be not clean, or if it be a water with sandy deposits or the like, and likely to prove an irritant when used. After being filtered, it should be boiled, and used at the temperature that may be borne by the patient, which varies from 85° to 100° F. Solutions of bichloride of mercury are not recommended, as applications for the ear, for the purpose of cleansing the auditory canal and tympanum, or for the purpose of subduing pain. The present writers do not believe there is any advantage in the use of this agent, as preliminary to operative procedures. They believe that the field of operation may be made thoroughly aseptic with sterilized water, and that the corrosive chloride of mercury, which is extensively employed, is an irritating application, besides being unnecessary. In deference to professional opinion, in the descriptions of the various operations, it has been stated that mercurial solutions may be used, but the writers wish to make this reservation, at this point, as to their own opinion, in regard to the necessity for them.

Results of Treatment.—The results of treatment of this disease are very satisfactory. More than seventy-five per cent of these cases are cured, that is, the membrana tympani is restored and the hearing power becomes normal. As has been said in another place, the old writers on diseases of the ear were not in the habit of applying accurate tests as to the restoration of hearing; so that their standard of cure is not so high as that which obtains among writers of the present day. Many of the writers of cases of aural disease, that have been reported as improved or much improved, would have been classed under the head of cured, by the less exact standard of ancient writers. When one ear only is affected, we are apt to be led into error as to the amount of impairment of hearing unless we are careful to exclude the sound ear as thoroughly as may be in our examination.

The consequences of a neglected or improperly treated aural catarrh are, that it runs into a case of acute suppuration; but those of a neglected or maltreated acute suppuration are still more grave, involving as they do all the perils of long-continued suppuration of the ear.

It seems to be supposed by some that peculiar means of treatment are at the service of specialists which are not in the hands of the average physician, and which can only be used when a disease has become well advanced. To those who hold such views, it may be said the time to treat aural disease is in the beginning of the attack. Aurists or surgeons have no means to combat inflammation other than those at the hands of every practitioner. To wait for so-called special treatment is to lose important time. Besides this, there is no special, mysterious treatment that can be of avail at any time, no matter in whose hands. It is true that we must wait for a cataract to ripen, before it can be removed, and then only an expert is competent to operate upon it. But no such condition of things exists in the progress of aural disease. Delay in its management will be as fatal to a cure as is delay in the treatment of glaucoma.

The course of acute suppuration occurring in the midst of a severe attack of scarlatina is apt to be violent. The symptoms follow one another with the rapidity of those of purulent ophthalmia. He who wishes to preserve the integrity of the organ, must be prompt and energetic in his treatment, or the drum-head and the ossicula auditus will be swept away and a profuse and fetid discharge of pus be set up within forty-eight or fifty-six hours.

Attacks of acute aural catarrh, or of acute suppuration of the middle ear, are more dangerous in persons who are affected with a chronic catarrh of the middle ear. This is because the drum membrane is so much thickened in such cases that the exit of the pus or mucus by its spontaneous perforation is much more difficult. A paracentesis will be much more likely to be required for them, than in those occurring in persons with drum membranes of normal density and tension. Erysipelas of the face of a severe type may occur in the course of acute suppuration of the middle ear. This is, of course, a serious complication, but fatal results from it are not at all frequent.

The practitioner who has not seen much of aural disease may be at a loss when called to a case of acute suppuration of the ear, to know whether its seat is in the auditory canal or in the middle ear. The parts should be carefully cleansed of pus before a decision is made, although it should be borne in mind, as was stated in the chapter on "Acute Affections of the Canal," that suppuration in the middle ear is much more frequent than the same process in the external auditory canal. Indeed, an acute diffuse suppuration of the external ear is an extremely rare disease. If an opening in the drumhead cannot be detected by the otoscope, the performance of the Valsalvian experiment by the patient, or the employment of Politzer's method, and a subsequent inspection, will determine the question. If the membrane be perforated, the air will be heard to whistle through the aperture, and an air-bubble, made by the pus or mucus, will be found at the seat of the aperture. The presence of an air-bubble, before the parts have been cleansed, is not, as Wilde thought, a pathognomonic symptom of a perforation, for this bubble may sometimes be seen when the membrane is intact, but fluid is lying on it.

SEROUS INFLAMMATION OF THE MIDDLE EAR.

An increased secretion of the middle ear is not always either of a catarrh or a purulent character. As has been observed in the account of the anatomy of this part, its lining membrane sometimes assumes the character of a serous membrane. In like manner an excessive secretion in the middle ear may be, in exceptional cases, predominantly or entirely of a serous character. This may occur when the membrana tympani is sound, and also during the course of a suppurative process. The membrana tympani, if entire, has an unmistakable appearance, when serum is collected behind it in great quantity. It is somewhat bulging, and through its transparent layers may be detected a yellowish fluid, which may be caused to change its position by movements of the head, just as water may be made to change its position in an aquarium. The subjective symptoms of this accumulation, like those from the accumulations of mucus, are sometimes very annoying and trying, without being absolutely painful. The movement of the serum is felt by the patient at each considerable change in position, especially on rising from lying down, and sometimes the sound of his voice becomes very distressing, and even "echo" hearing and double hearing may be present, just as it may be when mucus has accumulated in the ear in subacute catarrh. The hearing power is very much affected in these cases, but it may be variable, according as the serous fluid has changed in position. Great pain is sometimes spoken of by patients but this is usually in neurotic or hysterical subjects, for, while the presence of serum in the middle ear causes very annoying and disturbing sensations, they are not to be compared in severity with those from the accumulation of mucus, blood, or pus.

Dr. C. H. Burnett reported a case where the membrana tympani was opened for serous accumulations *thirty-seven* times by Dr. Burnett in nine years, and always with relief to the patient. In obstinate cases of this kind, the writer made as many as five or six openings in the drum-head in a few weeks.

Treatment.—Paracentesis of the drum-head is generally indicated in cases of serous accumulation, although at times the fluid may disappear under the treatment of the middle ear by inflation. At the same time, the general health will need careful looking after. Generally, paracentesis must be repeatedly performed in the same case before a cure results. Delstanche's masseur will be found very useful in drawing the serous-like fluid, or serum, or tenacious mucus, from the tympanum. Of the accumulation of serum and mucus in chronic cases, more will be said in an appropriate chapter. Leeches and the warm douche are of little or no avail in serous inflammation, but the use of gargles is strongly indicated. By them, the action of the Eustachian tube and the consequent passage of the fluid from the tympanum to the pharynx are promoted.

CHAPTER XI.

CHRONIC NON-SUPPURATIVE INFLAMMATION OF THE MIDDLE EAR.

For many years practice in diseases of the ear was very unsatisfactory, because it was chiefly devoted to chronic non-suppurative cases, while acute disease was little understood until Wilde's day, and the opportunities for successful treatment in the latter class of cases were scarcely embraced by any. It was even stated by an eminent medical writer that " those less serious diseases of the ear may be successfully treated by a well qualified general practitioner and the more serious by none." While this day has passed away, the cases that gave rise to the stigma upon otology still remain in the affection now about to be described, for as yet when it is fairly advanced, or even when it has just arisen, it is only in a small proportion of cases that we can expect a cure.

But many of these at an earlier period of their existence would have been benefited by treatment. The prevention of a chronic aural affection is often within the power of every practitioner, while once having become established, its cure is impossible. It may be said that there are but two classes of cases of aural disease in which we may not expect very good results from treatment and care. Nearly all the others are singularly tractable, under proper care. By these two classes we mean chronic non-suppurative inflammation of the middle ear, and the affections of the labyrinth, or internal ear. Of every thousand cases of aural disease about three hundred belong to the former class, while but a small percentage of disease of the internal ear occurs.

Chronic non-suppurative inflammation of the middle ear, is so insidious in its origin and progress, that it may have existed for months and years before its subject is aware of it, and brings himself under professional care. It may impair or nearly destroy the hearing, with but few of the subjective evidences of what is called inflammation—there may be no heat, redness, or pain—but we find many of the other marks of diseased action, in swelling, thickening, adhesion, which entitle it to be placed under this head. It has also been called a catarrhal inflammation, because the cavity, air-chamber, and tube, which form its seat, are lined by mucous membrane. We say middle ear, because these parts form the anatomical centre of the organ of hearing.

The reason for this classification of these affections as nervous is found in the fact that the poor means of diagnosis, which were in the hands of the profession until a few years since, the absence of a simple otoscope, and the want of knowledge of the Eustachian catheter, and the tuning-fork, did not allow of the appreciation of the delicate changes which make up what the Germans call the "*Krankheits bild*"—the picture of the disease. There was another reason in the fact that the poor, distressed patient, having gone in vain to his usual consolers, if not curers—the regular practitioners—often resorted to the charlatan. Under his wonderful but distressing treatment, added to the trial of the horrible tinnitus aurium, and impairment of hearing, he became so utterly worn out and so distrustful of each new adviser, that the so-called nervousness was very apparent.

The common idea of nervous deafness is that it occurs chiefly among the weak and sensitive; but this notion has no basis in pathology—so-called nervous people are not apt to be deaf, nor does their sensitive or nervous organism have much effect upon their hearing power, unless it is already impaired from an inflammatory cause.

As yet, this class of cases comes very often to the notice of the practitioner of modern otology, only when the disease is far advanced. The following table shows this. It is compiled from the first cases of this disease that were observed by one of the authors in private practice:

CASES OF CHRONIC NON-SUPPURATIVE INFLAMMATION.

Number of cases of 80 years standing	1
" " " over 40 " "	6
" " " " 20 " "	40
" " " between 10 and 20 years' standing	133
" " " " 5 and 10 years' standing	141
" " " " 3 and 5 years' standing	75
" " " " 1 and 3 years' standing	74
" " " one year's standing	42
" " " less than one year's standing	13
Total	525

By far the larger number, more than fifty per centum, had observed some loss of function for more than five years, while about eight per cent had been affected for more than twenty years.

Another table is added from a second five hundred and ten cases:

Cases of 50 years' duration	1
" " 40 " "	5
" " 30 " "	6
" " 30 to 40 years' duration	6
" " 20 to 30 " "	30
" " 15 to 20 " "	27
" " 10 to 15 " "	77
" " 5 to 10 " "	112
" " 4 years' duration	43
" " 3 " "	53
" " 2 " "	76
" " 1 year's "	41
" " 6 months' "	18
" " 3 " "	21
Total	510

It will be seen that even in the second table the proportion of cases of from five to twenty years' standing is very large, nearly one half of the whole number, but there is a gratifying increase in the number of those that have existed less than one year.

Every person has, so to speak, a superfluous amount of hearing, which he may lose before his hearing is sufficiently impaired to annoy him in the common affairs of life. People who spend many hours of the day in noisy places, such as boiler shops, on board steamships, in the stock-board of Wall Street, may lose very much of their hearing power before they are at all aware of it. Then, again, the poorer classes, who labor hard all day in the open air with their fellows, and who live at night in small and noisy rooms, where the demands upon the hearing power are very slight, hardly consider its impairment as a loss of function.

Besides all this, people in general, who have no scruples about confessing to impaired eyesight, very reluctantly admit a loss of hearing. It thus becomes very difficult in many cases to say when an impairment of hearing was first observed. These causes have conspired, with the general ignorance of the pathology and treatment of non-suppurative aural disease, to render the results of treatment unsatisfactory, as well as to cause patients to consult a physician if at all at a very late stage of their trouble.

After looking at many ears, in which there was no trace, either in the pharynx, Eustachian tube, or cavity of the tympanum, of an excess of secretion from the mucous membrane, but in which there were marked changes in the way of increase, hypertrophy or proliferation of tissue, and in others where the catarrhal symptoms were very much in the background, although they existed, aural catarrh seems a meagre and incorrect name with which to describe such a state of things. The very name "catarrh" as applied to an ear with a sunken drum-head, immovable chain of bones, dry pharynx, easily permeable Eustachian tubes, is repugnant to all our notions of scientific nomenclature. Whatever may have been the origin or exciting cause of such cases, they cannot be called catarrhal, when their examination shows such a state of things as this.

Gruber made a division in his text-book, and described an *otitis media hypertrophica,* or plastic inflammation; his description of the pathology of the disease shows that he is discussing not what has hitherto been comprehended under the head of sclerosis, but an extension of a suppurative process, such as causes the formation of granulations or polypi.

Our classification is founded upon clinical experiences and upon the reports of the pathology of this class of cases.

Chronic non-suppurative inflammation of the middle ear may be divided into two great classes, *Chronic Catarrhal and Chronic Proliferous Inflammation.*

The translation of the German word *wucherung,* has been chosen as furnishing the best terms to describe the changes in the middle ear, of which we now speak. Since this nomenclature was published, the term chronic non-suppurative inflammation, has been widely adopted in Great Britain as well as in this country, and some authorities have also accepted the term proliferous, in the sub-classification. Some authors and practitioners would admit another classification, based upon the parts involved, and speak of chronic catarrh of the Eustachian tube. Whatever we may believe of acute inflammation of these parts, one scarcely accepts the idea of one that has existed for any considerable space of time without involving either the cavity of the tympanum or the mastoid cells, or both. The nomenclature, tubal catarrh, also may lead to incorrect notions as to the therapeutic value of the Eustachian catheter, and of Politzer's method of inflating the drum *cavity.* These methods of treatment are useful, not altogether for what they do to the tube, as for their effect upon the cavities into which it opens. When air-bubbles are crackling in the cavity of the tympanum, as in catarrhal inflammation, or when the tube is greatly narrowed by the hypertrophy of its lining membranes, but at the same time we have, as we always do, in the latter case, a sunken drum-head, an altered light spot, signs of proliferous inflammation of many of the structures making up the middle ear. We cannot speak of a tubal affection, even if its symptoms are predominant, and even if treatment of, and through, the lining membrane of the tube, does place things in such a condition that Nature will complete the cure. In former times, the membrana tympani, under the assumption that such an affection as an independent chronic myringitis existed, was vigorously treated by instillations of various fluids, and by perforation, and of late, under the idea that we have a great deal of tubal catarrh without further progress in the morbid action, undue stress is sometimes laid upon applications to the mouth of the tube. Politzer's method is then used as a complete substitute for the catheter. Indispensable as it is, its chief value is as an adjuvant to that instrument as is the method of the double bag inflation.

SUBJECTIVE SYMPTOMS OF CHRONIC CATARRHAL INFLAMMATION.

From the history of cases, we may assume that this form of disease is either a consequence of frequent attacks of acute catarrh of the middle ear, or that it occurs in people who have what we may call a catarrhal diathesis. Those who suffer from hay fever, are very apt in time to be affected with chronic catarrh of the middle ears. The disease is, therefore, unlike its companion, proliferous inflammation, not at all insidious in its approach. The patient suffering from this disease, who consults us about his hearing, is usually aware that there is an excess of secretion in his pharynx, and that for years he has been annoyed and troubled by being obliged to use a handkerchief very freely, and by feelings of fulness referred to the frontal sinus and tympanic cavities. There is often, also, at times, a sound in the ear like the crackling of air-bubbles. The voices of friends appear muffled; and it is hard for the victims of chronic aural catarrh, when the disease is advancing, not to believe that every one is speaking in a much lower tone than is usual for them. Such patients often complain bitterly on this subject, and will scarcely admit that their hearing is at all impaired, or, if so, they stoutly assert that it is one ear only, when the fact is, that, with one ear perfect, it is only under peculiar circumstances, certainly not in ordinary conversation, in front of the patient, that a person will be observed to be at all hard of hearing.

There is a feeling about this that is different from that expressed about diseases of the eye at least. In most maladies, patients will express their feelings, and often with an exaggeration, rather than with an extenuation of the symptoms; but, however much patients with chronic inflammation of the middle ear may suffer from impairment of hearing, they will often insist that they are hardly affected, or that they have a very little trouble in that way, when they can scarcely hear loud conversation addressed specially to them.

Patients affected with chronic catarrh of the middle ear also complain, as a rule, of tinnitus aurium, and a sense of fulness in the ears. The ears feel as if the auditory canals were stopped up. They often ask very anxiously if there is not something in the ear, and seem incredulous when the negative answer is given. Vertigo is another symptom, and it is often considered as undoubted evidence that there is disease of the brain. Vertigo is a symptom by no means peculiar to catarrhal inflammation. It also occurs in impacted cerumen, and still more frequently in proliferous inflammation, as well as in affections of the labyrinth, and in cerebral disease. When vertigo occurs in aural disease, it is a consequence of increased pressure upon the labyrinth through the fenestra ovalis, or of an affection of the labyrinth or brain. It is by no means a serious symptom, when the cause is to be found in the middle ear, for it is usually relieved by a mechanical treatment, through the Eustachian catheter.

The subject of aural vertigo has been very much confused by the disposition, especially found among neurologists, to attach the name of "Ménière's Disease" to every case of aural disease in which vertigo is a symptom. Vertigo occurs at times in such large variety of aural cases, that it would be well to abolish the name of "Ménière's" disease, except with reference to those cases where the origin of the vertigo is undoubtedly in the labyrinth, and where it is not plainly secondary to an affection of the auditory canal or middle ear. As now used it describes nothing, and leads to want of exactness in the diagnosis.

Patients describe the feeling of fulness in the ears as a sensation as if often the ears were plugged with some foreign substance; it is almost impossible for them to avoid the impression that the auditory canals are plugged with cerumen. Tröltsch[1] relates a case from Meyer of Hamburg, where a melancholic person was relieved of a sound in the ear, seeming to him to be the cry of a child, by the removal of a plug of cerumen, which caused deafness on one side. The patient made

[1] Text-book, second American edition, p. 531.

a rapid and complete recovery from the mental affection, after the cerumen was removed. It is the opinion of Schwartze that subjective aural sensations, which are caused by demonstrable affections of the ear, may, in predisposed persons, especially when there is any hereditary tendency to mental disease, become the direct cause of aural hallucinations, that may accelerate the outbreak of a disease of the brain. He mentions a case where, in his opinion, and in that of one of the physicians of the Insane Asylum at Halle, a threatened attack of brain disease was prevented by treatment of the ear. In some cases, insane persons distinguish this tinnitus from that produced by mental disease. Dr. Koppe confirms this view, and shows that in some cases hallucinations disappear after treatment of the ear.

The senior author of this volume has elsewhere reported [1] a case of the suicide of a professor in one of our educational institutions, who consulted him on account of impairment of hearing, but more especially on account of tinnitus aurium. He said, on leaving the consulting room, that, if he felt sure the author was correct in his opinion (that he would not get great relief from this very trying symptom, tinnitus), he would put an end to his existence; which he did a few months after, by blowing out his brains.

The late Dr. O. D. Pomeroy examined sixty lunatics at Blackwell's Island Lunatic Asylum, and he found disease of the ear in many of those who suffered from what may be called aural hallucinations, although not in so large a proportion as stated by Schwartze and Koppe.

[1] *New York Medical Journal*, August, 1869.

Dr. C. E. Wright published a case of a patient in the Indiana State Asylum for the Insane, who attempted to destroy herself by putting a steel button in her ear. The patient was discharged from the hospital, as having recovered her reason, but became nervous and despondent until she was relieved by the removal of the button; and a dread of insanity and of sudden death, from which she suffered, then also disappeared.

Tröltsch speaks of confusion of the intellect, an inability to keep up a connected line of thought, as a subjective symptom of chronic aural disease. This opinion has been often verified by later writers. Patients with chronic disease of the middle ear, not suffering from pain, but from tinnitus, often say that these noises, together with the impairment of the hearing, had a great effect upon their mental powers. On the other hand, successful men, such, for instance, as distinguished general officers in the army, and celebrated writers, have suffered from boyhood with chronic inflammation of the middle ear and tinnitus aurium.[1]

The sounds in the ears, of which patients speak, are variously described; some speak of a ringing of bells, which is perhaps the most aggravating form; others have likened them to the murmur of trees, the hum of a tea-kettle, and so forth.

Wilde was undoubtedly correct in stating that the descriptions which patients give of the noises depend

[1] The late Dr. George M. Beard, often spoke of the tinnitus aurium with which he was affected. He had chronic non-suppurative inflammation and described the noises in his head, in graphic style. They never, however, dampened his cheerful and even humorous temperament.

St. J. R.

to a certain degree upon their fancy, their graphic power of explanations, and not infrequently upon their rank in life and the sounds with which they are most familiar; thus he says: "Persons from the country or rural districts draw their similitudes from the objects and noises by which they have been surrounded, as the falling and rushing of water, the singing of birds, the buzzing of bees, and the waving or rustling of trees; while, on the other hand, persons living in towns, or in the vicinity of machinery or manufactories, say that they hear the rolling of carriages, the hammerings, and the various noises caused by steam-engines. Servants almost invariably add to their other complaints that they suffer from the ringing of bells in their ears; while, in the country, old women much given to tea-drinking sum up the category of their ailments by saying that "all the tea-kettles in Ireland are boiling in their ears." No description of tinnitus aurium has ever surpassed this one given by the great Irish observer.

Tinnitus aurium is usually, although not always, a subjectively disagreeable symptom. Sometimes, however, it is not unpleasant to the patient but it may accompany its subject as a pleasing musical concert. The following is a musical record of tinnitus aurium kept by a young woman suffering from this symptom:

February 13,—Morning, C sharp, B flat, F sharp in right; B in left. Night, E flat, C flat.

February 14th,—Morning, E flat, C flat. Night, C sharp, B flat, F sharp.

February 15th,—Morning, C sharp, B flat, F sharp. Night, C sharp, B flat, F sharp.

February 16th,—Morning, C sharp, B flat, F sharp. Night, F. sharp, E. flat.

February 17th,—Morning, E, C sharp, A. Night, D, B. G, and so forth.

Thus far we have spoken of subjective tinnitus, of sounds of which the patients give graphic descriptions, as being in their head, but of which the physician can know nothing except from these narrations. There is also an objective tinnitus aurium, usually intermittent in character, and of a crackling nature. It is a rare symptom, and is always very distressing to the patient. In one case, where a crackling and intermittent sound could be heard in the ear both by the writer and the patient, the victim was driven into insanity and suicide by failure to get relief from it. This kind of noise in the ear is dependent upon abnormal action of the tensor tympani, stapedius, or of the muscles of the Eustachian tube. The symptoms may disappear when the disease by which it arose—subacute catarrh—is relieved, but it is never benefited by any treatment when it occurs in conjunction with chronic naso-pharyngeal catarrh. Ordinary tinnitus should also be distinguished from a venous murmur transmitted from the jugular vein, which runs just beneath the floor of the cavity of the tympanum, and from the pulsating sound of the internal carotid as it winds through the apex of the petrous bone. This variety of tinnitus is not necessarily connected with impairment of hearing but is usually dependent upon anæmia or aneurism.

The cause of the common form of subjective tinnitus aurium has been much discussed, but we are yet without any exact knowledge as to how it is produced. We do know, however, in what diseases it is usually found as a constant symptom. It is a very common, almost universal, attendant of chronic non-suppurative disease, and is most distressing in the proliferous form, when it forms the chief complaint of the unfortunate subjects. It also occurs in inspissated cerumen, in acute and subacute catarrh of the middle ear. It is not a prominent symptom in chronic disease of the labyrinth.

Reasoning from the standpoint of the disease in which the ordinary subjective tinnitus aurium is generally present, it may be considered to be a symptom indicating pressure upon the vessels of the tympanum and labyrinth. Dr. Theobald [1] seeks to explain the nature of tinnitus aurium by stating that it is due to "the existence of vibrations exerted in the walls of the blood-vessels of the labyrinth by the friction attending the circulation of the blood." The reasoning of Field, of London, as to the cause of tinnitus is very clear. He believes, as do most authorities, that any impairment of the "pressure equilibrium" of the ear will be a cause of tinnitus. He has illustrated this thesis in a very satisfactory way. He remarks, abnormal pressure of the air in the external auditory canal producing increased pressure upon the endolymph of the cochlea will cause it, just as a sudden striking of the key-board of a piano will set in "discordant vibration every note that it is capable of producing." Thus anæmia and hyperæmia, Mr. Field observes, are powerful agents in modifying *pressure equilibrium.* Overfilled arteries and arterioles cause undue pressure on the peri- and endolymph and excite tinnitus. The tinnitus from quinine, salicylic acid, wintergreen and so forth, may thus be explained. The decrease in the pressure of the blood-vessels in anæmia is also called in by Mr. Field, to

[1] *Transaction of the Medical and Chirurgical Faculty of Maryland,* April, 1875.

explain tinnitus, and he gives the familiar illustrations of chlorotic young women and patients who have suffered from great hæmorrhages, as examples, to which may be added the singing in the ears experienced in syncope. This theory of increased pressure, as the chief cause of subjective tinnitus aurium, is no doubt the correct one.

Patients suffering from chronic catarrhal inflammation of the middle ear, usually speak of the throat as troubling them quite as much as their ears. In many cases, however, they say nothing whatever about the throat, and even if asked about it, they will insist that it is quite well, although they will often admit that they raise a great deal of mucus in the morning and that they have sore-throat very often. The greater number of patients with aural catarrh complain greatly of the condition of their pharynx and nostrils, and under the stimulus of the advertisements and books of charlatans have generally very much to say of *the catarrh*, although they do not always trace a connection between the throat disease and that of the ear.

There are very often many other symptoms than these which have just been enumerated—feelings of fulness, confusion of intellect, vertigo, tinnitus, and neuralgic pains—of which patients with chronic catarrh of the middle ear often complain; but they are not always dependent upon the aural disease, and the examiner may often throw many of them out of consideration, and bring the patient back from the long story of headaches, dyspepsia, and so forth, by asking whether, after all, if the ear and throat were well, they would not consider themselves in good health, when an affirmative answer is often given.

SUBJECTIVE SYMPTOMS OF PROLIFEROUS INFLAMMATION.

If we now turn to the picture of the subjective symptoms of what may be termed proliferous inflammation, we shall find them much less positive than those of the catarrhal form. Some of the patients have no subjective symptoms at all, except that of loss of hearing, which is, an objective symptom as well. They have no sore-throat, no increase of the secretion of the pharynx or nostrils. Others, again, complain of feelings of fulness in the ears, and nearly all of tinnitus aurium. Indeed the tinnitus is apt to be more troublesome in the proliferous than in the catarrhal form. This we should suppose *à priori* to be the case, because the causes in the proliferous variety of middle-ear disease are constantly acting, while in the catarrhal variety the temporary removal of the increased secretion will often greatly alleviate this symptom, and sometimes completely remove it.

The origin of this form of aural trouble cannot be traced back to infantile earaches, frequent coryzas, or to naso-pharyngeal catarrh. It is a peculiarly insidious affection, one which is usually under full headway, and which essentially impairs the function of hearing long before the patient is aware that he has any affection of the ears. The pathology of the disease explains something of this insidious character.

Catarrhal and proliferous inflammation may exist in one and the same ear, when it will be impossible to make a differential diagnosis, yet in the greater number of cases the line can be drawn between the two forms. Chronic catarrh of the middle ear, as well as the proliferous inflammation, may also exist in connection with chronic disease of the labyrinth. The practitioner should not be too ready to conclude that the predominant or chief affection in a given case of impairment of hearing is to be found only in the middle ear, simply because the patient has a naso-pharyngeal catarrh, and is hard of hearing. There are means to distinguish these affections, of which we shall speak fully before finishing this subject.

OBJECTIVE SYMPTOMS OF CATARRHAL INFLAMMATION.

The objective evidences of chronic catarrhal inflammation of the middle ear, may be classified as follows:—

1. Impairment of hearing.
2. Changes in the membrana tympani.
3. Imperfect action and changes in the structure of the Eustachian tube.
4. Capability of hearing better in a noise than in a quiet place.
5. Better condition of sound through the bone than through the air.
6. Naso-pharyngeal disease.

If we exclude the latter, we have also the objective symptoms of chronic proliferous inflammation.

The Differential Diagnosis of Chronic Non-Suppurative Inflammation of the Middle Ear from a Disease of the Labyrinth.

The tuning-fork is the best means of diagnosticating an affection of the middle ear, from one of the labyrinth.

In the catarrhal form of disease its use is not as essential as in the proliferous, for the good reason that the subjective and objective symptoms together, form such a decided picture that it would be hard to fall into error as to the seat or nature of the trouble. But, in the proliferous form, both sets of symptoms are often of such a negative character, that without the tuning-fork we are sometimes in doubt as to whether we are dealing with a peripheric or central disease.

Starting from the well established fact, that, if the auditory canal of a person having healthy ears be closed by the finger, or in any other way, the sound made by a vibrating body is heard more distinctly on the side of the head where the ear is closed, it has been shown that, in most diseases of the auditory canal and middle ear, such vibrations are more distinctly heard on the affected side, or, if one only be diseased, that they are heard more distinctly on the side of the ear affected, and the side on which the ticking of a watch or the sound of conversation is not as well heard.

The differential diagnosis between a chronic proliferous inflammation of the middle ear, and an affection of the acoustic nerve is important and often difficult. It is important, for while local treatment of a proliferous inflammation of the middle ear is often beneficial, such treatment applied to an affection of the nerve is always useless and generally harmful. Certainly it adds to the annoyances of the patient. The differential diagnosis is sometimes difficult, because a secondary affection of the nerve often exists in connection with chronic non-suppurative inflammation of the middle ear. But, some of these difficulties have been removed, so that we may now more readily make a diagnosis than was formerly possible. The tests which were formerly exclusively used to differentiate between diseases of the middle ear and of the nerve, and which have just been described, may be abandoned, not because they were not valuable, but because the *test of the aerial and bone conduction* is much more easy to carry out, and is more certain. When both ears are diseased, it is often difficult for a patient to say whether or not he hears a vibrating tuning-fork better in one ear than the other, but the most stupid person can easily determine whether a vibrating tuning-fork is heard better through the air, when held in front of the meatus, or through the bone when placed on the mastoid process. It is a rule without exception, that when the tuning-fork C^2 is heard louder and longer through the bones than through the air the predominant disease is one of the external or middle ear. Of course, the external ear may be readily excluded or included, by ocular examination. There may, however, be predominant disease of the middle ear, when through any cause,—wax in the canal, mucus, blood, serum, or pus in the tympanum,—abnormal pressure is made upon the peri- and endo- lymph, *and yet the tuning-fork be heard better through the air.* When the pressure is removed, if there be remaining disease of the middle ear, the tuning-fork C^2 will be heard better through the bones. This is beautifully shown in the examination of boiler-makers, who become hard of hearing from their noisy occupation, and acquire disease of the nerve. They are of course also liable to disease of the canal, such as inspissated cerumen. Before the wax is removed in certain cases, the bone conduction is better, but on removing this, the hearing power remains impaired, but the tuning-fork is heard, as it always is heard in disease of the nerve, better and longer through the air. The table showing the results of examination of boiler-makers in the chapter on "Diseases of the Internal Ear" prove this.

The only difficulty then, in the test with the tuning-fork, is that we cannot always tell on the first examination, when the tuning-fork is heard better through the air, whether this be due to pressure upon the labyrinth from temporary causes, or to intrinsic disease of the nerve.

Of temporary causes, an accumulation of wax in the canal, or of mucus, pus or blood in the tympanum are examples. These being present, pressure may be made upon the labyrinth, and cause the aërial conduction to be temporarily better than that through the bones. We cannot, therefore, in some cases when we find better aërial conduction, determine at once, that it may not be due to disease of the canal or middle ear. We may be obliged in some such cases, to make more than one examination before we come to a positive conclusion. With better bone conduction, however, we have no such difficulty—and with constant use of the tuning-fork in diagnosis, we may become more and more confident and exact in our deductions.

The authors employed the older tests, until constant examinations have convinced them, that the one as to the *aerial and bone conduction* is entirely reliable and easiest to conduct of all those that have resulted from Müller's first experiments.

The tuning-fork need only be used to determine which is better, the aërial or the bone conduction. It is indeed a very simple thing to determine whether the vibrations of a tuning-fork are heard better through the air or through the bones, and this is the gist of the test. In some cases it is well to also test the time during which the fork is heard. An easy way of doing this is to place it upon the bones, after the patient says it is no longer heard through the air, or vice versa. In many instances however, a stop-watch and a test of the duration in each position, are necessary to an accurate idea as to the relative intensity of aërial and bone conduction.

After having, in the doubtful cases of the proliferous variety, settled the fact as to whether we have an affection of the middle ear or of the labyrinth, the ticking of the watch, and ordinary conversation become the natural tests as to the impairment of hearing.

The watch is an inadequate test, for the reason that has already been mentioned in the introductory chapter, that is, that some persons can hear a watch quite a number of inches from the ear, while they hear conversation very badly. Lucae explains the fact by saying that speech is made up of an extremely complicated system of tones, and sounds of most different tone-heights, while the tick of a watch is made up of a class of very high tones which are usually better heard than low tones. But there are cases where speech is heard much better than the tick of a watch. Careful observation of the lips of the speaker, by the person whose hearing is defective, may have something to do with explaining this class of cases. Excluding these, however, there is disease of the acoustic nerve, when conversation is heard relatively better than the tick of a watch.

In commenting upon Lucae's explanation of the occasional disproportion, between the power of hearing the watch and conversation, Politzer remarks that he believes it to be due to the fact that in anchylosis of the stapes, the membrane of the *fenestra rotunda* often remains normal. If this be not thickened, simple tones and noises may be transmitted without difficulty through the air of the tympanum to the membrane of the *fenestra rotunda,* while speech can only be perfectly transmitted through the ossicles. "The greater the impediment to the conduction of sound through the ossicles, the greater is the impairment of hearing for speech." This explanation is perfectly consistent with our experience, that an adhesive process in the tympanum is more destructive to the hearing power for speech, that is for ordinary conversation, than a moderate disease of the labyrinth. Deaf mutes, who are usually deaf from adhesive inflammation of the middle ear, are striking examples of persons deaf to speech, although they may hear sounds and noises through the bones.

BETTER HEARING IN A NOISE.

Persons affected with disease of the middle ear, uncomplicated by secondary disease of the labyrinth, hear better in a noise than they do in a quiet place. This is true of acute, subacute and chronic disease. But it has only been especially commented upon when occurring in chronic non-suppurative cases. Consequently it has often been mistakenly assumed, that it is always a very unfavorable symptom. It is not necessarily so, but inasmuch as it is chiefly observed in cases that are actually incurable, it is not at all strange that it has been so considered. Important deductions can already be made as to the situation of the nature of the lesion that causes the impairment of hearing in a given case, from this symptom, and from a right interpretation of it, may yet come an invention to improve the hearing power of a large class of persons. In the collected works of Doctor of Medicine Thomas Willis, published in Amsterdam, a little more than two hundred years ago, in a chapter upon the sense of hearing, and in a paragraph relating to deafness caused by relaxation of the membrana tympani, there is an account of a somewhat famous woman, who could only hear the voice of her husband when a servant was beating a drum in the same room.[1]

Although this passage is often alluded to, it is seldom quoted.

"Although hearing is very little produced by the membrana tympani as compared with the proper organ of the sense, yet it so far depends upon it, that depriva-

[1] *Archives of Otology*, vol. xii., No. 2, June, 1883. The original reads as follows:

Quanquam auditus à tympano, velut proprio sensionis organo, minime peragstur, tameu iste in tantum ab dependet, ut non raro a tympani actione læsa, aut impedita senius illins priaatio, aut diminutio procedat. Enimvero snrditatis species quædam occurte, in qua licet affecti au itus sensu penitus carere videantur, quam-dium, tamen ingens fragor, uti bombardarum, campanardm, ant iympani bellici, prope aures circumstrepit, adstantinm colloquia distincte capiunt, et inserrogatis apte respondent, cessante vero immani isto strepitu, denuo statim obsurdescunt. Accepit olim a viro fide digno, se mulierem quæ licet eurda fuerat, quosque tamen intra conclave tympanum pulsaretur, verba quaevis clare audiebat; quare maritus ejus Tympanistam pro fervo domestico conducebat, ut illius ope, colloquia iaterdum cum uxore sda haberet. Etiam de alio Surdastro mihi narratum est, qui prope campanile degens, quoties una plures campanæ resonarent, vocem quamvis, facile audire, et non alias potuit. Procutdubio horum ratio erat, quod tympanum in se continuo relaxatum, soni vehementioris impulsu ad debitam tensitatem, quo munere suo aliqualenus de fungi poteruit, cogeretur.

tion or diminution of that sense not infrequently proceeds from its injury or impeded action. Indeed, a certain kind of deafness occurs, in which, although the patients seem completely to lack the sense of hearing, yet so long as a great din, such as that of bombardments, or of chimes of bells, or of drums, resounds about their ears, they take in distinctly the conversation of those about them, and answer questions intelligently, but, upon the ceasing of such tremendous uproar, they immediately become deaf again. I once had it from a trustworthy man that he had been acquainted with a woman, who, although she was deaf, would, nevertheless, distinctly hear whatever was said so long as a drum was beaten within the room, and consequently her husband employed a drummer as a household servant, in order that by his aid he might occasionally hold conversation with his wife. I have also been told of another deaf person, living near a bell tower, who could easily hear any voice whenever the bells were pealing—but not otherwise. Doubtless the reason of these things is, that the membrana tympani, habitually relaxed when left to itself, was forced by the shock of a sound much more intense than usual, to a state of tension sufficient to enable it to perform its function in some degree."[1]

In the two centuries that have followed the narration of Willis's observations, the symptoms of hearing better in a noise, has not only been given the name of the author, and is known in our time as *Paracusis Willisiana,* but the facts as stated by the author, have in turn been denied and affirmed, and while many have

[1] *Opera Omnia, Amstelaedauia, apud Henricum Wetstenium, Pars physiologica,* Cap. xiv. p. 69.

admitted the truth of the observations, and have conceded that there are some persons with impaired hearing who hear better in a noise, Willis's explanation of the phenomenon has been rejected by them. The writers on aural medicine who allude to it at all, are by no means agreed upon the facts nor upon their explanations.

Tröltsch[1] says: "These statements (as to hearing better in a noise) "are founded, as a rule, upon a want of exact observation, as well as upon self-deception." He then relates one of Willis's cases, and also one reported by an author named Fielitz. The latter was that of a deaf son of a shoemaker, who could hear conversation in the room, when he stood near his father and the latter pounded sole leather upon a large stone. This same boy heard well in a mill when it was in action. Tröltsch was in error in his idea that the symptom of hearing better in a noise is not a common one.

Rau,[2] like Kramer, believed that better hearing in a noise depends upon excitement of a torpid acoustic nerve. He says: "If the auditory nerve be awakened from its slumber by loud talking, the patient will momentarily hear even words spoken in a low tone very well. This sometimes goes to such an extent that the hearing is restored to a considerable degree by a loud and regular sound, for example, during the pealing of bells, drumming, a ride in a rattling wagon, or the like." Burnett[3] was positive that the symptom is a real one, but confines it to the later stages of chronic aural catarrh, "when the condition of the tympanum has become dry or sclerotic, or when the

[1] *Troltsch: Lehrbuch, Sechste Ausgabe*, p. 253, passim.

[2] *Lehrbuch*, p. 292.

[3] *Treatise on the Ear*, p. 386.

thickening of the mucous membrane has become great in the moist form."

Dr. E. E. Holt[1] doubts if, in any case, the hearing power is improved by noise, and he states that, so far as he is aware, no one has "ever made a careful investigation to ascertain whether the claim of such persons was a real one or not."

In the first edition of a text-book by the senior author of this volume, and in all the subsequent editions, there was related from personal experience the case of a mail agent, on one of our railways, who, although very hard of hearing in a quiet place, could hear very well in his car amid the noise of the train. The author had frequent opportunities to study this case, and there is no question as to the facts. No person who did not know of this gentleman's infirmity would ever suspect him of impaired hearing while conversing in the din of a rapidly going train of railway carriages. But the instant he reached a quiet place it was with the greatest difficulty that he could even hear loud conversation especially addressed to him.

Politzer has no doubts as to the existence of these cases and confirms what was stated by the present writer, "that the patients can understand speech during such noises much easier, and at a much greater distance than people with normal hearing." Politzer, however, states that he has observed this symptom "almost exclusively in the incurable forms of affections of the middle ear."

There are cases where this symptom occurs, in patients who regain their hearing perfectly. While

[1] *Transactions of American Otological Society*, 1882.

the symptom frequently accompanies incurable disease of the middle ear, it is a very frequent symptom in subacute cases, when both ears are affected. Of course, it would not be observed in disease of one ear only.

While the occurrence of the symptom in subacute cases disposes of the notion that hearing better in a noise implies an incurable disease, the fact that it also may exist when the membrana tympani is gone, shows that Willis' explanation of the phenomenon is not exclusively, if at all, correct. The symptom never occurs except in cases where the nerve is sound. The theory of an extraordinary excitement of the nervous apparatus, as a cause of the phenomenon, must be rejected. Buck and Politzer explain the symptom by a reference to some effect upon the ossicula auditus, made by the great din. This is the only theory, incomplete as it is, which fulfils the conditions made by such cases as those just mentioned, where, although the membrana tympani were gone, the ossicles were intact. How the ossicles are affected is a problem yet to be solved, but when it is solved, it will be possible to invent an instrument to enable those deaf from disease of the middle ear, to hear conversation not only in a noise, but in the quiet of an ordinary room. This latter will, certainly, not be a task beyond the capabilities of a physicist of the twentieth century. As yet the telephone is the best apparatus for enabling patients with this symptom to hear, but this apparatus is not a portable one. These cases are not at all rare. They are very common. The proof is overwhelming that a large class of persons with impairment of hearing, not only hear *better,* but hear perfectly well, in noisy places.

The statement, that these cases rest upon defective observations, will soon be disproven by a ride of a few miles in a railway carriage or in a clattering wagon, with a person deaf to ordinary conversation in a quiet place from disease of the middle ear. Examinations of boiler-makers, or of those who suffer from affections of the acoustic nerve, will, however, be disappointing unless they are carefully analyzed, and will lead to a doubt in the mind of the observer as to the reality of the symptom.

The power of hearing better in a noise is a different subject from that of the effect of certain noisy occupations upon the ear. Patients like the mail agent may travel for years in the din of a train, and always find their hearing improved and not decreased, so long as it depends upon disease of the middle ear. But although there is a class of patients who have been made deaf by noise whose symptoms are often confounded with those whose impairment of hearing has resulted from catarrh, they should be entirely disassociated from them. Boiler-makers and those who become deaf from an exposure to the continuous shock of loud sounds, suffer from a lesion of the acoustic nerve. These patients do not hear better in a noise, but they have a source of relief in quiet places and, like ordinary people, they hear better away from the din that is such a comfort to a person deaf from many forms of disease of the middle ear. But that boiler-makers do suffer from a lesion of the internal ear, and not of the middle ear, in so far as they have a peculiar affection from their occupation, does not admit of a doubt. The very fact that they do *not* hear better in a noise, is an incidental proof that they suffer from a disease of the labyrinth. Boiler-makers, like men in other occupations, often have impacted cerumen, and occasionally catarrh of the middle ear, but the disease caused by their occupation, "boiler-makers' deafness," is easily shown to be a disease of the labyrinth. Other occupations of a similar nature, that is, occupations amid continuous concussions, undoubtedly cause the same lesion. A recent visit to an establishment where two engines were employed for the production of electric light, showed the writer that those employed there had become somewhat hard of hearing. They had been engaged in an occupation exposing them to the sound of regular concussions from the striking of metallic plates together.

Tests may be made in the following manner, for the purpose of demonstrating this phenomenon to classes. First test the perception of sound by aërial and by bone conduction. The room is kept as quiet as is possible while the capability of the patient for hearing conversation is tested. Then when as much noise as is possible is made which is readily done by moving chairs on the tiled floor, rapping on walls and tables, and so forth, the hearing is again tested. Invariably, it is found that when the tuning-fork is perceived on both sides better through the bones, that the power of hearing is better in a noise, and also that the reverse was true. The results may be formulated as follows:

Bone conduction better.
Better hearing in a noise.
Disease of middle ear.

Aerial conduction better.
Worse hearing in a noise.
Disease of acoustic nerve, either primary or secondary.

This symptom would often be found in acute disease of both sides did such diseases last long enough to admit of proper tests. To say that the whole explanation is to be found in the fact that the voice is raised when in a noise, is to forget that even in a quiet place, with just such an elevation of the voice, these patients do not hear as well as they do in the noise. Besides, the elevation in the voice is usually only slight and sometimes there is none at all. When the symptom does occur, it is so marked that no mistake can be made. When a patient does not know whether he does or does not hear better in a noise, we may assume that he does not, and when he does not, the case will be proven to be one in which the nerve is somewhat involved.

From careful observations of a vast number of cases we draw the following conclusions:

1. There is a large class of people suffering from impairment of hearing in quiet places, who hear very acutely and with comfort amid a great din or noise.

2. The disease causing the impairment of hearing thus relieved, is situated in the middle ear. It is usually observed in the chronic non-suppurative form of disease of the middle ear, but it may also be found in acute or subacute catarrh of this part, as well as in a chronic suppurative process with loss of the whole or a part of the membrana tympani.

3. The proximate cause of this phenomenon is probably to be found in increased action in the articulations of the ossicula auditus. They acquire a greater power of vibration.

If a physicist can give us an instrument which, being placed in the auditory canal, will produce sound enough to act upon the ossicles, as does a great noise in a room or the noise of a railway train, we shall have found magnifying lenses or the like for impairment of hearing.

The telephone now often has this effect in middle ear cases.

CHANGES IN THE MEMBRANA TYMPANI.

The appearance of the drum-head cannot be regarded as positively indicative of aural disease. In some few cases we find the membrane in what may fairly be said to be a normal condition in appearance, and yet we may have a very great impairment of hearing, which the other objective symptoms as well as the tuning-fork show to depend upon disease of the middle ear. These cases are not common, and then, if the loss of hearing is great, we may conclude that the alterations in structure are chiefly upon the inner or labyrinthine wall of the cavity of the tympanum. We very rarely find an absolute sinking inward of the membrane, unless attended by some impairment of hearing. A sunken drum-head, that is, one in which the head of the malleus stands out like a miniature button, while the whole membrane seems collapsed and sunken, is good evidence of the existence of adhesions in the cavity of the tympanum and of impairment of hearing.

The first question in studying the membrana tympani is, very naturally, what is the appearance of a normal one? Tröltsch and Politzer have given such perfect descriptions that we now have a complete guide to the changes that may occur upon it. In order to determine what may be fairly considered a normal membrana tympani, we have made examinations of ears in which the hearing power was normal. The persons whose ears were thus examined were not aware that they had ever had any kind of aural inflammation even in childhood. They did not suffer from naso-pharyngeal catarrh and never had suffered from it. The hearing distance, as tested by the watch, was normal, and the tuning-fork was heard equally well on both sides of the head. From these cases the observations of the writers above noted were verified. The color of the membrane may vary from a neutral gray to a dark blue; but it is rather more inclined to a gray than to a blue. The lustre and transparency vary exceedingly; the membrane may be very brilliant and transparent, so that the stapes is seen through it, and it may be quite dull and hazy in appearance.

The light spot at the end of the malleus is usually triangular in shape, although not always. It is, perhaps, always present in some form if the hearing be normal. The head, handle, and short process of the malleus are plainly visible. There may be opacities at the margin of the membrane, where, as Tröltsch showed, the mucous membrane is thickest. The gray color may be modified by a delicate pinkish injection along the periphery of the membrane and handle of the malleus.

It is not uncommon to find chalky spots or points of calcareous degeneration in the membrana tympani. They are found not only in the ears of persons with impaired hearing, but also in those whose hearing power is acute. Undue weight should, therefore, not be attached to these appearances.

Tröltsch[1] seems to have been disposed to regard these calcareous formations as connected with high degrees of impairment of hearing, but this is not found to

[1] Politzer; *The Membrana Tympani*, p. 58.

be necessarily the case. Politzer[1] regards them as the products of suppurative processes that have run their course. In some cases, as we know, such inflammatory affections are perfectly recovered from, and if the calcareous degeneration do not occur on an important part of the membrane, it probably will produce no impairment of hearing of itself.

It has been shown that a calcareous degeneration may occur in the course of a non-suppurative process. Calcareous degenerations, as shown, by the miscroscopic examinations of Politzer, usually occur in the fibrous layer. Where the deposit was not very thick, the integument was quite easily separated from the calcified parts. The mucous layer was a little more adherent. In some cases, both the external and middle layers were involved in the calcific process. Politzer once found a true osseous deposit, together with the calcareous degeneration, in one of his cases. Black or dark brown pigment was also found by him and fat globules everywhere.

An acute catarrh of the middle ear in childhood is sufficient to change the color or curvature of the membrana tympani, and thus render it impossible to say that we are dealing with a normal membrane. The membrana tympani of the child, differs from that of the adult, in being more transparent, while it is rather of a yellowish tinge than gray, and the handle of the malleus is not as distinctly seen.

Politzer long ago proved that the triangular spot of light, which is one of the chief points for study in this part, is due to the manner of the reflection of light

[1] Politzer ; *The Membrana Tympani*, p. 58.

from its surface, and the factors which cause this reflection have been fully detailed in the chapter upon the Anatomy of the Middle Ear.

Politzer[1] believes that we can form no conclusions as to changes in the cavity of the tympanum and membrana tympani, from alterations in the size and shape of the light spot; but this view may not be correct. In the first place, if changes have taken place in the outer layer, or layer of epidermis, the reflecting power of the membrane is nearly removed, and there is no light spot. Its absence certainly indicates changes in the drum-head. Again, if it be smaller than usual, or if it can be changed in form by the Valsalvian experiment, or by other methods of inflating the middle ear, we may draw quite positive and valuable conclusions as to the traction exerted by the malleus, and as to the inclination of the membrane. We may find an irregular or small light spot on a person with normal hearing power; but such a state of things is rare, and its shape and size will be found to be, in the majority of cases, a pretty fair guide in a general way, as to the loss of function. From the notes of ninety-four ears affected with chronic non-suppurative inflammation of the middle ear, recorded by Dr. D. Webster:

In 59 the light spot was present.
In 32 " " " " absent.
In 9 " " " " normal.
In 44 " " " " smaller.
In 2 " " " " larger.
In 4 " " " " divided.
(that is 2 or more light spots existed.)

In a hundred cases of chronic catarrhal inflammation

[1] *The Membrana Tympani*, translated by Mathewson and Newton, p. 8.

of the middle ear that were seen in private practice, the following notes as to the light spot were made:

Well shaped	16
Small	48
None	17
Two	1
Interrupted	8
Fairly shaped	9
Very broad	1
	100

The experiments of Magnus in compressed air, which have been alluded to in the chapter on "Injuries of the Membrana Tympani" also prove that the non-existence of the light spot does show, that the membrana tympani is forced or drawn inward.

CHANGES IN THE MOBILITY OF MEMBRANA TYMPANI.

If a person, having normal hearing power, forces the air into the cavities of the tympanum by a prolonged inspiration and expiration, with the nostrils closed, he has performed the Valsalvian experiment for testing the permeability of the Eustachian tubes, and, on examination during this act, we find that the membranes moved outward and then inward. This change takes place, in a healthy membrane, chiefly at the apex of the light spot, or extremity of the malleus; but it may occur in other parts, especially in Shrapnell's membrane. In the catarrhal form of affections of the middle ear, the mobility of the drum-head is not affected to any extent. It may be even preternaturally movable. In the proliferous variety, adhesions are apt to occur between the malleus and the membrane, and between the other ossicula, and these will seriously affect the normal movements of the drum-head and the chain of bones. It is true, however, that mere swelling of the membrane, such as obtains in the second stage of the catarrhal form, will to some extent, affect the motions of these parts.

It should not be thought that the tympanum is necessarily in a normal condition because a drum membrane moves. The membrane may move well, and yet the most serious changes may have taken place in the cavity behind it. Patients who suffer from impairment of hearing have pretty generally learned the Valsalvian test or experiment, and when they are so deaf as not to hear ordinary conversation at all, and have been so for years, they will often triumphantly, and with great skill, show the examiner how well they can blow air into their ears, as evidence that there can't be very much the matter with them after all. The promulgation among the laity and profession of the valuable character of this experiment has harmed many ears. It is an experiment simply. Its chief value belongs to the observer. It is an abuse of it to make it a method of treatment. It can be theoretically demonstrated that it is even a somewhat, although slightly, dangerous experiment to persons at all disposed to congestion of the head and neck; but this danger is not great enough to lead the practitioner to wholly abandon it as a means of treatment, were it not almost useless therapeutically, and dangerous to the integrity of the tension of the membrana tympani. A membrane that has been thus treated very frequently becomes very flaccid, and moves, at every swallowing motion.

Siegle's instrument, enables us to form a pretty accurate notion of the mobility of the membrane. The air may be exhausted by means of the lips, while the membrane is carefully watched for its movements, or a syringe may be used, such as Dr. Ely attached to the instrument. Care should be taken that the *speculum*, as it should be called, fits accurately in the auditory

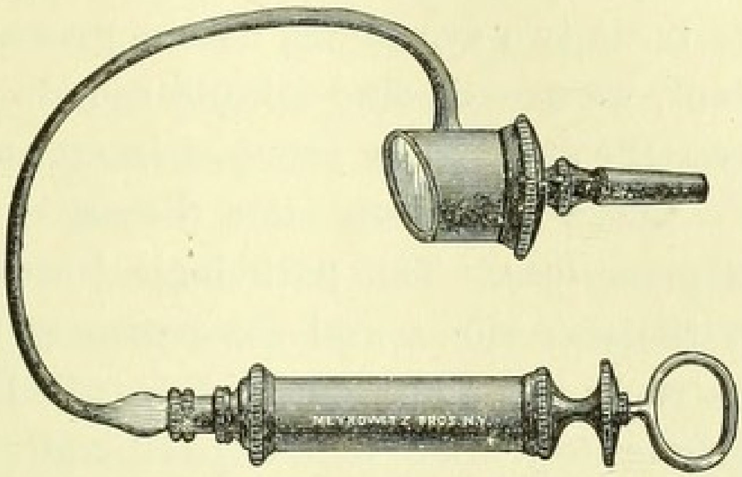

Fig. 58.—Siegle's Otoscope with Ely's Syringe.

canal, so that exhaustion of the air may actually occur. Of course, the otoscope must be used to examine the drum-head through the glass of the speculum.

CHANGES IN THE EUSTACHIAN TUBE.

We have next to examine the Eustachian tube and pharynx, and note the changes which appear there. At this point the boundary line may be distinctly drawn between the catarrhal form and the proliferous form of inflammation. In the former class of cases, the pharynx and Eustachian tube show marked evidence of morbid action; while in the latter there are scarcely any changes in the pharynx, and often no very striking ones in the Eustachian tube. The pharynx, in a true case of catarrhal inflammation of the middle ear, is found in one of the following conditions:

There may be great swelling of the pharynx and of the tonsils, with or without increase in the amount of secretion. There may be, however, excess of secretion, without any considerable swelling. In such cases the patient is usually very conscious of the trouble in his throat. He may not be aware of pharyngeal affection, and yet have a pharynx that is considerably relaxed and swollen. If these two symptoms be not present to any marked extent, we usually find minute round elevations scattered over the surface, or grouped in an arch under the uvula. These constitute the disease known as *pharyngitis granulosa.* The pathological condition is stoppage of the secretions, and consequently hypertrophy of the structure. This affection is called by some authors chronic follicular pharyngitis, and its more advanced stages glandular hypertrophy ; but the terms pharyngitis, in the stage of increased secretion and swelling, and granular pharyngitis, when these characteristics of the inflammation are less prominent, but where the granulations or hypertrophic glands are very marked in appearance, should be used. If the tonsils are not enlarged, they often exhibit, by a jagged appearance, the evidence of former disease.

Dr. Wilhelm Meyer, of Copenhagen, in 1873 [1] brought to the particular notice of the profession a disease of the naso-pharyngeal space, which, although known by reports of isolated cases, was never adequately studied until Meyer began his investigations. "Adenoid growths in the naso-pharyngeal space" is the title of Meyer's first paper upon the subject. These

[1] *Archiv fur Ohrenheilkunde*, Bd. 1, *Neue Folge*, p. 254, Bd. 11., pp. 129, 241.

growths must be known to every practitioner who sees much of naso-pharyngeal disease. They are developed in the course of a chronic inflammation of the pharynx. They are of two varieties in shape, follicular or tongue-shaped. The first variety is more common. These cases have been described by Czermak, Türck, Semeleder, and Lowenberg. The latter author speaks of them under the head of granular pharyngitis, and until Meyer's papers were published they were generally and properly enough comprehended in this title. The microscope, according to Meyer, after the examination of forty different specimens, showed that these growths were of the same structure exactly as the so-called "adenoid tissue" of His. When these adenoid growths or vegetations are found in the pharynx, the surrounding parts are intensely injected, and secrete a delicate, often greenish mucus abundantly. The velum is most swelled, so that it is very much enlarged. The mouths of the Eustachian tube in this disease, are very often red and swelled, and covered by mucus so tenacious, that it is very difficult to remove it by syringing. In some few cases the mouth of the tube is narrowed to a mere fissure. Of 175 cases observed by Meyer, 130 were associated with disease of the ear. By far the greater number were cases of catarrh of the middle ear, while suppurative inflammation of the middle ear was found in one-fourth of the cases. Of 1083 cases of aural disease observed by Meyer, adenoid vegetation in the naso-pharyngeal space were found in about seven and a half cases in a hundred. Meyer cautions us against ascribing too great an importance to these growths as a cause of aural disease, for he recognizes the fact that many of these cases never come under professional observation and treatment, because the subjects of them are sometimes troubled only with a catarrhal throat, for which they do not consider treatment necessary. It is surprising that there are many cases of naso-pharyngeal disease of a severe form in which there is no disease of the ear. The intensity of naso-pharyngeal inflammation seems often to stop at the mouths of the Eustachian tubes. A patient may have chronic naso-pharyngeal catarrh all his life and never suffer from aural disease.[1] Adenoid vegetations should be distinguished from simple granular pharyngitis, with which it may coexist. These growths affect the physiognomy and the speech, just as do enlarged tonsils. Patients speak "through their nose," say "dose" for "nose," "sogh" for "song," and so forth. The resonance of the voice is very much impaired by enlarged tonsils, and granular pharyngitis, as well as by general hypertrophy of the naso-pharyngeal mucous membrane.

Meyer's experience, that adenoid vegetation are chiefly seen in youth, is verified by all observers. They are frequently associated with cleft palate, according to Meyer, and Smith and Coles, quoted by him (Lancet, 1869, p. 772). Of the prognosis and treatment, something will be said in subsequent pages.[2]

Very many of the patients who suffer from pharyngitis and naso-pharyngeal inflammation, scarcely speak

[1] Beverley Robinson seems also to have noted this. *Transaction of American Laryngological Association*, 1883.

[2] Meyer's first observations were published in 1868, in Danish, and copied in Schmidt's Jahrbuch for 1869, and as he says with candor, even before this, other observers had published striking cases. They escaped general notice, however.

of it when asking advice in regard to the disease of the ears, and it is only on close questioning that they will admit that they are annoyed by the accumulation of mucus in the throat, causing frequent expectoration, hawking, and the other symptoms of chronic pharyngeal catarrh. At other times the catarrh, as they term it, is the great burden on their minds, and they talk freely of the stuffed feeling in the head, and describe their symptoms in a graphic style that has been obtained by a diligent perusal of the advertising columns of the daily newspapers.

THE VALUE OF THE EUSTACHIAN CATHETER.

The Eustachian catheter is a very valuable means of diagnosticating not only the changes in the cavity of the tympanum, but also those in the naso-pharyngeal space. In passing this instrument through the nostrils it should always be used as a sound, and the condition of this portion of the mucous tract carefully noted. The inferior meatus is often found swollen and even granular. In some cases nasal polypi may exist. There may also be an abnormal position of the septum which renders the canal very narrow and irregular. The manner in which the air passes through the catheter into the tube is deemed by many as of much importance in the diagnosis of chronic catarrhal or plastic inflammation. The passage of a full and strong current almost necessarily precludes the idea of any considerable change in the calibre of the Eustachian tube, unless it be atrophy of its tissue. The mere fact that air can be made to enter the tube, either by the Valsalvian experiment, the Eustachian catheter, Toynbee's or

Politzer's, the double bag, or any other method; in other words, the fact that the Eustachian tube is open, so that the patient perceives the fulness in the ears, which shows that a column of air has been forced against that already in the middle ear, is no evidence whatever that the ear is in a healthy condition. Closure of the Eustachian tube is one of the rarest of conditions. By closure, is meant such a state of things, that, by trial of the catheter and Politzer's method, the air cannot be made to enter the ear.

The two nostrils often differ very much in size. This difference is usually due to a deviation of the septum to one side or the other, in consequence, perhaps, of an injury received when the patient was young, and the bone was soft. In some very rare cases not even the smallest catheter that can be made, can be passed through the nostril of one side. As already intimated in the second chapter, much smaller catheters than those usually employed are very useful, even necessary in some cases. Large catheters are very difficult of introduction, and their use is generally very painful to the patient. One-half of the difficulties encountered by the inexperienced practitioner in the use of the Eustachian catheter, will vanish, if he will be content with hard-rubber catheters of small calibre and curve. In order to test the permeability of the tubes, the subsequent examination of the membrana tympani and the patient's own sensations become important evidences. The membrana tympani may become reddened by the mere application of instruments to the external canal, and to the mouth of the tube, so that we must be careful to exclude such sources of error.

The diagnostic tube of Toynbee, by means of which we listen to the sounds of the air passing through the tube up to the drum-head, is also thought by many to be of assistance in determining the patency of the tube and the size of the cavity of the tympanum. Kramer claimed to determine by the use of the diagnostic tube, the character of "exudation" and the width of the tube. If there is a penetrating (*durchgehendes*) near, rattling, vesicular sound, he then diagnosticated the existence of a free exudation. If, however, a sonorous, near vesicular sound, it is proof that there is no free exudation; if there is a distant, muffled, vesicular sound, then we are dealing with sub-mucous exudation, which is united to free exudation, and so on.

The true value of the diagnostic tube is only in connection with the other means that have been mentioned, the appearance of the membrana tympani, and the patient's own sensations.

The diagnostic tube could well be dispensed with in aural practice. Whether a Eustachian tube is pervious or not, may be learned much more readily than by listening with the diagnostic tube. The old ideas as to the importance of mere permeability of the tube, have been properly lost sight of, in the study of the nature of the inflammatory changes in the calibre of the tube and in the tympanic cavity. We are unable to get much light as to these points from the use of the tube.

PATHOLOGY.

After the clinical investigations of Kramer and Wilde, the first great advance that was made in Otology were the dissections of Toynbee. The museum of preparations illustrative of diseases of the ear, in London, is a memorial to Joseph Toynbee, that will be as enduring as scientific truths. From the time of Toynbee until now, the dissection of ears of those who were known to be deaf continues; and from the labors of Von Tröltsch, Schwartze, Voltolini, Hinton, Gruber, Orne Green, Moos,[1] and others, we have verified on the dead bodies diseases that have been diagnosticated in the living one, but in many cases, we have only learned, from the inspection of the ears of the cadaver, what is probably the condition of ears in life.

The pathological appearance in chronic catarrhal inflammation are—

1. Collections of mucus or serum distending the cavity of the tympanum.
2. Thickened mucous membrane.
3. Filling up of the cavity by lymph.

PATHOLOGY OF PROLIFEROUS INFLAMMATION.

In the form of inflammation that shows a higher formation than the catarrhal, there are changes which may have resulted directly from the increase of secretion; but the stage of catarrh having completely passed over, or, in some cases, never having existed, these pathological appearances may be properly classed together as evidences of what I have ventured to designate the proliferous form. They are:

1. Connective-tissue formations in the cavity of the tympanum.
2. The mucous membrane of the tube covered by dense fibrous tissue.

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[1] A Descriptive Catalogue of Preparations Illustrative of the Diseases of the Ear, London, 1857. *Archiv fur Ohrenheilkunde*, Bd. I. V., *Monatsschrift fur Ohrenheilkunde*. *Guy's Hospital Reports*. *Gruber's Lehrbuch*. *Transactions, American Otological Society*. *Moos Klinik der Ohrenkranheiten*. Wendt, quoted by Schwartze, *Pathology of the Ear*, p. 106.

3. Hypertrophy of the bony walls of the tube.

4. Obstruction of the tube and cavity of the tympanum by dense fibrous tissue.

5. The stapes bone completely and firmly anchylosed to the margin of the fenestra ovalis.

6. An exostosis on the inner surface of the neck of the malleus.

7. Malleus and incus anchylosed together.

8. Firm bands of adhesion in the mastoid cells.

9. False membrane on the tendon of the tensor tympani muscle.

10. Partial obliteration of the cavity of the tympanum by adhesions of the membrana tympani to the labyrinth wall.

11. Hyperostosis of the petrous bone, and anchylosis of both stapes.

12. Atrophy and fatty and fibrous degeneration of the tensor tympani.

13. Thickenings and deposits of lime, and of large round cells in the connective-tissue stroma of the fenestra rotunda.

14. Pseudo-membranous growths, sometimes filling the whole cavity with an irregular network, and sometimes covering the fenestra rotunda, and the tympanic orifice of the Eustachian tube.

These are actual appearances of individual cases, taken from Toynbee's catalogue and from the writings of other authorities mentioned; some of them are perhaps consequences of suppurative inflammation, although all cases in which there was loss of the membrana tympani, or other positive evidence of a suppurative process, have been excluded.

ETIOLOGY.

This is only to be learned by careful investigation, since by far the greater number of patients ascribe their disease to causes which are certainly very remote, if not doubtful, and to others which have certainly had no influence. Thus patients will assert that their loss of hearing results from cold, when they cannot remember that they ever had a severe cold affecting the ears, but they conclude that it must have been a cold; others, again, declare that their throats have always been well, that they seldom require to use a handkerchief, and yet an examination will reveal a bad condition of the naso-pharyngeal mucous membrane.

The following causes are among the most probable causes of chronic non-suppurative inflammation of the middle ear:

Remote: 1. A feeble state of the system due, for example, to inherited or acquired syphilis, phthisis pulmonalis, and so forth.

2. Defective hygienic management, neglect of bathing want of exercise in the open air, lack of proper food, care as to dress, and so forth.

Proximate: 1. Repeated attacks of acute catarrh of the pharynx and middle ear, a disease popularly known as earache.

2. Naso-pharyngeal inflammation.

3. Diseases of the lungs and bronchial tubes.

These proximate causes are chiefly to be made out in the catarrhal form of chronic inflammation, while in the proliferous form, the practitioner is often greatly in doubt, as to what may have been the origin or exciting cause of the insidious affection, which goes on so steadily to change of structure and loss of function. Indeed, we are often obliged to be content to acknowledge the fact of change of structure without being able to definitely assign a cause for it. Why the changes that make up a true case of proliferous inflammation or one of a bastard form in which the proliferous element predominates, continue to advance in spite of treatment and of proper hygienic management, is one of the most disheartening problems that a practitioner who treats aural disease attempts to solve. It is not strange, that cases of insidiously advancing impairment of hearing, dependent upon illy defined, but positive causes, have excited the minds of physicians to adopt even what may appear to be fanciful means for their cure.

The history of coryzas and earaches and of chronic sore-throats, is usually distinct enough in chronic *catarrhal* inflammations, and even if there be no such history, then the appearances of the pharynx, and the results of tactile investigation of the tubes, are sufficient to allow us to determine just what kind of a process has been going on.

It would be interesting to accurately trace the origin of these proximate causes. We should find that the most of them were due to neglect, or improper management; for example, the heads of some children are sometimes vigorously washed without being thoroughly dried; they are allowed to remain in water unduly long; their legs and chests are left uncovered in weather in which strong men are clad in beaver cloth, and women in furs; they play about the streets, and sit down, when tired and warm, on the damp and cold stone steps of city houses; they are held thoughtlessly by an open window on a cold day; they are warmly clad by day but insufficiently covered at night; in short, the temperature of the body is not properly regulated, and a pharyngeal catarrh passes in an instant to the tympanic cavity, where it is acute catarrh. If the acute catarrh does not go on to suppuration, it is half recovered from under the use of anodynes applied to the outer surface of the drum membrane; in which and the tympanic cavity a thickening is left which forms a good basis for a case of gradual and mysterious middle-ear trouble, and with no known cause. In large towns where the system of drainage or sewerage is sometimes imperfect, foul air may be forced back through the water-pipes, and becomes a cause, often unsuspected, of catarrhs of the worst type.

With older people a slight and neglected coryza or pharyngitis is followed by a fulness in the ears, that "will wear away," and which does wear away in part; but if it occurs in persons who have no good hygienic habits in such matters as bathing, eating and drinking it leaves behind a degree of hyper-secretion or proliferation, which, as has been said, is the foundation for repeated attacks, and, finally of permanent thickening and of adhesions.

The syphilitic catarrh of infants and young persons is the frequent cause of an affection of the middle ear, which, unlike its frequent companion, *interstitial keratitis*, is one of the worst forms of disease in the obstinacy with which it resists all treatment. The eyes may, and generally do, get well; but if once the tympanic cavities be attacked, intra-auricular adhesions occur, the membrana tympani is drawn inward, the nerve is secondarily involved, and the loss of hearing often becomes almost complete.

There are no peculiar aural symptoms, by which we may positively distinguish a case of chronic disease of the middle ear that was caused by syphilis, from one occurring in a non-syphilitic patient. Yet we may say, in general, that a syphilitic diathesis seems to cause the proliferation of tissue to be more rapid and less amenable to treatment.

Why pregnant women are so often affected by a proliferous inflammation of the middle ear, is not determined; but it is a fact that many women trace their impairment of hearing to their first pregnancy, and state that they became worse at the birth of each child. Such patients should be warned that great attention should be paid to their throats and ears, by means of gargles and Politzer's method, during the period of utero-gestation. It is the proliferous form of inflammation and not the catarrhal, which is usually observed during such cases.

Proliferous inflammation of the middle ear is often produced by cerebro-spinal meningitis. In scarlet fever and measles, we are more apt to have suppuration than in the former disease. It has been supposed that disease of the internal ear, is more frequently produced by cerebro-spinal meningitis than that of the tympanum and Eustachian tube. This may be an error, but for a fuller discussion of this subject, the reader is referred to the chapter on "Deaf-Muteism." Parotitis also is a cause of disease of the middle ear, but more frequently perhaps it affects the labyrinth, if not exclusively, certainly in connection with disease of the middle ear. This subject also will again be alluded to. The excessive use of quinine may also, in rare instances, cause incurable disease of the middle ear.

We may, perhaps, sum up our knowledge of the causes of chronic non-suppurative disease of the middle ear, by stating that they are such as dispose to swelling and infection of mucous membrane. Our increased knowledge of the pathology of this tissue will serve us in good stead in investigating the affections of a part which is thoroughly lined by it.

When the frequency of the affection that we are now discussing, is considered, it is remarkable that even with the light that has been thrown on aural diseases in the last fifty years, very many patients who have need of treatment for chronic aural disease, have had none that is serious or rational, until a very late period. It is the neglect of aural therapeutics of the last and preceding generation that recoils upon this. Since, however, the thorough study of the naso-pharynx was begun and early attention to enlarged tonsils and adenoid growths has been given, there is a great diminution of diseases of the ear among the young, so that the statistics in chronic non-suppurative disease will show a great lessening of cases of this affection in adults in the results of treatment in the coming time. But, even in our day, while very thorough attention is given, on almost every hand, to cases requiring a surgical operation, the early diagnosis and proper treatment of chronic non-suppurative inflammation of the middle ear is very much misunderstood.

TREATMENT.

The treatment of catarrhal inflammation may be fairly distinguished from that of the proliferous form. In the catarrhal form we must give a great deal of attention to the naso-pharyngeal space while in the other we scarcely need to treat it. We may classify the treatment as follows:—

1. Constitutional and hygienic.
2. Counter-irritation.
3. Applications to, and operations upon, the naso-pharyngeal space.
4. Applications to the Eustachian tube.

5. Applications to the cavity of the tympanum.

In the older text-books constitutional remedies figured very largely in the treatment. The use of mercury and iodide of potassium was strongly insisted upon. We, of the present time, are skeptical about the constitutional treatment of such affections as chronic catarrhal and proliferous inflammation of the middle ear. No thoughtful practitioner will attempt to disregard the general indications of a cachexia, or of a debilitated system, in which there is chronic inflammation of the mucous membrane of the middle ear, but the time has gone by when a person in fair health, suffering from chronic aural catarrh, and who has no constitutional taint, will be treated by alterative doses of the bichloride of mercury, followed by the iodide of potassium. The symptoms of the earliest stages of the disease were usually those of a coryza or acute catarrh, which finally settled down into an insidious and chronic process, when it has become impossible to trace the remote causes.

In our northern climates all people should wear flannel next the skin, winter and summer, of course varying the thickness according to the temperature and the strength of the individual. Thick boots in the winter, and overshoes in the wet, are also necessities for those who wish to avoid catarrhs. While fresh air should always be admitted, the temperature of a sleeping room should not be allowed to go down at night to a point below 60° ; these rules are especially applicable to persons disposed to inflammations of the naso-pharyngeal space and ears. A whole chapter might easily be written upon this subject of personal hygiene.

The causes of these forms of disease suggest a kind of constitutional treatment, which should never be lost sight of. Everything that will render a patient more vigorous, and less likely to take cold, will assist materially in curing or alleviating a chronic aural catarrh. We shall thus find much to do, in the way of correcting improper habits of life, in regard to bathing, exercise in the fresh air, ordinary clothing, sleeping apparel, and the like. Hence the Turkish bath, sponge bathing, walking, riding, boat-rowing, bicycling, golf, the general application of electricity, the internal administration of iron, and so forth, become prescriptions which the otologist will be called upon to give very frequently, if he properly appreciates cause and effect. A routine system of prescribing a constitutional remedy in the vague *hope* that it may do good, is to be condemned.

Local treatment of the nose and pharynx has already been dwelt upon in the chapter on diseases of the nose and throat causing disease of the ear. But we may here add a few words on the subject of gargling.

Gargling is a very efficient means of cleansing the pharynx, if it be performed in the manner advised by Tröltsch. The fluid is held in the back part of the mouth, the head being thrown well back, the nostrils closed by the fingers, and then the motion of swallowing is performed. With a little practice, the patient will become very proficient in this method. Those who are skeptical as to the virtue of gargling, and who claim that the process does not cause the fluid to wash the pharynx, will be convinced of the contrary by the following simple experiment: Let the posterior wall of the pharynx be painted with the tincture of iodine, and then a gargle of starch-water be used in the manner described, and the characteristic reaction will be found in the ejected fluid.

It has been generally observed that persons having enlarged tonsils, granular pharyngitis, adenoid growths or nasal obstructions, breathe through the mouth. The reasons for this are evident. Dr. Cassels made mouth-breathing the subject of an interesting paper entitled "Shut your Mouth and Save your Life." He quoted largely from Catlin, celebrated as an observer of the Indian tribes of this country, who denounced mouth-breathing in no measured terms in his work upon this subject. Catlin says: "If I were to endeavor to bequeath to posterity the most important motto which human knowledge can convey, it should be in three words, Shut your Mouth." It is certainly of the highest importance that the mouth should be closed in ordinary breathing, and if the conditions are favorable, that is to say, if the nostrils and pharynx are healthy, this will always be done. Catlin claims to have visited two millions of individuals, living in a savage state in 150 different tribes. Among this number he found only three or four deaf-mutes, and not another individual who was hard of hearing or deaf. None of the chiefs of the tribes who were questioned upon this point could remember or find an Indian who was hard of hearing, and Catlin further says, according to Cassels, that not a mouth-breather was known to exist in all these tribes. Dr. Ely wrote his friend, the late Lewis H. Morgan known to many of our readers as a distinguished

Ethnologist, as to the correctness of Catlin's observations among the Indians, and he received the following reply:

> As a rule, so far as my observations have extended, the Indians are sound in hearing and in vision, both senses being more acute than with us. I have seen cases of sore ears among the Western Indians and which may have been attended with defects in hearing. At the time, I supposed the cases due to syphilis, which has been a scourge upon some of the tribes.
>
> If you were to select a hundred Indians at random, with a hundred white men the same, you would, I believe, find a larger number of the former sound-headed, limbed, and sound in the physical senses than of the latter. Moreover, on general principles this ought to be the fact.
>
> Yours truly,
>
> L. H. Morgan.
>
> P.S.—Catlin was a good observer.

Catlin was correct without doubt as to mouth-breathers among healthy Indians, but he overlooked the fact that they were nose-breathers, not from habit, but because they had healthy naso-pharyngeal spaces. Secure this for the human race and they will all breathe with the mouth closed. In the writings of Catlin, and in Morgan's note, there seems to be an overlooking of the fact, that Indians, like the Spartans, may have been the *survival of the fittest.* Delicate children with the snuffles, will probably survive in civilization, when Spartan exposure, or a home in an American wigwam, would soon cut them off.

TREATMENT THROUGH THE EUSTACHIAN TUBE.

Among the means employed in the treatment of the Eustachian tube, the use of the Eustachian catheter stands preëminent. It is difficult to say whether we treat the tube or the cavity to which it leads by the means of this instrument. We may often very much improve the hearing power of a patient by the introduction of the instrument between the lips of the tube, even when no air, vapor, or fluid is passed through it. After such a procedure it is much more easy to inflate the ear by Politzer's method. Some have rather hastily concluded that all or the greater part of the effect produced by the catheter might be had by applications to the mouth of the tube, and have discarded this instrument; but experience shows the Eustachian catheter is essential in the treatment of chronic non-suppurative inflammation of the middle ear. The agents to be introduced through it are: Atmospheric air, Fluids, Bougies, Vapors, Electricity.

The effect of unmedicated air used by the catheter is often sufficient without the use of vapors from medicinal agents or fluids. It is, however, not so efficient in chronic as in subacute or acute aural catarrh, where its effects are almost magical. In fact, it may be claimed that there are no idiopathic affections for which relief is so immediately obtained as acute catarrhal inflammation of the middle ear, where inflations of the tympanic cavity with simple air are often sufficient to cause a patient, for whom the world of sound is again open, to shed tears of joy.

In chronic catarrh and especially in the proliferous form of non-suppurative disease, the senior author has been for years in the habit of employing the vapor of iodine and camphor by means of the simple applications pictured on page 380. The patient holds the apparatus in the hand while the surgeon forces the vapor into the catheter by means of an ordinary soft rubber air bag, one drachm of pure camphor to two ounces of tincture of iodine will be found to be a solution tolerated by all patients and even liked by some.

Fluids, such as solutions of iodine, corrosive chloride of mercury, nitrate of silver, sulphate of copper, sulphate of zinc, are used through the Eustachian catheter by some aurists, but they have gotten out of fashion and been pretty generally displaced by various medicated vapors. Sprays entering the calibre of the tube are now not widely used.

It may be said in general terms that the use of the

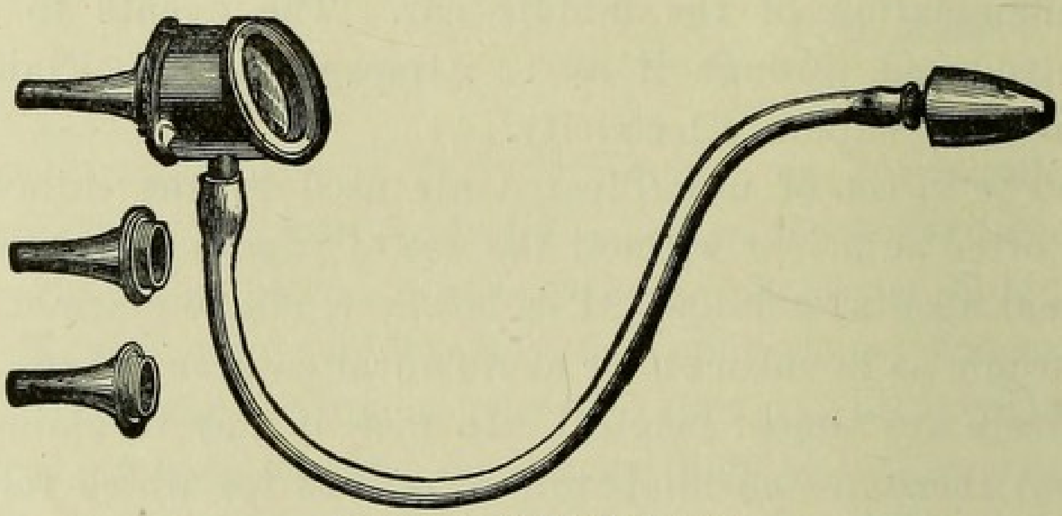


Fig. 59.—Siegle's Otoscope.

spray of astringent fluids to the Eustachian tube, is chiefly of value in these cases in which the evidences of catarrh or increased secretion, are strongly marked, while fluids are to be employed in the tympanic cavity, when there is marked evidence of the predominance of the proliferous form of disease. The injections of simple air, or of medicated vapors, in what may be called the mild cases of catarrhal inflammations, will be found quite as efficacious as fluids or spray. As has been already mentioned, steam and iodine vapors are chiefly applicable to cases of proliferous inflammation.

Politzer's method of inflating the drum cavity should be employed immediately after the use of the Eustachian catheter, in all cases of chronic disease of the middle ear, but it is not a substitute for the catheter. It is very often found that no impression can be made upon the tube or middle ears by the use of Politzer's method alone, but after the catheter has been passed into the mouth of the tube, and some muscular spasm set up in the abductor and dilator of the opening, that this means of treatment becomes effectual.

Some years since the senior author adopted the practice of injecting vapors into the ears by means of a simple apparatus,[1] represented on page 31. The apparatus consists of a hollow metal bulb, which is attached by a bit of rubber tubing to the air-bag used in Politzer's method. Any fluid that is readily vaporized is placed upon a sponge or absorbent cotton contained in the bulb, and on practising inflation of the ear, the vapor is forced into the Eustachian tube and the cavity of the tympanum. The tincture of iodine and chloroform are the agents usually employed. Dr. J. S. Prout taught us the value of chloroform as a means of diagnosticating closure of the tube. This vapor will penetrate the ear when air or iodine are not perceived, and when all attempts at inflation with air have failed, or, as should be said, when the patients experience no sensation in the ears from the use of air through the catheter, or by Politzer's method. Caution should be used in employing the chloroform; that is, but a few drops should be used, or the most intense pain may be caused. Patients will sometimes jump from the chair in surprise and pain, after one careful

[1] *American Journal of the Medical Sciences*, vol. liii, p. 62.

inflation, when only two or three drops were upon the little sponge in the bulb, and this, after attempts to cause a sensation in the ears with common air had utterly failed. Others, however, tolerate a considerable dose on the cotton. The use of chloroform vapor is certainly a very valuable diagnostic means, although

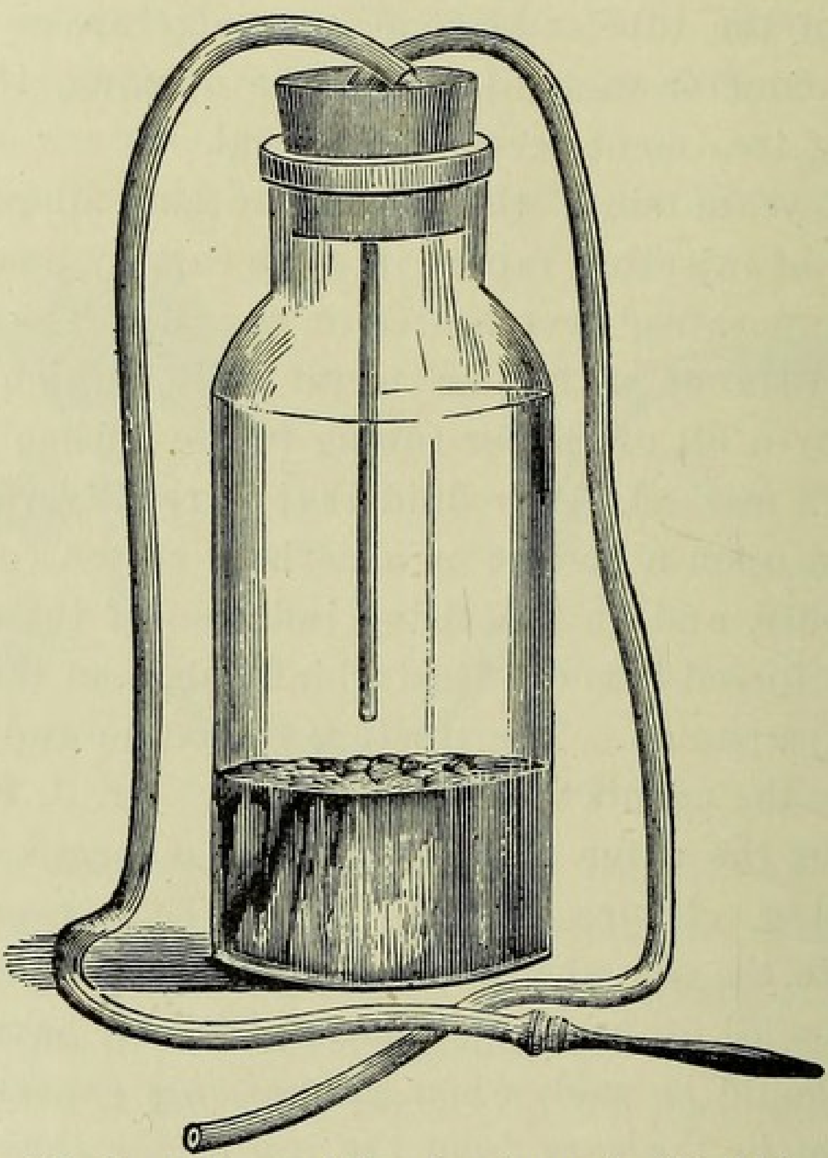


Fig. 60.—Iodine and Camphor Apparatus (Rankin).

its therapeutic value is limited. In advanced cases of proliferous inflammation it has a positive value.

THE DOUBLE INFLATOR.

A means of treatment, which appears to be promising, is that promulgated for the relief of senile deafness only, by Dr. Achscharumow in Poltawa (Southern Russia,[1]and which has been described in an early chapter. For the convenience of the reader the method of its use will again be described. The writer uses a new means of securing a permanent dilation of the Eustachian tube. The writers of the present volume have somewhat extended the application of this method, and it is now in process of trial in the hands of many of our patients and in our own.

The air is blown into the tympanic cavity by means of the ordinary apparatus used for spraying the nostrils or larynx. On the free end of it, a proper tip to fit the nostrils is inserted, and for convenience of use, the tube between the two air bags should be doubled in length by an intermediate piece. The patient who wishes to treat himself sits or stands before a table upon which the apparatus lies, having inserted the nose-piece and closed the nostrils over it with two fingers of the left hand, *the mouth being open,* the procedure begins. Seizing the terminal air bag of the apparatus with the right hand, it is pressed together several times until the second air bag is sufficiently distended. This widens the opening to the Eustachian tube and the strong tension of air is felt in the inner ear. The opening of the tube and the membrane of the drum remains in this moderately dilated condition as long as the nose is hermetically closed, and the second air bag fulfils its function of not allowing the air to pass backward. The right hand is then pressed on the second air bag and pressure made with strokes that are light and quickly following each

[1] *A contribution to the Treatment of Senile Impairment of Hearing Therapeutische Monatsschrifte,* Jan. 1904.

other, by which the opening of the tube is enlarged in spurts and the drum-head put in vibration. This pressure must be made very rapidly at the rate of a hundred and fifty times in a minute, perhaps more. When the nose is kept closed, the bag air tight, and the tension of the air moderate, these passive gymnastic exercises can be kept up on both structures as long as we like, but in general, in consequence of incomplete closure of the nostrils, the air bag becomes relaxed and must be filled again by a little pressure, consequently some minutes will be taken up. Each pressure of the hand, even the resting of the fingers on the second air bag, causes the sensation of a light blow in the ear. This method constitutes a kind of vibratory massage of the affected portion, the walls of the opening of the Eustachian tube, the Eustachian tube itself and the membrana tympani.

The greatest care should be taken to see that the nostrils are hermetically closed during the operation, while the mouth is wide open. The manipulation may be continued for three to five minutes and practised twice a day. The sensation of air entering the ear is sometimes at first not very decided, but, with a little practice, it becomes marked. As a means of enabling patients to carry on inflation at home continuously, it appears to be a useful instrument. Still more in the surgeon's own hands its use may be greatly extended in subacute or chronic cases of chronic non-suppurative inflammation.

BOUGIES.

Bougies, for the purpose of dilating the Eustachian tube, are highly spoken of by many writers. Bonnafont and Kramer, were perhaps the first to use them. Guye[1] of Amsterdam and Ménière also employ them.

Their use is chiefly to stimulate the mucous membrane lining the Eustachian tube, and thus to remove the swelling. Complete stricture of the tube is too rare an occurrence to be really much considered as an indication for the use of the bougies. In injections of vapors or fluids the stimulant thus sought may be without any of the unpleasant features of the bougie treatment, such as the production of emphysema, breaking of the bougie in the tube and severe pain. The instrument having been passed through an ordinary Eustachian catheter and once engaged in the tube is pushed onward as far as the isthmus, allowed to rest there a few moments and then withdrawn, and air gently blown in through the catheter. If the air does not readily enter the tympanic cavity, all forcible attempts to force it should be carefully abstained from and the bougie reintroduced, either then, or preferably at another sitting, and carried only to a very short distance, say one or two millimetres farther on, and the experiment resorted to, to ascertain if the tube were open. "The conical French bougies should be discarded as dangerous, from the tapering ends being too long; but the catgut bougies might be made slightly conical by rubbing them on emery paper." (Weir.)

In some cases of adhesive inflammation of the tympanum with a Eustachian tube of small calibre, the use of a bougie has been known to produce great improvement in the hearing. (Phillips.)

[1] *Archiv fur Ohrenheilkunde*, Bd. 11, p. 6.

ELECTRICITY.

This is an agent whose real value has been much underestimated in many departments of medicine, but which has been overrated in the treatment of aural disease. It is only necessary to say at this point, that not much is to be expected from the use of electricity in chronic non-suppurative inflammation of the middle ear.

Of late years the use of electricity through the Eustachian catheter has found advocates. Besides, electrical massage is widely recommended, but the present writers have found, after very thorough trials, that nothing is accomplished by electricity that is not achieved by the use of common air, medicated vapor and bougies.

DURATION OF TREATMENT.

Something should be said as to the length of time a case should be treated. Inasmuch as we cannot hope, in many of the cases, to do more than arrest the progress of disease, and perhaps improve the condition, since we cannot dismiss them as *cured*—that is to say, with the hearing perfectly restored, the tinnitus aurium gone—we desire to know how long we shall treat the ears locally. The general hygienic treatment, such as the frequent employment of baths, of a gargle, the exercise of great care to keep the extremities warm, to avoid taking cold, and so on, should be kept up during a patient's life, and he should be told at the first consultation, that he has a life-long warfare to engage in unless he desires to end his days with the use of an ear-trumpet.

But we cannot keep up a local treatment of the Eustachian tubes and pharynx indefinitely. Those who believe that a catarrhal pharynx and nares can be thoroughly cured in our climate, that a disposition to colds in the head, can be effectively subdued by the use of the spray of nitrate of silver, or the spray of any other agent used by means of the most perfect apparatus, will continue to use these means of local treatment until the end is accomplished. But those who have been less successful in such attempts must fix some limit to the time of treatment. If it be proposed to get the confidence of a patient suffering from chronic non-suppurative middle ear disease, which is progressive in its character, it is proper to tell the whole truth at the first consultation and say we have no hope of making him hear *very well* again. It is only a question of arresting the progress of the disease, and perhaps, of increasing the hearing power. To this end, about twice a year, perhaps three times in some cases, the patient should receive a course of local treatment until the disease has ceased to progress, for a period of time varying from three to eight weeks, while the general treatment is to be a life-long course. Daily treatment is the most useful. It may be continued longer than three weeks if improvement is going on. It may be well for the patient, after a course of treatment, to continue the inflation of his own ears by the method with the double air bag.

There is a class of patients who never do more than to occasionally consult a new aurist whose advice never influences them. One of their families has been a victim of chronic aural disease for a period varying from two to twenty years, and they have at last, at the request of the family physician, screwed themselves up to the courage of consulting a specialist. They come in town for a day's shopping, and call upon the doctor, meanwhile, always being in a great hurry, and sending word to the consulting room, that they have come fifty miles to see him. When such advice as here delineated is given, and the almost bewildered physician sits down to lay out a plan of treatment and correct the improper habits of life that have induced and maintained the disease, he finds that he is dealing with persons who expect magic ear-drops, vibrators, ear-drums or some mysterious and quickly acting agent that will restore the hearing in the interim of rest of a New York shopping excursion. Of course, such patients figure in the statistical tables under the head of "seen but once, result *unknown*," although in the mind's eye we can set them down as going on slowly but surely to the ear-trumpet, and banishment from social intercourse.

The practitioner, young or old, will do much better in such cases, both for the patient, his own reputation, and that of the profession in general, if he declines to prescribe at all for such persons, for it is only under favorable circumstances, that is to say, with intelligent patients, in easy circumstances of life, who are attentive to advice and punctual in attendance, that anything can be accomplished to stay the progress of a well-advanced catarrhal or proliferous process in the middle ear.

Even then it is not always possible. Certainly those who have waited ten or twelve years, and have finally consulted a physician on account of impairment of hearing, depending upon chronic non-suppurative inflammation with the idea of getting relief in one or two or three visits, have nothing to hope for. It is better to tell them so at once, lest we unwittingly emulate the charlatans, to whom all disease is an object of attack by medication. Otology has suffered much, from innocent attempts to accomplish that which is in the nature of things, not to be accomplished. A little frankness about chronic non-suppurative disease of the middle ear, will soon awaken the laity to the necessity of attention to the causes of the disease, and furnish us all with a large proportion of curable cases.

Chronic catarrhal cases are much more amenable to treatment than the proliferous form. Indeed the former cases are frequently curable, but the proliferous variety never. In its results, in spite of good local and general care, it is very like progressive atrophy of the optic nerve or chronic glaucoma.

Since the publication of the works of the modern German school in this country there has been a tendency to refer too many cases of progressive impairment of hearing to catarrhal or proliferous inflammation of the middle ear, and diseases of the nerve are ignored, or their existence, except as secondary affections, have been even denied. The practitioner is advised to attempt to make a differential diagnosis between disease of the middle ear and of the nerve, especially in cases of supposed chronic proliferous inflammation. The means we have at hand for this purpose, will be fully dwelt upon when we come to the discussion of disease of the nerve. It need only be said here that the treatment of disease of the internal ear, by the local means generally employed in treatment of the middle ear, is harmful, since it aggravates the conditions by inducing congestion of the labyrinth.

OPERATIONS UPON THE MEMBRANA TYMPANI,

Operations upon the membrana tympani, the ossicles and muscles of the tympanum, were practised during a number of years by Politzer, Weber-Liel, Orne Green, Pomeroy, Sexton, and more recently by Burnett, Dench and other authorities, for the relief of chronic non-suppurative disease of the middle ear. Burnett was, perhaps, the most decided in his opinions of the merits of ossiculectomy for the relief of vertigo and tinnitus in advanced cases. But, for the most part, the treatment of proliferous inflammation by this method, has been abandoned. Much of the treatment was avowedly experimental, the conditions being so detrimental to the comfort of those affected by it, that every effort that promised anything in an operative way, was made, in the hopes of procuring some relief. In spite of the fact that a few cases out of a very large total, have, no doubt, been permanently freed from terrible tinnitus, and a few also from vertigo, the results are so uncertain, and the patients who recover are so few, that it may be said that operations for this disease have practically been given up.

For actual relaxation of the drum-head, painting the drum-head with collodion and paper disks are of essential service. (Blake.)

EXHAUSTION OF THE AIR IN THE AUDITORY CANAL.

Politzer recommends the exhaustion of the air in the external auditory canal, by plugging the meatus with cotton-wool, saturated with oil, as a means of drawing out a sunken drum-head, when we have reason to believe that the tensor tympani is retracted. The patient closes the auditory canal in this manner in the evening, and removes the plug in the morning. If the plug be used two or three times a week, for two or three weeks, and no result be obtained, Politzer considers the remedy of no value.

DELSTANCHE'S MASSEUR.

A great advance in the treatment of adhesion be-

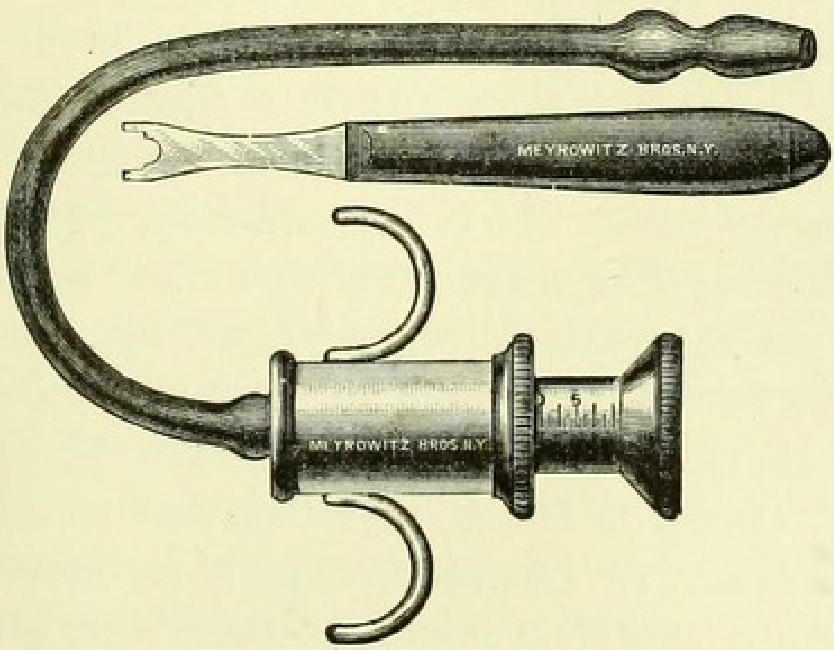


Fig. 61.—Delstanche's Masseur.

tween the ossicles has been made by Delstanche's improvement upon Pinkney's apparatus. The ancient instrument of Pinkney was efficacious, but it is a clumsy instrument, which was displaced by the Ely-Siegle otoscope. This in turn gives way to Delstanche's instrument, which is not only an excellent means of testing the mobility of the ossicles, but also of treating cases of chronic catarrh or chronic proliferous inflammation with the characteristic rigidity of the ossicles. By means of this instrument in the treatment of the rigid ossicula, much is sometimes accomplished. It may be used daily for weeks. It is an adjuvant of considerable value in the treatment of chronic non-suppurative inflammation, in the relief of tinnitus aurium, and impairment of hearing.

THE RESULTS OF TREATMENT.

After long experience, we are constrained to say that results of treatment of chronic non-suppurative inflammation of the middle ear, are not brilliant. It is, essentially, an incurable affection, even in the decidedly catarrhal form. It is a disease that may often be alleviated, and sometimes arrested, but in adults, never cured. It is preëminently, especially in the proliferous form, a condition that is not benefited by the best general treatment the world affords. A patient with this affection, may avoid northern winters, and live in a climate like that of Nice, Cairo, Aiken, Thomasville, Augusta, Coronado Beach, and then not recover from aural disease. In Colorado, indeed, he may become worse, since chronic catarrh is there very common. If in the former named places, he has appropriate local treatment, his chances of improvement will be better. But we do not mean to be understood as saying that a change from a harsh climate, in the winter, to a mild one, will not be of avail, in preventing attacks of coryza, in lessening the horrors of tinnitus aurium, and arresting the advances of disease of the middle ear. But yet, after the lapse of many years in treating such cases, we are not at all certain but that patients in good physical condition generally, are quite as well off in the North as in the South, if they undergo a local treatment, during the winter, that has been outlined in the preceding pages. If, to the change from a harsh to a mild climate, be added proper local treatment, the patient will do much better, than if they have the benefit of the climate alone.

Sometimes the tinnitus aurium accompanying this disease, is alleviated by a winter in the mountains of the South, for example, those of North Carolina. Some patients find the seashore, especially that of the New England coast, in the summer, of benefit to the naso-pharyngeal space, while others find their ears filling up in all seaside places. On the whole, we are inclined to think that in the summer the mountains are better for chronic aural patients.

It should be remembered that chronic non-suppurative inflammation is not an entity, which can be subdued or driven out by special means, adapted to many cases. We are inclined to think, without the positive knowledge, which only the statistics of a large number of cases would furnish, that the disease is on the decrease, in this country, since acute aural disease, and the affections of the nose and pharynx, are better understood and managed. Just as chronic suppuration, with its consequences, has been markedly lessened in our own time, as the result of a wise appreciation and treatment of earache, and acute catarrhal suppuration, so has chronic aural disease been lessened by the appreciation of the importance of incipient aural and naso-pharyngeal disease.

If the picture of the prognosis of chronic non-suppurative affections of the ear is a gloomy one to the young and enthusiastic practitioner, he may find great consolation in lessening their number in the next decade, by a proper treatment of acute aural disease in this. And he may also rejoice that a vigorous fight is now maintained by all special practitioners to, at least, arrest the progress of a disease, which, when well advanced, takes away very much from the ordinary enjoyment of life.

CHAPTER XII.

CHRONIC SUPPURATION OF THE MIDDLE EAR.

THE chapters in which acute aural catarrh and acute suppuration have been considered, have prepared us for the description of the disease properly classified as chronic suppuration of the middle ear, which is a direct consequence of these affections. It was formerly almost universally known and described as otorrhœa. But this term, simply meaning a discharge from the ear, and being one that does not in any proper way define the seat or character of the disease, should be banished from the nomenclature of Otology. Chronic suppuration of the middle ear is the affection which, among the laity, is called "a running from the ear."

The name chronic suppuration comprehends a large variety of disease in one of the important parts of the body. The term chronic suppuration of the middle ear usually implies a perforation of the drum-head or membrana tympani. In exceedingly rare cases, there may be a suppuration in the tympanic cavity and mastoid cells, especially in the latter, for weeks or even months, without the occurrence of a perforation of the thin but strong membrane that forms the boundary between the middle and the external ear. In all but exceptional cases, however, when chronic suppuration of the middle ear is stated to be the diagnosis of a given case, it is meant that the disease involves the drum-head.

Chronic suppuration of the middle ear was formerly often confounded with that *rare disease,* chronic suppuration of the external auditory canal. When it is demonstrated that the pus has its origin, not from the auditory canal, but from the middle ear, it is usually an easy task to convince the person affected of the danger of a neglect of the disease. This error as to the origin of the affection, is in many cases the cause of its neglect. An eczema, or a so-called seborrhœa, or even a suppurative external otitis, may, perhaps, when occurring with young children, be left to itself or to general hygienic attention and tonic treatment with comparative impunity; but the best of such care will not usually avail to stop a formation of pus in the cavity of the tympanum or the mastoid cells, unless local treatment is also employed.

We may almost take it for granted that any case of *long-existing* suppuration in, or discharge of pus from the ear, will be found to have its origin behind, and not in front of the membrana tympani.

Cases of suppuration of the middle ear preponderate over the cases of external otitis of all kinds in a proportion exceeding that of five to one. The proportion may be larger than this. In some cases the diagnosis is made of inflammation of the canal, simply because at the outset the inflammation was so great as not to allow of a view of the drum-head, which was afterward found to be affected.

Symptoms:—A discharge of pus through a perforated membrana tympani is the most striking symptom in chronic suppuration of the middle ear. The term perforation includes a great variety of pathological conditions. For example, the drum-head may be entirely swept away; one-half of it may be gone; one-third of it may be gone; only a small opening about as large as the head of a pin may exist; two openings may exist; so that in the very appearance of the drum-head we may meet the greatest difference in conditions. Besides, polypi may be seen through the perforation, springing from the tympanic cavity, or there may be small growths or granulations hardly to be dignified by the term polypi. We may find the opening covered by hardened wax, or even by dried pus. Quite large quantities of muco-pus, pus, or of mucus, or of a fluid, like serum, may conceal the opening and be formed in a quantity sufficient to cause a constant flow into the auditory canal, or the quantity may be very small, and only to be detected on careful examination. In any consideration of the diseases of the middle ear, the practitioner should remember that the mastoid cells, as well as the cavity of the tympanum, are an integral portion of this anatomical region. Hence it is that the lining membrane of the mastoid is usually involved in any inflammation of the tympanum.

Sometimes one-half of the membrane is cleanly cut away. In fact, the appearance of the membrane is as various as the number of cases. The description of no one case will do for another.

Besides polypi, exostoses may exist in the canal, or even in the walls of the tympanic cavity; the bone may be exposed, that is denuded of its periosteum, roughened, and in a condition of caries. The seventh nerve, in its passage through the aqueduct of Fallopius, may be destroyed by the morbid process, when the smirk and uncovered eye of facial paralysis are added to the disgusting detail of the ravages of disease.

The term chronic suppuration of the middle ear is a very comprehensive one. No discussion of the treatment of the formation and discharge of pus from the tympanum, will be profitable unless there precedes it a full understanding of the anatomical and pathological condition which allow the pus to be formed and collected. If the middle ear were a simple canal or cavity the principles at the basis of the treatment would, perhaps, be the same that they are now, but it comprises a *series* of anatomical parts, and the details in carrying out these principles are very different, and are much more varied than they would be were we dealing with a simple and easily bounded space. It is the anatomy of the middle ear, that makes the treatment of its disease not an entirely simple matter. There is, perhaps, no one point more than another, in the membrana tympani, where perforations are apt to occur. Some writers say that they are most frequently situated in the anterior and lower part of the membrane, where the air blown through the Eustachian tube impinges. Hinton, has seen quite as many in the inferior and posterior segments, an experience which the present writers confirm. They are found in every quadrant of the drum-head.

Perforations are sometimes so small as not to be easily recognized unless air is forced through the Eustachian tube and made to pass through them. As has been stated in the preceding chapter, a pulsation at the bottom of the auditory canal was formerly thought to be pathognomonic of perforation of the drum-head. Where this pulsation occurs, it is a very suspicious circumstance; but the membrana tympani, in a state of acute catarrhal inflammation, will sometimes exhibit this phenomenon when the drum-head is intact. "This motion (pulsating) is imparted by the blood, and implies not necessarily an aperture, but a thin surface of fluid in contact with a beating vessel" (Hinton). The complete absence of the membrana tympani especially if the mucous lining of the tympanic cavity have a granular or velvety appearance, is often very puzzling. Such cases will sometimes require the most careful cleansing before we can determine how much, if any, of the drum-head remains.

We need not enter into any detailed account of the condition of the pharynx and Eustachian tubes in the affection now under consideration, since this subject has been so fully already dwelt upon. It may be sufficient to say here that we find in chronic suppuration, as well as in all the varieties of inflammations of the middle ear, except the purely proliferous forms, that the naso-pharyngeal region has been the usual point of origin of the disease, and that any successful management of the ear, will require great attention to the pharynx and Eustachian tube.

The general health of a patient affected with chronic suppuration of the middle ear is often impaired, even if none of the serious consequences have occurred. Such a drain upon the system is not tolerated with equanimity by nature. Hackley found albuminuria in a number of cases of chronic suppuration of the middle ear, where there was no apparent cause for the disease, except the long-continued secretion of pus in the tympanic cavity. Such cases he thought were analogous to those of the development of lardaceous kidney from debilitating diseases. The fact that a running sore is detrimental to the continuance of good general health, would scarcely need assertion, were it not there was formerly a very deeply rooted idea among the laity—an idea that was first inculcated by the profession—that there is no harm resulting from a chronic ulcerative process in the ear, when it is well out of sight. The anatomy of the middle ear, showing as it does, the relations of this small portion of the organism to the important parts of the system, to the great arterial and venous vessels, to the nervous system, to the organs of respiration, is of itself a sufficient proof of the necessary importance of a long-continued suppuration in this part.

There still exists among many a prejudice against the stoppage of a purulent discharge from the ear. This prejudice is chiefly dependent upon the erroneous teachings of the older French writers, Du Verney and Itard. "Because it was observed that on the supervention of cerebral disease, discharges from the auditory canal have lessened, practitioners mistaking the effect for the cause, have been led to believe that the sudden 'drying up' produced a metastasis to the brain, a notion as crude as it is unsupported" (Wilde). There is no pathological experience on record which can sustain the quite common assertion that it is dangerous to stop a discharge from the ear. There are more cases on record—of which there are, alas! many more than were ever recorded—where disease of the brain has occurred from the extension of a neglected suppuration to the cerebral membranes and substance, and the discharge from the ear has nearly ceased; but these certainly form no argument against the arrest of an ulcerative process before any parts beyond the cavity of the tympanum are involved.

He who believes that we can easily cause a discharge of pus to cease, after caries of the temporal bone has occurred, will find many cases which will cause him to doubt the efficacy of his therapeutics. As well might we refuse to heal an ulcerated hip-joint as to neglect to check a discharge from a diseased membrana tympani or lining membrane of the tympanic cavity. It is doubtless true, judging from the histories of cases and the inspection of the membrana tympani, in which cicatrices occur, that many cases of chronic suppuration are cured with very slight treatment or with none at all. The fact remains, however, that many of the neglected cases do not so recover, and after a purulent discharge from the ear has once set in, "*we can never tell how, when or where it will end, or what it may lead to*" (Wilde).

A careful treatment is usually required to check the discharge and treat the ulcerated membrana tympani, and restore the hearing power. Even with the most careful and skilful treatment, we cannot always succeed in all of these things. In some rare cases we do not succeed in any of them, when a major surgical operation should be resorted to.

The degree of the impairment of hearing, in cases of chronic aural suppuration, is variable. It depends, of course, upon many factors; for example, the condition of the Eustachian tube, and the integrity of the structure in the cavity of the tympanum. The hearing power by no means depends upon the presence or absence of the membrana tympani. The chief function of this membrane is to protect the tympanic cavity, and not merely to transmit the vibrations of the atmosphere, which when conveyed to the acoustic nerve, we call sound. Some persons have large perforations in each membrana tympani and yet hear well enough for all the ordinary purposes of life, although not with perfection. Sir Astley Cooper, in a paper published in the "Transactions of the Royal Society," in 1800,[1] showed that there could be very good hearing powers with a perforate membrana tympani; and yet the question is often asked, as well by physicians as by laymen, if anything can be done when there is a hole in this membrane; and it is also often stoutly asserted that when this membrane is once gone, the hearing is irrevocably lost. This false idea continues to prevail not only in spite of scientific demonstration of more than a hundred years ago, but also in the face of clinical facts that are every day within the reach of each attentive physician. Truly, a lie will travel around the world while truth is putting on its boots.

The parts which form the middle ear make up a cavity which has perhaps as many, if not more, important anatomical relations than any one of similar size in the human body. The cavity of the tympanum is covered above by a thin, rarefied bony plate, which is in direct communication with the cerebral meninges; the floor is close to the jugular vein. Its internal wall is the labyrinth wall, with its two fenestræ, covered only by thin membrane and opening into the ramifications of the acoustic nerve and the fluid which is continuous with that of the sub-arachnoid space; while externally we have a membrane of about the thickness of letter paper.

[1] *Philosophical Transactions*, Part 1, 1800.

Treatment.—The proper treatment of the chronic suppuration in such a space should be a matter of the greatest solicitude. It involves not alone the hearing powers but also the life of the patient. There is one prerequisite to the successful treatment of this affection, and that is, *a frequent and complete removal of all the morbid material that has formed in the middle ear.* This is simply another way of stating that the parts must be often thoroughly cleansed. The ear once being cleansed, a procedure which may require several sittings after the first time the case is seen, the process should be repeated often enough to prevent any accumulations of the pus. It is an art, to thoroughly and painlessly clean an infected tympanum. This art must be diligently practised by him who will successfully treat suppurative cases.

As we have seen in the discussion of the various affections of the middle ear, their starting point is usually in the fauces or pharynx. But the ulcerative process which has been set up in the tympanic cavity has broken through the membrana tympani, and the result shows itself in the external auditory canal. The problem to be solved is, how may we stop the ulcerative process, heal the membrana tympani, and restore the hearing power, which has been impaired by the inflammatory process in the sound-conducting apparatus. In many cases, however, we may be well satisfied if two of these requirements be fully fulfilled, while the hearing power is improved. A radical cure of a suppurative process in the middle ear, of long standing, from the very nature of things, even with the employment of modern surgical proceedings, is sometimes impossible.

The old method of treating such a suppuration was to advise the patient to syringe the ears with soap and water, put a blister on the mastoid process, and at the same time the physician got the system to rights by using alteratives, laxatives, and purgatives. The general principle of treatment thus held in view was correct, but in the matter of the local treatment, which is of far more importance than the constitutional, altogether too much was left to the supposed knowledge and skill of the patient or his attendant. Perhaps not more than one layman in a hundred can, without instructions, thoroughly cleanse an ear by syringing. It is generally thought that any person can syringe an ear, while the facts are that no patient can properly cleanse his own ear, and almost every one requires instruction before he can even syringe the ear of another. In one of the preceding chapters of this book the proper method of syringing has been carefully described.

Objections have been made by some authorities to the use of the syringe. One writer says, in referring to the cleansing of the ear, and in italics too, "*The syringe, as a rule, is not to be used.*" When differences of opinion like this as to modes of treatment arise, there is not much to be said except to show that one recognizes his own standpoint, and the difficulties of it, and gives good heed to the contrary one. There may be an abuse of syringing. Much that is called cleansing the ear by syringing has no right to such a name. There are ill effects in isolated cases from syringing. A case was reported by one of the authors of this volume in which a gentleman suffered so seriously from syncope, after a very gentle syringing of the ear, that for some moments it was thought he was dying. This patient, however, would probably suffer in the same way from any surgical procedure. After his recovery he said that he had once fainted in the same alarming way on calling upon a surgeon who proposed to make some kind of an examination. Faintness, vertigo, and nausea are also sometimes produced even by gentle syringing of the ear. Yet, if the proper method is practised, and the proper care as to gentleness be taken, it is not one case in a thousand in which any unpleasant symptoms will occur. Simple a procedure as it is, the proper method must first be learned. The water should be sterile and warm; it should be injected upon the concha before it is allowed to pass into the auditory canal—in short, until you know your patient, you should always proceed very slowly and gently with the syringe, especially in the removal of pus.

But, in spite of all these drawbacks, none of which should be underrated, it remains the best means, on the whole, in by far the largest number of cases, of cleansing the ear. The use of warm water to the ear thoroughly and often is no more dangerous but, on the contrary, of the same amount of good as the use of the same agent in the same way in cleansing fistulous ulcers, open cavities, and other parts of the body which may from time to time become filled with pus. There is no argument in the reasoning that because warm water may soften the tissue, its use should be avoided for the purpose of cleansing a cavity which requires it.

The india-rubber syringe sold in the shops will do very well for patients to use in cases of short duration; in chronic cases a good metallic syringe is required.

The fountain syringe is valuable where merely irrigation is necessary. But the piston syringe, made of metal, is the preferable one for the purpose of removing pus from the ear.

The following is a simple method of cleansing a suppurating ear and capable of being fully carried out by any practitioner, but not by the patient or a nurse. The personal care and supervision of a physician, are necessary to the successful treatment of any case of chronic suppuration in the ear. This personal care need not always be daily, although it is better to have it so; but it should, at the very least, be given twice a week, while the attendant of the patient is instructed as well as may be, for the performance of the duty of cleansing the ear in the intervening time. The importance of the cases for which the daily attendance of the physician is required, if properly set forth, will do away with any objections that may be made. No one certainly would object to the daily attendance of a physician upon a case of suppuration of the cornea, and a suppuration in the cavity of the tympanum and membrana tympani is of equal importance with the disease of the organ of vision.

The ear is first carefully cleansed with lukewarm water, which has been sterilized by boiling, by means of a good syringe. The bowl to contain the water coming from the ear, should be held by the patient himself—unless a very young child be the subject—and be pressed well into the glenoid fossa, when no water will be spilled. After this the ear is filled with lukewarm water poured from a test-tube, a spoon, or the like, and the meatus carefully stopped by a bit of absorbent cotton. The Eustachian tube is then inflated by means of Politzer's method, and to such an extent that a few drops of the water are forced by the side of the cotton out of the canal. This is, of course, conclusive evidence that the air has been forced through the tube into the middle ear, and through the hole in the drum-head into the external canal. The ear is again carefully syringed and examined by the surgeon. A long slender pipette, or Hartmann's tympanic syringe, are sometimes necessary to clean a tympanic cavity that is not well exposed because the hole in the drum-head is small. The curette will sometimes be necessary also, in order to cleanse the tympanum from inspissated pus.

Sometimes the use of the piston syringe is not well borne by the patient, the shock of the water being too great. In such cases the fountain syringe should be used or a simple rubber air bag. Instead of the thin bowl recommended as a receptacle for the fluid that comes from the canal, after having been injected, a pus basin—the "Eiterbecher" of the Germans—may be used. It is especially adapted for use with children.

It adapts itself well to the glenoid fossa, but it is not deep enough if any prolonged syringing is required. Then the bowl will do better. Cases are often seen where parents in obedience to their medical adviser have faithfully syringed the ears of a child suffering from chronic suppuration for years, but where the parts have not been perhaps even once thoroughly cleansed. Exuberant granulations or polypi have sprung up, bony growths have occurred, which are positive evidences of the imperfect removal of pus.

After the syringing, the parts should be dried by the use of absorbent cotton or gauze twisted about a bit of wood, or a wire cotton-holder, very carefully applied, with the aural mirror on the forehead, so that both hands are free. After thorough cleansing is secured medication is of secondary importance. Wilde's snare and Buck's curettes are the best instruments for removing polypi where instrumental interference becomes necessary. Nothing will keep up a discharge of pus from the ear so persistently as a small polypus or granulation. Often a discharge of very long standing will disappear, as in the twinkling of an eye, on the removal of small growths. The curettes should be made with sharp edges. Penduncculated granulations and polypi should be removed as one of the first steps in any continued treatment. Granulations with a broad base are very troublesome, it being very difficult to remove them thoroughly, even when the patient is under observation for a long time. It is often necessary to etherize the patient in order to free the tympanic cavity from granulations. The great prerequisite having been accomplished, of securing a free tympanic cavity, the question then is, what agent shall we choose for the cure of the diseased membrane, and, consequently, for stopping the discharge? A very great deal has been claimed for the so-called dry treatment of suppuration of the middle ear. There was a famous peripatetic quack who practised a dry treatment which was successful for a brief period. He was in the habit of pouring in plaster-of-Paris for the cure of long-existing discharge of the pus from the ear, and the cure appeared to be effectual. Much of the so-called dry treatment of today will be as disappointing as was its prototype.

In spite of all the claims for the exclusive use of powders, in the treatment of the ear, and valuable as is their place in our therapeutic resources, installation of fluids hold the first rank and the use of powders is of secondary value.

For the healing of a diseased mucous membrane that has for some weeks or months secreted pus, and which is free from polypi or large granulations, fluid applications should be first tried. Sulphate of zinc from one to four grains to the ounce; sulphate of alum in the same proportion. Nitrate of silver upon a cotton-holder is better used from five to sixty grains to the ounce, or from a long, slender pipette adapted to the middle ear in the weak solutions. If a strong solution of nitrate of silver be used, it should at once be neutralized with salt and water. Alcohol, especially in cases where the tissue is granular, is excellent. A preparation of resorcin in cases where the mucous discharge exceeds the purulent, is also valuable. Boracic acid in solution seems to me to accomplish no more than sterilized water. For very minute granulations or for the surface, after the removal of a granulation, besides chromic and nitric acid, pure carbolic acid followed at once by a swabbing with alcohol does exceedingly well. Adrenalin is very useful in restraining the hæmorrhage after the removal of a small growth.

The dioxide of hydrogen (U. S. P.) is generally well borne in suppurative ears, although there are exceptional cases where it is an irritant. After cleansing with water, a few drops of the dioxide are put in the ear, and when the bubbling has ceased the ear is cleansed. Patients themselves may use dioxide with benefit.

It is indeed difficult to say which are the best astringents. But some cases do well with any of the ordinary astringents, and some never cease to be the seat of the formation of pus, no matter how long, how carefully they are treated, and what agents are used.

When solutions do not act well or promptly, powders may be resorted to. Iodoform is valuable in some cases. Well-triturated boracic acid is also a useful agent but it is by no means a panacea, no matter how it is applied, or with whatsoever combinations. There are objections to powders which at once suggest themselves when their

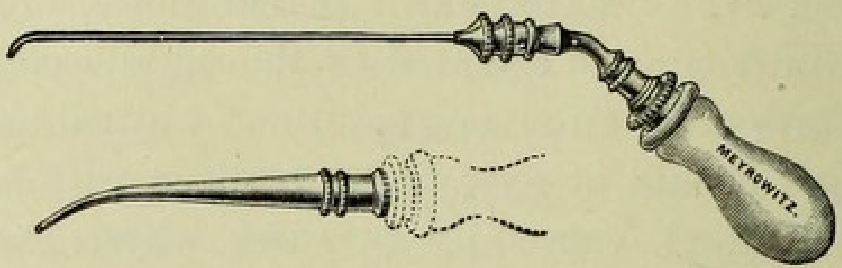


Fig. 62.—Tympanic Syringes.

use is advocated in treating diseased mucous membranes, like those of the nose or middle ear. They are not always absorbed and they sometimes leave a troublesome, irritating mass behind. Then they occasionally impair the hearing by mechanically obstructing the passage of the sound waves. While a solution is poured into the ear, and in from five to ten minutes that which is not absorbed may be allowed to run out, the powder must remain until the ear is again cleansed, which is not for hours. A tube made from a quill or one of the powder-blowers especially invented for the purpose, does equally well for forcing the powder into the canal of the tympanic cavity. Large masses of the powder should not be employed—simply enough to give the ulcerated or carious portion a good coating. When a powder is employed, the mirror should be used from the forehead, so that one may know just where it has gone, and renew the application if not enough is applied.

Solutions are usually much better tolerated by the ear when they are warm. A lighted gas-burner, the flame of a candle, a bowl of hot water, are all convenient means for heating the solution which is to be used.

Whatever may be said in favor of certain specifics, used either as powders or solutions, certain cases of suppuration of the middle ear will remain uncured in hands never so skilful. They are, from their nature or their environment, incurable. A case of long-standing ulceration in the tympanic cavity and mastoid is almost certain to involve more or less superficial death of the bone. When there is dead bone that cannot properly be removed by instruments, solutions of dilute mineral acids, nitric acid and sulphuric—one-quarter to one-half per cent—dropped into the ear twice a day (Urban Pritchard) will be serviceable. An error in treatment, an injudicious mode of life, an undue exposure to wet and cold, may at any time cause the smoldering disease to blaze into a condition that is fatal to life. Pyæmia, meningitis, and cerebral abscess are by no means the infrequent ending of some of those cases. He who has found a panacea for all of them, is in a state of mind far removed from a scientific consideration of the conditions which are to be found in chronic suppuration of the middle ear.

When it is said that "a moist treatment in many instances has a tendency to keep up rather than to check the morbid discharge from the ear,"[1] if by this,

[1] Burnett: *American Journal of the Medical Sciences*, Jan. 1883.

it is meant that careful cleansing of a suppurating middle ear with warm water, and the subsequent installation of solutions, is in many instances a bad surgical method, it can only be said that this statement, according to the experience of the writers, is not borne out by facts. The presence of granulations and polypoid growths does not contra-indicate the use of warm water. Their presence does indicate, however, a necessity for their immediate removal, either by the snare, the forceps, or caustics, *pari passu* with the constant cleansing process. But growths often shrivel and disappear, before the operator is ready to remove them by cutting or twisting instruments or by caustics, under the simple plan of cleansing the ear with warm water.

It is important to inflate the ears very frequently, from two to four times a week, and sometimes daily, by means of Politzer's or the double bag method, during the treatment of chronic suppuration of the middle ear. The current of air is useful to dislodge inspissated pus or tenacious mucus, and it assists materially in the essential preliminary of all applications; that is, complete removal of the pus. Sometimes exhaustion of the air from the tympanum by Siegle's otoscope aids in getting the cavity clean. An ordinary air-bag may also be used for this purpose. Those cases in which there is a constant accumulation of long strings of very tenacious mucus, with very little pus, are exceedingly difficult to manage. The cause for this is to be found in the excessive catarrh of the naso-pharyngeal space, and of the Eustachian tube, which usually accompanies this condition of the tympanic cavity. The mucus is so tenacious in these cases that not even the syringe or the cotton-holder will remove it, but the forceps must be resorted to. Of course, fundamental treatment will begin at the *fons et origo,* of the disease of the middle ear, that of the nose and throat. The general condition is to be most carefully considered in all cases of chronic local disease. The restoration of a perforated drum-head is a most interesting reparative process. The ease and rapidity with which they heal in recent cases is startling, and even in chronic cases, we are sometimes agreeably surprised to see how soon a membrana tympani is restored, after simple cleansing of the middle ear has been maintained for a few weeks.

It has been said that zinc-drops may supply something which makes the bottoms of the auditory canal favorable to the growth of the aspergillus or aural fungus. As proof of this, is adduced the fact that fungus is sometimes found in zinc solutions that have been imperfectly stoppered. All the harm that fungi in zinc or other solutions can probably accomplish, is to weaken the solution. A little strict care will prevent this.

SKIN GRAFTING.

In June, 1878, Dr. Edward T. Ely made use of skin grafting in the treatment of chronic suppuration of the middle ear. Dr. Ely continued this practice in nine cases and it was repeated by the senior author. This method of treatment is especially indicated for cases where we cannot expect a restoration of the membrane and a cessation of the discharge by the ordinary treatment. The results obtained have not been brilliant, but in two cases a substantial gain in the condition of the tympanic cavity was secured. This operation is available in cases where the membrana tympani is nearly gone, and where the discharge is at times considerable, but which at other times ceases. The ear is first carefully dried, and with aseptic precautions, and a small bit of integument is removed from the arm of the patient. It is carefully soaked in a solution of boracic acid, and applied by means of a cotton-holder, silver probe, or Politzer's eyelet forceps, to the exposed surface of the tympanic cavity. As many as three or four grafts may be applied. The canal is then gently packed with absorbent cotton and the patient is advised to be very careful to avoid active exercise, riding in wagons, stages, or other conveyances, in which there is much motion, for two or three days. The grafts may be examined in three or four days. If union has occurred the packing should be continued for a few days longer. This method of treatment will be of service in a limited class of cases, where an occasional period of suppuration occurs in a largely exposed tympanic cavity, over which the drumhead cannot be made to heal by ordinary means, and where the discharge of pus only occurs at intervals, for example, during a coryza. If the grafts do not completely cover the exposed tympanic cavity, they may diminish the secreting surface.

Berthold, in August, 1878, two months after Ely's cases, performed myringoplasty in two cases. The perforations healed, apparently as the result of a new inflammation set up by the manipulations and by the adhesion of a portion of the graft which became a portion of the new tissue. Berthold put a piece of court-plaster upon the drum membrane, which he allowed to remain there three days. The object of this was to remove the epithelium. The drum-head was found to be closed on the twentieth day. In a second case, also, a perforation was healed by this method. Since this time this operation has been exploited by the secular papers as being an entirely new procedure.

An efficient method of applying nitrate of silver to the whole mucous tract of the middle ear, at least to the lining of the cavity of the tympanum and the Eustachian tube, is the following: the solution is dropped into the cavity of the tympanum through the external meatus, and then forced through into the tube by two or three puffs, from the ordinary air-bag used in Politzer's method. Of course the patient will taste the nitrate of silver if it be used in this manner.

The late Mr. Hinton advised the forcible syringing of the tympanic cavity, by means of a syringe whose nozzle is made to fit into the external meatus, so as to exclude all the external air. He also syringed the tympanic cavity through the Eustachian tube, and used, both for this external and internal syringing, solutions of carbonate of soda, say of twenty grains to the ounce. This latter method of washing out the cavity of the tympanum, was revived and applied to cases of suppuration by Dr. Millinger, of Vienna. The washing of the middle ear, with the solution of soda, is a very useful adjuvant in these obstinate cases now under consideration.

Instead of washing out the canal with a solution of bicarbonate of soda, it is better to cause the patient to drop in a solution of say twenty grains to the ounce, once or twice a day. After this has had the effect of softening inspissated pus, the ear may be syringed with warm water.

It is necessary, in some cases that have resisted less active treatment, to apply the solid nitrate of silver to the edges of the perforated membrana tympani, as well as to the tympanic cavity. It is best applied on a probe, upon the point of which it has been fused, in a platinum cup, placed over a lighted lamp or gas-burner. This treatment should be performed under the influence of cocaine. It is a method, however, only to be resorted to when other means fail.

Many cases of chronic suppuration of the middle ear are not cured because the treatment is carried on by the patient himself or by his friends. No person can thoroughly cleanse the ear of another unless a special training for this object has been undergone. In fact, a successful treatment of these cases requires the care of a physician. It is easier to learn to clean and dress an ordinary bone fistula, than to learn to remove the secretions from an infected tympanic cavity and mastoid cells. He who would bring his cases to a successful ending, must himself bear the brunt of the labor of the treatment. It cannot be given over to inexperienced hands. Whenever this personal care of the physician is not to be obtained for these chronic cases, only approximately good results are possible.

Besides all this, each case should be considered by itself. Some cases will tolerate thorough cleansing by the syringe, cotton-holder, and curette, while others will resent all but the most delicate handling, by fits of vertigo, fainting, and inflammatory reaction, so that a case must be studied for a few days before it can be definitely determined as to how much and what is to be done.

In cases of chronic suppuration of the tympanic cavity, where the opening in the drum-head is very small, or when from any other reason it is very difficult to thoroughly remove the pus—in connection with the use of Politzer's method of inflation—Siegle's otoscope attached to a syringe may be used, for the purpose of sucking out the fluids from the drum-cavity. After all the other means of cleansing the part have been thoroughly used, it will be sometimes found that more pus may be evacuated by the suction method.

Hartmann's tympanic syringe, which has been mentioned on one of the preceding pages, is often useful in cleansing the tympanum. It consists essentially of a silver tube 2 ½ mm. in circumference and 7 cm. long. Each extremity is curved, the one for the tympanum at a right angle; the curved portion is about 1 mm. long. the distal end of the tube is curved at an obtuse angle, and has somewhat of a funnel shaped orifice, to which a bit of rubber tubing is attached. The tubing should be as delicate as possible, so that its weight may not interfere with the position of the tube in the tympanum. The water is injected by means of a Davidson syringe, affixed to the rubber tubing.

The surgeon who is in the frequent habit of examining the membrana tympani will find many cases that show how easily an ulcerated drum-head will sometimes heal under very simple or very crude treatment. Cicatricial drum-heads are a very common experience in the aural surgeon's observation. A little study of the history of these cases shows that in very many instances they were healed when they were being treated with what we should term neglect. All this should teach us to be very careful students of the healing process of Nature. In our anxiety to see results from treatment, let us remember to put ourselves in the position of Ambroise Paré, whose benediction to his wounded patients was, " I have dressed you, may God cure you."

All cases of chronic suppuration of the middle ear, will not be cured even by good treatment and favorable conditions, while here and there, we are surprised to find that some unpromising cases do fairly well, even under bad circumstances and with no thorough treatment. To expect too much from treatment, to do too much, is to be meddlesome in intent and action. If we are to make a choice of evils; it is better to be skeptical and inactive, than credulous and meddlesome.

Very few patients suffering from pulmonary tuberculosis recover from a suppuration of the ear. Even so far as the accumulation of pus is concerned, no matter how long they may live, the cough usually prevents any healing of the membrana tympani.

THE IMPAIRMENT OF HEARING IN CHRONIC SUPPURATION OF THE MIDDLE EAR.

This symptom is generally relieved, to a certain degree, by the maintenance of absolute cleanliness, by the means that we have already pointed out. In addition to this, inflation by the Politzer method, preceded, usually, by catheterization, in adults, should be employed. We shall later discuss the operative and radical treatment of chronic suppuration. There is a prejudice in certain quarters against inflation of the tympanum during the progress of *acute* suppuration, but we are not in sympathy with that indisposition to keep the Eustachian tube active, and there is certainly no question but that the inflation of the tube should be maintained throughout chronic suppuration. As has been before indicated, the Valsalvian method is not worthy of any consideration, as a means of treatment. The use of the masseur is also important in chronic suppuration, after cleanliness is assured, and the discharge brought within moderate bounds, is important in maintaining the mobility of the ossicles.

The art of cleaning a tympanum which has secreted pus for months or years, is a very important one. It will often be necessary to use saturated solutions of bicarbonate of soda to soften the secretions, and it will always be important to clean the various parts with the cotton-holder. Sometimes with a delicate curette.

The beginner in aural practice should spend a considerable period in cleansing ears, under the supervision of men of experience. This art is one not generally practised in its perfection, and on it, the prognosis often depends.

OPERATIONS UPON THE DRUM-HEAD, TYMPANUM AND VESTIBULE FOR THE CURE OF CHRONIC SUPPURATION.

It has already been plainly shown that granulations should be removed from the tympanum, when they exist in cases of chronic suppuration. If the ossicles become necrosed, it is also important to remove them, unless it is certain that they may come away voluntarily, while the patient is under observation.

It also becomes important in some cases, to thoroughly curette the tympanic cavity, in order to get a healthy fundamental tissue, and stop suppuration. Beyond all this, under circumstances that will be detailed a little further on, it becomes necessary, in certain cases, to perform what is generally termed a radical operation, which we will now describe.

RADICAL CURE BY OPERATION.

It is for these cases that are incurable by ordinary treatment, which cannot be kept in an aseptic condition and when the hearing is very much impaired, that Stacke's operation may be advised. This radical means is to be reserved for the class of cases just mentioned, since the facial nerve in its passage through the tympanum may be injured, so that permanent paralysis is produced by the operation. Besides it is not always certain of accomplishing the result desired, and there is a danger to the life even, in the operation.

RADICAL OPERATION OF STACKE.

Stacke's operation is performed most frequently to relieve chronic suppuration of the middle ear which has not yielded to other treatment. If a chronic suppuration is advancing and cannot be kept in an aseptic condition, an operation is often indicated. Since the radical operation is a serious one, it is not to be lightly undertaken. A serious and intelligent effort should be made to heal a chronic suppuration of the tympanum or to keep it aseptic before an operation which destroys the hearing and is not without danger of life, is undertaken.

It may be said, that with the increased facility and safety of operations upon the temporal bone, a general knowledge of the methods of treating the tympanum without an operation, has not kept pace. There is sometimes a tendency to perform unnecessary operations. The good of the patient should, of course, be the first consideration in the mind of the surgeon in deciding about an operation. After years of urging the rather reluctant profession to undertake operations upon the tympanum and the mastoid, the senior author of this book has seen a day arrive when operations are sometimes undertaken when they are not required and are harmful. The treatment of chronic otitis media, as taught by Wilde, Tröltsch, Hinton, and others is sometimes not understood and practised as thoroughly as it should be. Were this done many operations would be avoided.

The *first step* consists in making the incision through the soft part of the ear and separating the membranous canal from the external auditory canal. The incision in the Stacke operation is the same as in the ordinary mastoid operation except that it is carried a little further forward at the upper part. Only the skin and connective tissue down to the muscle is divided until the lower edge of the temporal muscle is reached, when firm pressure is made on the knife and the periosteum divided from this point to the tip of the mastoid, the incision extending about one-half inch below the tip as in the ordinary mastoid operation. The skin and attached border of the auricle are now dissected from the underlying tissue. The auricle and skin are then pulled forcibly forward and a second incision at right angles to the first and beginning at the point where the first incision crosses the lower border of the temporal muscle is made through the periosteum and soft tissue, extending forward to the concha, but not cutting the skin. The periosteum included between the two incisions is elevated from the bone up to the posterior rim of the auditory meatus, and down to the lower rim of the meatus. With a narrow elevator the skin lining the meatus is now separated from the posterior bony wall down to the drum-membrane, and a narrow knife introduced into the canal and the skin incised behind and above from its attachment to the annulus tympanicus. The entire cutaneous lining is lifted from the canal by means of a bent elevator and held forward by a blunt retractor.

The *second step* is to remove the upper portion of the drum-membrane, the malleus, and incus, if they are still in position, but to leave the stapes untouched. Then with a gouge the suprameatal triangle is to be taken away, beginning at the forward part of it and continuing backward and upward until the roof of the epitympanic space is continuous with that of the canal. On reaching the antrum and at a depth opposite the facial nerve, Stacke introduces a flat metal protector into the antrum to guard against injury to the nerve and stapes. Backward from the facial nerve and upward the bone may be removed more freely; but even here we must guard against injury to the dura mater. At the lower part of the antrum and forward, the gouge should be used very carefully, lest the facial nerve be injured. All dead bone should be removed, and, when this part of the operation is finished, the antrum, epitympanic space, and external auditory canal are converted into one common cavity. The posterior wall is on a line with the posterior wall of the antrum, and the upper wall of the bony canal slanting upward to the top of the epitympanic space.

The *third step* is to slit open the membranous canal, beginning at the inner extremity above and carrying the incision longitudinally outward to the concha. At the point where this incision reaches the concha another incision is made at right angles to it, downward and backward to the floor of the membranous canal. A quadrilateral cutaneous flap is thus secured which may be used to cover the posterior wall of the bony canal, or even a portion of the floor of the antrum when the soft parts are readjusted. (The direction of the incisions in the membranous canal and the shape of the flap have been modified by some of our American *confreres*. Even part of the concha has been dissected away (Dench) to get a better flap, while a flap of skin from the mastoid region with pedicle (Berens, Phillips) has been used to help line the bony walls of the canal. And Davis [1] has made use of the "Cargile membrane" in one case with success in lining the bony canal.)

In order to keep the cutaneous flap in contact with the bony walls the cavity is packed firmly with pledgets of sterilized gauze. The upper part of the wound back of the ear is sutured, while the lower part is packed with gauze and kept open for four or five weeks. Some operators, in this country, at least, suture the entire wound behind the ear and try to secure union by first intention, treating the ear through the external auditory canal. A large amount of gauze and absorbent cotton over the ear, held in place with a bandage, completes the dressing. The outside dressing may be removed from

[1] Case as yet unpublished.

the second to the fifth day, but the deeper dressings in the canal and wound back of the ear should not be removed until the seventh or eighth day. The dressings, after this, are to be repeated every second or third day (sometimes daily), as the case demands. Stacke never irrigates the wound during or after the operation, but is always careful to treat it antiseptically. The packing in the can is kept up, as a rule, for four or five weeks, and excessive granulation tissue is cut away or burned away with galvano-cautery or lunar caustic. It may require from one to three or four months for a complete cure.

In this country, at the end of ten days, skin grafting on the raw bony surface is often resorted to with marked acceleration in the cure.

THE ARTIFICIAL MEMBRANA TYMPANI.

This contrivance is at times a valuable means of treating a chronic suppurative process in the middle ear. A

Fig. 63.—Toynbee's Artificial Membrana Tympani with a modification of the same.

New York layman was the actual inventor of a substitute for the natural membrane. This gentleman used a bit of paper moistened with saliva for this purpose in his own ear, and showed it to Dr. James Yearsley, of London, who seized upon the idea, and gave it to the profession, substituting cotton-wool for the paper. Besides acting as an artificial membrane, the cotton plug is sometimes used as a means of treating a chronic suppurative process in the ear. It is then packed in the canal quite thoroughly. When it is employed for the purpose of improving the hearing, having been slightly moistened, it is inserted under inspection—that is, while the parts are well illuminated by the otoscope—by means of a pair of forceps, that should be very weak in the spring, so that the blades may come together with very little pressure, or by a probe.[1]

The appropriate position for the cotton where it will improve the hearing, will be found, if it is to do any good, by placing it on different parts of the exposed tympanic cavity, or the remains of the drum-head, until the

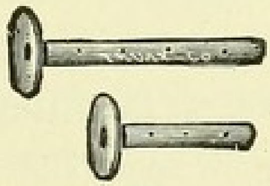


Fig. 64.—Artificial Membrana Tympani with Tubular Handle.

patient experiences an improvement in the hearing power.

To Yearsley belongs all the credit of quickly utilizing the strong hint given him by the New York merchant with his spill of paper, and of suggesting a practical use of an artificial membrana tympani.

In 1853, Toynbee suggested another artificial membrana tympani, without knowing of the previous invention. Toynbee's appliance consists of a thin disk of vulcanized rubber, in the centre of which is attached a fine wire about an inch long, which terminates in a little ring, to enable the finger to more readily grasp it when its removal is desired. An improvement upon

[1] *Yearsley on Deafness,* p. 245.

the original method of attachment of the wire, is to insert it spirally into the disk, like a corkscrew in a cork.

We can never tell without trial, whether the artificial membrana tympani will, or will not improve the hearing. Inasmuch as we are sometimes asked if an artificial membrana tympani will do any good, if the membrane be intact, it may be as well to state, that it is only of service in cases of partial or complete loss of the drum-head. The improvement to the hearing that does sometimes occur when the cotton-wool, or the membrane of Toynbee is used, is probably due to the restoration of the interrupted continuity of the ossicula auditus, or even of the stapes alone, to the fenestra ovalis and the labyrinth. Toynbee explained its benefit by stating that it occurred as a result of the closure of the membrane; but this has been shown to be an erroneous explanation. Cases have been seen where the perforation was not closed by the artificial membrane, and yet great improvement to the hearing resulted from its use. When the patient first begins to wear this membrane, it should be used but for a very short time during the day. It is always a foreign body, and hence it is liable to produce irritation and increase the suppurative process. The artificial membrana tympani in all old cases of chronic suppuration in the middle ear, when the loss of hearing is very great, may be tried. If one ear be sound, so that hearing for ordinary purposes is very good, as it always is under such circumstances, it is not worth while to use the artificial drum-head for the diseased ear. An excessive inflammatory action in the remains of the drum-head, or in the middle ear, precludes any use of the artificial membrane. The patient for whom it is to be employed should also be an adult, and possessed of a considerable amount of intelligence. It is not of any use in the case of children, or of unusually heedless or stupid adults. The wire to which the disk is attached, sometimes becomes separated in removing the membrane, and the disk of rubber is left behind. This accident, although a very insignificant one—for the disk is readily removed by syringing—is very apt to frighten the patient, unless he has been previously warned not to be disturbed if such an accident occur, and not to allow any improper attempts to remove such a foreign body. Various modifications of Toynbee's disk attached to a wire have been made. Thus, Lucae attaches the disk to a small rubber tube. Burkhard-Merian uses a solid piece of india-rubber instead of a wire. Politzer makes one especially to spare the poor the expense of buying Toynbee's disk. A piece ½ ctm. long is cut from the side of an india-rubber tube 2 to 3 mm. in thickness, a hole is then made in one end and a wire handle fastened in it. Politzer also recommends the use of an india-rubber tube, as long as the canal, rounded off at the distal end and pushed down to the remains of the drum-head. In cases in which the sides of the stapes bone have been destroyed, Politzer has also attached a stapes bone taken from a dead body to Toynbee's disk, and introduced it, so that the bone lies in the niche of the fenestra ovalis,[1] with benefit to the hearing.

Michael[2] instils glycerine, in some cases medicated with tannin, and then collodion, and thus forms a membranous covering, of which he speaks highly. Hart-

[1] Politzer: Text-book, p. 482, original p. 563.

[2] *Transactions of International Congress, London,* vol. iii, p. 434.

mann[1] recommends, in cases where the other varieties of artificial membranæ tympani do not prove serviceable, a noose of the most delicate and elastic whalebone, wound about with cotton.

In introducing this appliance the auditory canal must be straightened, by pulling back the auricle, while the bone is placed in position, somewhat anteriorly in the depth of the canal. Its use requires some care, but this may be said of all artificial membranes. Paper disks are sometimes used with great success.

PROGNOSIS.

The prognosis in chronic suppuration of the middle ear depends upon a variety of local and constitutional symptoms. If the consequences of chronic suppuration have occurred, such as exfoliation and death of bone, the formation of polypi, exostoses, and so on, the treatment is apt to be prolonged, and in some cases may never be entirely or even partially successful. Again, when the membrana tympani is entirely removed, and one or more of the ossicula lost, the prognosis is grave. Yet the membrana tympani has a regenerative power second to that of no other membrane of the body. It is often entirely restored after all but a narrow rim has been entirely swept away. This has even occurred in cases of long standing. The prompt healing of the drum-head after operative perforation and in acute inflammation, is a matter of common experience.

The state of the general system will also at times influence the prognosis to a marked degree. The physician

[1] *Die Krankheiten des Ohres,* p. 99.

will find ample material for general advice in some cases, and yet there are many in which local treatment only is required; while it is essential in all. We may say, on the whole, that the prognosis can never be decidedly given so long as the membrana tympani is open, for this membrane is essential to the safety of the ear from renewed attacks of acute suppuration. All our efforts should be directed, therefore, to closing up this opening. There can be no danger from closing it too soon. Our chief difficulty will be in closing it at all. If the membrane cannot be restored, the tympanic tissue may sometimes be made cicatricial, and thus the suppuration be stopped. If regular and careful treatment by a physician, continued for months, fails to close the opening, and remove the granular material and the carious portions, or to cause the discharge of pus to cease, the family and friends should be taught to cleanse the ear thoroughly, as long as any purulent inflammation occurs, and they should know that the chief danger to the ear, and the general system, lies in an accumulation and retention of pus. If an aseptic condition of the cavity cannot be maintained, a radical operation should be advised.

Patients suffering from an accumulation and discharge of pus from the tympanum cannot be too careful of their general health. A simple cold in the head may be fatal to them by causing an inflammation of the ear, followed by meningitis.

CHAPTER XIII.

THE CONSEQUENCES OE CHRONIC SUPPURATION OF THE MIDDLE EAR.

If a chronic suppurative process in the middle ear, remained uncomplicated, it would be a condition of things to be preferred to a chronic proliferous process in the same part. The hearing power is often very good, the tinnitus aurium is not usually excessive, and sometimes does not exist or it may generally be relieved by simple syringing and inflation of the ear. These are the symptoms which are so trying in the proliferous form of disease. But the almost inevitable consequences of chronic suppuration in the middle ear, are dangerous to the health and life of the patient.

It is in view of these consequences that many insurance companies decline to insure the lives of persons that are affected with chronic suppuration of the middle ear. Any person who has a hole in the membrana tympani, and an ulcerative process in the parts beyond, has a much less chance for long life than one whose brain and vascular circulation are not thus exposed to the ravages of disease. Very few persons, comparatively, who suffer from chronic suppuration, live out their days, while many of them die very young.

CICATRICES AND ADHESIONS BETWEEN THE OSSICLES.

In some fortunate cases of chronic suppuration, as we have seen, an end is finally reached by a closure of the membrana tympani. This may even occur when one or all of the ossicles have been removed. The impairment of hearing may be very great with a neoplastic membrana tympani, but the danger to life, and to the general health, is much lessened by a closure of the tympanum. Healing of the ulcerated membrana tympani is therefore a result to be desired, even if the hearing be not as great after this has occurred, as it was when it was perforate and ulcerating. The drum-head, however, may not close, and yet its edges cicatrize and adhere to the tympanic wall. The tympanum then will be converted into a dry chamber, its mucous membrane so altered that it scarcely secretes, and only under great provocation takes on inflammatory action. It is sometimes difficult in such cases to determine what is left of the normal furniture of the tympanum, such a mass is it, of displaced and neoplastic tissue. If the stapes bone still remain, or even its foot-plate, it is sometimes possible to use an artificial membrana tympani with great benefit; but generally the adhesions and cicatrices involve so much of the air chamber, with perhaps an extension into the tissues of the labyrinth, that literally nothing can be done for the patient except to leave his ears to themselves. Bad as this condition is, it is a more favorable one than when the ulcerative process still continues, with perhaps some one or more of the results that are now to be recorded.

Cicatrices in the drum membrane are formed by the healing of perforations after the suppurative middle ear disease has subsided. They are most apt to form when the inflammation has been acute, for in chronic cases the discharge continues so long that the edges of the drum perforation granulate and cicatrize without closing the opening. Cicatrices of the drum membrane are unimportant unless they are accompanied by adhesion within the middle ear, or themselves become adherent. An unattached cicatrix does not interfere with the hearing. The scars may be large or small, and present glistening and shiny membranous surfaces which are more relaxed than the tissue of the drum membrane. They are distinguished from the latter by their appearance and relaxed condition, which is easily observed when a Siegle otoscope is used and alternate suction and pressure on the drum-head is produced. When this is done, the entire membrana tympani will move forward and backward corresponding to the rarefication and condensation of the air within the external auditory canal, but the cicatricial tissue will move much farther outward and inward than the drum membrane, thus producing a marked bulging or concavity of the drum at the point of cicatrization.

Adherent cicatrices interfere with the function of hearing. In this form connective tissue is produced behind the scar so that it is attached to the inner wall of the middle ear by an adhesion of varying length. Sometimes the adhesions are narrow bands, sometimes they are broad septa. Their existence shows that the tympanic cavity has suffered destruction of its lining membrane, while the non-adherent form indicates a less severe lesion. Sometimes multiple septa are formed by these adhesions within the chamber of the middle ear, so that the membrana tympani and the ossicles are absolutely immovable, and the middle ear is divided into a series of unequal spaces. This form is very destructive to the hearing.

Diagnosis.—The diagnosis may be made with a Siegle otoscope and a probe. With the Siegle otoscope the examiner notices that when suction is made the movements of the drum are much restricted or are abolished, or the drum may move slightly in some places while in other parts it is fixed. The fixed points indicate the position of the adhesion. The adherence of the drum membrane is further shown with the probe. If the drum is not attached, it will recede under pressure from the probe; when it is adherent, it does not yield. An experienced examiner will generally be able to diagnosticate the presence of adhesion by examination alone without the Siegle otoscope or a probe. The condition thus delineated may be called chronic adhesive inflammation of the tympanum.

POLYPI.

Celsus and Pliny used the term polypus for a tumor springing from any cavity of the body. The name was adopted under the old system of nomenclature, when an exact knowledge of the nature and structure of growths of parts was not regarded in giving them a name. It is an unfortunate one, for there is scarcely any resemblance between the *many-footed* aquatic animal, after which morbid growths were called, and the exuberant granulations or tumors which arise from the cavity of the tympanum and the auditory canal.

An aural polypus is a pedunculated connective tissue growth springing from the mucous membrane of the middle ear. Occasionally it may spring from the subcutaneous tissue of the external auditory canal; and less frequently, from the membrana tympani. It is usually formed within the chamber of the middle ear, makes its way to the external auditory canal through a perforation in the drum-head, and appears in the canal as a tumor of varying size. Sometimes it is so small that it projects only slightly beyond the membrana tympani, at other times it entirely fills the canal and projects from the external auditory meatus. It most frequently springs from the posterior and inner wall of the middle ear, and sometimes from the posterior superior angle of the external auditory canal. The surface of the polypus is generally smooth and glistening, but it may be nodular and irregular like a mulberry.

The diagnosis is made from the presence of a growth within the canal which is movable and attached at one point. Usually the pedicle cannot be seen. This growth may be confused with growths of a more serious character, such as sarcinoma or sarcoma, but a microscopic examination of a piece of the growth, will avoid any error in diagnosis. It is to be distinguished from an exostosis by its inconsistency, and from a bulging membrana tympani by its location, its unattached borders, and irregular surface.

MALIGNANT GROWTHS.

The malignant growths which may be mistaken for malignant polypi, are epithelial carcinoma, fibrous and medullary carcinoma. Cholesteatoma, the pearl tumors of J. Muller, have also been found in the cavity of the tympanum, arising from an inflamed or ulcerated mucous membrane. They consist of small degenerated epithelial cells, between which lie cholestearine crystals and other fatty material. They sometimes destroy the bone by pressure and they may even extend into the cranial cavity. Osteo-sarcoma of the cavity of the tympanum, extending into the auditory canal, was also observed by Böke. These malignant tumors of the ear should be carefully distinguished from the benign mucous and fibrous polypi that are the frequent results of a neglected suppuration. A patient with an aural polypus should therefore not be lost sight of, until the danger of a recurrence is over.

Treatment.—The treatment of an aural polypus

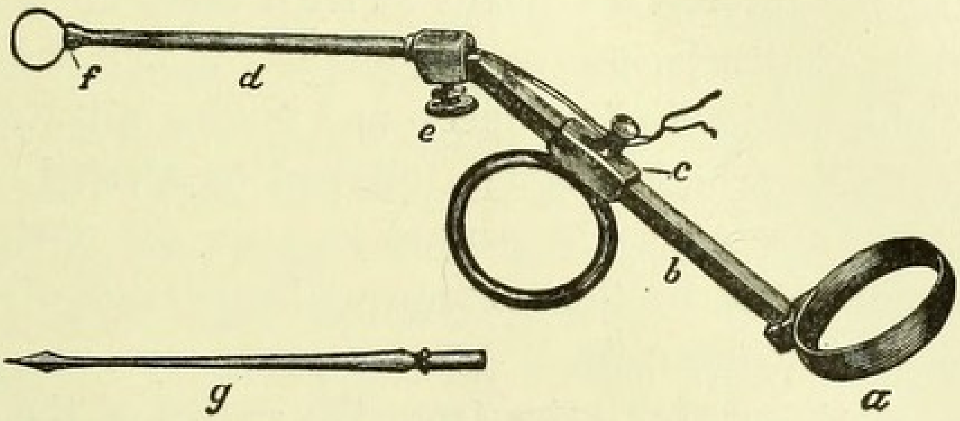


Fig. 65.—Wilde-Blake Snare with paracentesis needle attachment.

should begin with the removal of the growth. The term *begin* is used with deliberation, because it is a mistake to suppose that the removal of the polypus will be any more than the beginning of the treatment of the disease of which the polypus is a symptom. Besides, aural polypi often spring up very rapidly, even after they have been thoroughly removed, and when they are simple growths.

Wilde's snare, as modified by Blake, will be found the best instrument for the removal of well-defined polypi with a pedicle. Angular shaped scissors curved on the flat may also sometimes be used with advantage.

Forceps may sometimes be employed although the snare, scissors, and curette are to be preferred to all mechanical means for removing polypi or granulations. Forceps, unless used with great gentleness and care, may wrench more than the morbid growth from the cavity of the tympanum, and thus do great harm.

Very small pedunculated growths may be often removed by simple angular-toothed forceps. True exuberant granulations, having no pedicle, but arising from a broad surface, are difficult to remove with instruments, and they usually cover carious or necrosed bone. Caustics are the only means of removing such growths. The agents for the treatment of such cases are strong solutions of nitrate of silver—from forty to four hundred and eighty grains to the ounce—and fuming nitrate acid and carbolic acid, the latter followed by alcohol. The nitrate of silver may be poured in upon the part, and then neutralized by the subsequent instillation of a solution of common salt.

Granulations that arise from the cavity of the tympanum where forceps, scissors, or snare cannot well be used, may be treated by numerous punctures with a cataract needle. The puncturing causes considerable hæmorrhage. After the blood is wiped away a caustic should be applied. Nitric or chromic acid may be thus used, by means of a glass rod, a cotton-holder armed with cotton, or a bit of wood. The pain from these applications is usually so little that even children will bear them without shrinking, under the local use of cocaine. There are, of course, many other agents than those that have been mentioned, which may be profitably used in cauterizing the bases of polypi that have been removed by instruments and in destroying fungous granulations. Chromic acid is very much employed as well as the acid nitrate of mercury.

Two or three drops of the liquor ferri perchloridii, or of the liquor ferri persulphatis, may be injected into the growth by means of a hypodermic syringe.

No difficulty will usually be found in the removal of large or pedunculated polypi or granulations. It is only those that are small and flat, arising from dead bone, and which are very rapidly reproduced that give trouble in removing. Each surgeon will soon learn how he can best deal with the former variety, whether with forceps, snare or curettes. The latter form, especially if buried, so to speak, in the tympanic cavity, will often tax the surgeon's skill and ingenuity to the utmost. The use of alum will sometimes shrivel the granulations so as to cause a pedicle to show itself. Iodoform is a good application to pale growths. Alcohol is also valuable. It should be used at least three times a day, and warmed before it is dropped into the ear, when used for polypi. It causes considerable pain, but it is only for a short duration. It is well to begin with a fifty per cent solution and rapidly increase in strength. Free incisions into the granulations, down to the bone, by means of a narrow cataract knife, are also effective, especially in recent cases.

No matter which of the methods that have been detailed be employed in removing an aural polypus, the subsequent treatment will be the same. The case, after the removal of the growth—if caries, necrosis, or exostosis do not exist—is one of simple chronic suppuration, that should be managed in the manner that has been set forth in the preceding chapter. The removal of the polypus may improve the hearing very much, or it may scarcely benefit it. If the polypus were a mere mechanical obstruction to the entrance of sound, its removal would of course at once restore the hearing power; but, as has been seen, it is much more than that. The prognosis in regard to the hearing power in cases of aural polypi should always be guarded. The hæmorrhage from their removal is usually profuse but soon ceases. Hot water and suprarenal solution are good styptics.

BLAKE'S MIDDLE EAR MIRROR.

Dr. Blake's middle ear mirror, for the purpose of examining cases of suppurative inflammation of the middle ear more accurately than can be done with the aural speculum,[1] is especially useful in detecting the exact size of small granulations. The use of Dr. Blake's instrument, as he himself states, "is of necessity limited to a very small number of cases, as both a moderately wide meatus and a comparatively large opening in the membrana tympani must exist, to permit of the introduction of a mirror of sufficient size." The instrument was first constructed to accurately determine the origin of a growth which was external to the membrana tympani, but which was hidden from view by the conformation of the external auditory canal.

The mirror is attached to Weber's tenotome, the cutting hook being replaced by a polished steel mirror of from one-sixteenth to one-eighth of an inch in diameter. In some cases a larger mirror is made by flattening out

[1] *Transactions of the American Otological Society*, 1872, p. 83.

the end of the shaft, bending it at the proper angle, tempering and polishing it. The shaft is ductile, so that the angle of the mirror can be varied at will. Shafts of various lengths with mirrors of various sizes may be used in the same handle, and the mirror may be rotated by movement of the stud in the handle.

CONCLUSIONS.

I. True aural polypi are morbid growths analogous to exuberant granulations.

II. They are the result of a long-continued, or recent and violent purulent inflammation of the cavity of the tympanum or external auditory canal—usually of the former.

III. Their removal is usually but the beginning of a treatment of the disease of which they are consequences and symptoms.

IV. The hearing power of the patient will not be restored, although usually improved by the removal of an aural polypus.

V. Malignant growths occur in the ear, which assume the form of and may be mistaken for, simple polypi.

BONY GROWTHS.

Exostoses, hyperostoses, or bony growths, sometimes occur in the osseous portion of the auditory canal, and in the cavity of the tympanum. They may be divided into two great classes—the congenital and acquired forms. With the congenital we have very little to do. Inasmuch as they are not consequences of chronic suppuration, they do not usually, if ever, become a source of trouble, and are generally seen incidentally—that is, when a patient's ear is being examined for some disease independent of the exostosis. In these congenital cases the whole calibre of the canal is sometimes lessened by a general thickening of the bone, but more frequently the growths extend from one point, with a pretty well defined pedicle.

Moos thought osseous tumors in the external auditory canal were relatively frequent, and he observed three cases of the symmetrical formation of exostoses in both auditory canals in persons who consulted him for a catarrh of the middle ear. "The tumors developed invariably from the upper wall of the external auditory canal, close to the drum-head and opposite Shrapnell's membrane." None of the patients had ever suffered from gout, rheumatism, syphilis, or a suppuration in the ear. These cases, according to Moos, were consequent upon irritative processes occurring at the time when the annulus tympanicus unites with the squamous portion of the temporal bone. Gruening reported two similar cases. These congenital bony growths do not require treatment, and should not be interfered with.

When the subject is old, and the auditory canal is naturally narrowed by the alteration in position in the lower jaw, some trouble may be experienced from the impaction of wax in the ear in cases of congenital exostoses, inasmuch as the usual means of its removal—the motion of the jaw—cannot produce the same effect upon the narrow passage.

Professor William Turner[1] describes an exostosis of

[1] *Journal of Anatomy and Physiology*, xii, part 2, p. 200.

the canal in an adult male skull obtained near Pisaqua, Peru. Both passages were nearly closed by hard, ivory-like exostoses. These were pedunculated, and on the left side, when the integument existed, they must have blocked up the canal. The exostoses on both sides grew upon that part of the wall of the canal formed by the auditory plate of the expanded tympanic ring. In the adult skull of a flatheaded Chenook Indian, from the district of the Columbia River, Turner found the right external auditory canal partially closed by a broad-based exostosis which grew from the posterior wall formed by the tympanic plate. There was also a linear shaped exostosis deeper in the canal. Turner observed narrowing of the external auditory canal in several specimens of Peruvian skulls not artificially deformed.

Blake has examined the skulls of the mound-builders of Tennessee from the collection of the Peabody Museum in Cambridge, Mass. He confirms Professor Turner's opinion that the modifications in the shape of the external auditory canal, so often found in aborigines of America, is not due to the artificial elongation of the skull induced in certain tribes by pressure in infancy. Blake's attention was drawn to the subject by the late Professor Jeffries Wyman, who found exostoses of the auditory canal in 6 out of 334 Peruvian crania. Blake examined 195 skulls. In 36 exostoses were found in one or both canals as well as narrowing of the canals. 50 Californian skulls, taken from graves in the island near Santa Barbara, were measured for the sake of comparison with those of the mound-builders. The average vertical diameter was found to be more than a millimetre greater in the former, and the antero-posterior diameter more than 3 mm. greater. Of 108 California crania, 5 had exostoses in one or both canals and in 3 of the 5 a corresponding narrowing of the canal. Blake does not think there can be any positive opinion, as yet, as to the cause of these exostoses in the aborigines of various countries. There were no evidences of syphilis in the bones of the Californians examined. He has found that the majority of the cases of exostoses he has seen in aural practice "occurred in certain families, in the male members of successive generations, the most marked instance being in the three successive generations of one family in which there *is no tendency either to gouty or rheumatic disease.*" Blake also examined 37 skulls from mounds in Arkansas. Exostoses of the auditory canal were found in 6 of the 37 skulls. Careful search was made for evidences of syphilitic disease, by examination of the long bones, but none was found. The 6 containing exostoses came from one mound.

INFLAMMATION OR ACQUIRED EXOSTOSES.

The cases of acquired exostoses are a much n e serious matter than the congenital affections of the same kind. They arise in the course of a chronic suppuration of the middle ear; they usually grow with more or less rapidity, and they may finally block up the tympanic cavity and cause retention of pus with all its fatal results. They are the results of a local irritation which has caused in the first place a periostitis, and secondarily an enlargement of bone. This local irritation may be either the constant presence of pus on the walls of the canal, or the extension of the inflammation of the lining membrane of the cavity of the tympanum, a membrane which is essentially a periosteum, to the true periosteum of the osseous canal.

Virchow [1] taught that *local* influences are in very many cases the exciting cause. "Some have, indeed, educed the frequent cases where certain constitutional diseases, especially rheumatism, arthritis, syphilis, scorbutus, rachitis, have produced bony tumors as being something opposed to these local causes. Undoubtedly the field of these conditions was formerly too amplified, and we may say that scorbutus is now almost entirely excluded from the list of causes, and that the gouty enlargements of bone are no growths, but only deposits; but we cannot deny the influences of the other so-called dyscrasia, especially of the rheumatic, syphilitic and rachitic diatheses. In spite of this, their influence should not be overestimated." Polypi are frequently found upon the exostoses that arise in the course of a suppuration in the ear. This is, of course, proof that the tissue beneath is one that has been frequently the seat of inflammation.

Bony growths within the external auditory canal also show themselves as diffuse, subcutaneous thickenings, when they are known as hyperostoses; or as circumscribed growths of small size, when they are known as exostoses.

Diagnosis.—Within the external auditory canal a white protuberance is seen which when examined with the probe is found to be subcutaneous and hard. Generally the surface is smooth, but it may be irregular.

[1] *Die Krankhaften Geschwulste* 11, Bd Halfte I. p. 73 *et seq. passim.*

The size varies, usually however, they are about the size of an ordinary pea. The favorite site is in the bony canal, just in front of the membrana tympani, and usually at the junction of the upper and posterior walls of the canal.

From all the evidence it is probable that all exostoses of the canal may be finally traced to local inflammation. Blake's cases, in the aborigines, as well as the cases occurring in private practice, and those of the authors of this work, pretty thoroughly dispose of syphilis as a prominent cause. The evidence for a rheumatic diathesis as a factor has not been made tenable.

All the cases of which we have full histories, go to sustain the view, first clearly and fully put forward by Roosa,[1] of local irritation as the determining cause.

Treatment.—The treatment of exostoses unless they are so large as to prevent access to the tympanum should begin by a treatment of the suppuration that has caused them to appear. If we cannot heal the perforated and ulcerating membrana tympani, as may be the case, we should keep the middle ear scrupulously free from pus, so that no blocking-up may occur. The patient should be taught to cleanse the canal and tympanum. Small growths may be painted with the tincture of iodine. If the exostoses are large enough to close, or nearly close, the canal, Mathewson's operation for removal of these growths by a drill in a dental engine should be performed.

The patient must be under ether. The integument covering the growth is first removed by a dental instrument known as a scaler. The bony growth is then per-

[1] *Text Book*, 7th Edition, p. 485.

forated at several points near its centre with small drills about one and a half millimetre in diameter. Larger drills, $2\frac{1}{2}$ to 3 mm. diameter are next used to enlarge the openings. The bleeding is so great that the probe becomes the chief guide in the operation. "The excavation is to be continued cautiously," till the largest drill—about three millimetres in diameter—passes freely with room to spare." (Mathewson) The purulent discharge that ensues should be treated by warm douche and an astringent.

Exostoses seem to be a much more frequent result of aural disease in England than in this country; at any rate there are many more cases reported by English experts than by those of the United States. If the membrana tympani be intact, as it is in many cases of bony growths, even in those where there was at one time suppuration in the tympanum, the cases are much easier to manage. There being no pus to rest upon them, they do not usually grow, and if the ear be kept carefully clean and free from wax, they need not be interfered with. In rare cases, the osseous auditory canal just at its beginning is closed by a thin bony plate, evidently the result of, or long continued, local inflammation. Such a thin plate is easily removed by gentle chiselling.

CHOLESTEATOMATA.

In chronic suppuration of the middle ear the discharge is composed of pus, bacteria, serum, and a certain quantity of epithelium which is derived from the external auditory canal. In some cases the quantity of exfoliated epithelium is markedly increased and appears in the discharge as small gritty or cheesy lumps. The constant maceration of the epithelium of the external auditory canal increases the number of the epithelial cells and hastens their exfoliation. This is further favored by the inflammation or hypertrophy of the skin of the canal which often accompanies middle aural suppuration. Undoubtedly some desquamation of the epithelium occurs from the mucous membrane lining of the middle ear, which also under certain abnormal conditions may be increased.

The term cholesteatoma is usually applied to a single mass of considerable size composed of desquamated epithelium and originating within the external auditory canal, but it may also be applied to the small white or yellow accumulations of laminated squamous epithelium which develop upon the mucosa of the middle ear, as tiny white shining bodies. There are two forms of cholesteatomata—one occurring upon the lining of the tympanum of the ear as tiny pearly projections with but little tendency to desquamation; the other appears as loose unorganized and unstratified irregular masses of epithelium beginning within the external auditory canal, and having a tendency to disintegration, thus furnishing the cheesy or gritty masses which are present in the discharge. The first form is probably unimportant; the second not only furnishes the gritty masses of epithelium in the discharge, but it tends to accumulate and produce absorption of the temporal bone from pressure. This form also readily undergoes disintegration and becomes infected with bacteria, thus furnishing the foul-smelling discharge which characterizes its presence. It may even invade the brain and the mastoid.

These growths vary in size. They may be as small as the head of a pin, or large enough to fill the middle ear and the entire mastoid region. Such large masses produce absorption of the temporal bone by pressure, or they render the bone necrotic by secondary bacterial infection, and may prove fatal by exciting an acute infective meningitis.

Symptoms.—The symptoms of cholesteatoma are headache, heaviness in the affected ear, dizziness, a sensation of pressure, and the presence of the characteristic discharge. This is composed of small foul-smelling cheesy or gritty fragments of a yellowish or whitish color, and is generally mixed with pus. Sometimes the whole of the cholesteatomatous mass is discharged. Under the microscope the gritty particles can be identified as disintegrated squamous epithelium. The appearance of the mass within the external auditory canal is characteristic. The canal is more or less occluded by the presence of these heaped up masses of macerated epithelium, and after the external ear has been cleaned the same material may be seen within the middle ear. If the cholesteatomatous mass produces absorption of the temporal bone and invades the brain, the characteristic symptoms of a septic meningitis develop.

Cholesteatomata terminate either by the expulsion of the mass through the canal as a whole or in fragments, or by necrosis of the temporal bone. The discharge then occurs through the fistulous openings. Death from sepsis may result if the brain is involved. The disease may last for years, slowly invading the bony structure and producing a constant foul-smelling discharge from the ear.

Treatment.—The treatment consists in first softening the mass by soaking it in a saturated solution of bicarbonate of soda, and the careful removal of the soft epithelium with cotton covered applicators. When the loosened epithelium has been removed in this way, the remainder of the mass should be removed by gentle curettage. The curette should not be used within the middle ear unless the masses are plainly visible, then it becomes a very efficient instrument. If the treatment by washing is performed frequently enough, and the ear is kept clean, the foul-smelling discharge will subside, and it will then only be necessary to cleanse the ear occasionally in order to prevent the reappearance of the macerated epithelium. When the cholesteatomata are large and involve the entire tympanic cavity or invade the mastoid, or if there seems any danger of cerebral involvement, they must be removed by operation. Access to them is obtained by performing a mastoid operation.

CHAPTER XIV.

DISEASES OF THE MASTOID PROCESS, WITH THE VARIOUS OPERATIONS FOR THEIR RELIEF.

Historical.—There is a tendency in recent accounts of the operations upon the mastoid process, to underrate the contributions of the great Irish surgeon, Sir William Wilde, to this subject, by his use of leeches and a deep external incision through the periosteum. Besides this there is not always a full appreciation of the part that America has taken in rehabilitating this important procedure.

The first complete account of this operation, which appeared from the time of the publication of Lincke's writings, when it had been abandoned as a dangerous procedure, until its revival, was published in 1870, by the senior author of this volume. The operation had been taken up in a very timid way, by Tröltsch, but this author only recommended opening the bone, when the disease had reached its outer surface. A general surgeon, Dixi Crosby, as well as Lawrence Trumbull, in this country, James Hinton, in England, Triquet, Follin, in France, Ludwig Mayer and Jacoby in Germany, took up the operation, discarding traditions, and decided, on surgical principles, that when there is evidently pus in the mastoid, it should be evacuated. The field of aural surgery had been so neglected for a long time, that this sound surgical procedure remained for many years utterly unconsidered by the profession. The teachings of Sir William Wilde, in Ireland, and Alfred C. Post, in New York, who recommended and performed early, free, and deep incisions through the periosteum, in mastoid periostitis, besides curing many cases, prepared the profession for the gradual reinstatement of the operation of opening the bone.

Tröltsch, in 1858, opened the mastoid with a probe, some days after he had made a Wilde's incision, with only partial relief, but this author said that he would have hesitated to have undertaken the operation with anything but a probe. The case was successful, and eight cases were reported from various authors, by Tröltsch in 1861. It was Tröltsch's paper which reopened the subject of operations upon the mastoid bone at this time.

In 1863 Hermann Schwartze reported a case in a child of one and a quarter years' old, where a Wilde's incision was made, and examination with the probe detected rough bone, which was easily perforated. This patient died in six weeks from the time of the first examination.

In 1864, Ludwig Mayer opened the mastoid, and he seems to have been the first German surgeon who performed the operation, after Tröltsch's suggestion.

In 1868, L. Jacoby began to publish cases. He reported five at various times, and in 1870, he recommended a special trephine.

Pagenstecher reported four cases, as well as did Vlaitz, in 1867. Triquet's cases were reported in October, 1864.

Kessel reported three cases, 1869. In that year, Koppe and Schwartze reported a case of reflex epilepsy, with caries of the mastoid process, cured by an operative perforation.

The first case of the senior author of this volume, was performed in 1869, reported in 1870,[1] accompanied by a historical account. Crosby had used a gimlet in perforating the mastoid in 1864. He performed this operation three times with the gimlet. All of his cases recovered.

A. H. Buck published a paper upon the subject, in 1873, with a tabulated report of thirty-five cases, six of which are from his own practice. Roosa seems to have been the third in America to have performed a mastoid operation.

Although the revival of the operation in this country met with some opposition, thanks to the earnest advocacy of some of the most distinguished of American Otologists, in 1883, at a meeting of the American Otological Society, namely, Knapp, Kipp, Burnett and Gruening it became thoroughly established as a proper surgical procedure.

The senior author began in 1869, as stated, to perform the operation, and not a year of his practice has passed without it has been necessary to continue it, and as he said in the last edition of his text-book on the *Ear*, he would rather err on the side of an unnecessary operation, than to lose one patient from neglecting a surgical principle, of which there can be no question. Sir William Wilde's incision was the first step that led to a proper appreciation of the whole subject. Many a life was saved by this procedure, before it was fully established that there were many cases where it is necessary to go much further. The history of the operation

[1] *Transactions American Otological Society.*

thus shows that America was not behind hand, but in the very front of those who rehabilitated and firmly established this important and necessary procedure.

Before advancing to the discussion of mastoid disease a few general points are worthy of consideration.

First. A chronic mastoid disease is always the result of neglect. Early treatment of the acute inflammation of the middle ear, of which it is a part, will always prevent serious mastoid disease.

Second. The anatomical relations of the various parts of the ear are so close that an *otitis media acuta* always involves the mastoid cells to a more or less degree. It is only when the mastoid symptoms overshadow those of the drum-head, the tympanum and the Eustachian tube that the momenclature should be narrowed.

Third. If an *otitis media acuta* be treated antiphlogistically and thoroughly, at an early period in its course, an especial interference will scarcely ever be necessary. Not every mastoid should be opened because it is tender, nor every drum-head incised because it is red. An unnecessary paracentesis of the drum-head not only may, but often does, aggravate a mild case of acute inflammation of the middle ear, until it becomes a severe and dangerous one. Suppurative disease of the mastoid process usually develops from suppuration of the middle ear, either by extension of the inflammation through the mastoid antrum, or by direct infection from pus in the tympanum which flows into the mastoid cells, when the patient is lying upon the back. It is, of course, possible for mastoid disease to develop without involvement of the tympanum but this is a very rare occurrence.

But mastoid disease may develop in children without any involvement of the tympanum requiring an opening of the membrana tympani, although the mastoid must be opened. The mastoid cells are lined with a mucous membrane, and it is of course possible for any mucous membrane to become diseased. Practically, however, the mucous membrane lining of these cells is never diseased without previous involvement of the tympanum, for it has been demonstrated that all of the cells of the mastoid process are not only lined with a mucous membrane, but that the mucous membrane is continuous from the tympanum to the most remote mastoid cells, the channel of communication being from the tympanum to the mastoid antrum, and thence by inter-cellular openings. Pus may flow from the tympanum through this series of openings into the mastoid cells, and from one cell to another, if the patient lies for some time in the dorsal position, and it may easily be forced into them if air or any liquid is driven into the middle ear under sufficient pressure. Politzer states that in very acute tympanic aural suppuration pus is present in the mastoid cells, but that if the communicating openings between the mastoid cells and the antrum are large and remain unobstructed its presence is of no importance. If, however, the drainage is blocked, the pus acts as the irritant cause of further disease. In general sepsis or in some of the infectious diseases, suppurative mastoiditis is an expression of the systemic poisoning of the patient and need not be dependent upon previous disease of the tympanum; but even in these cases, suppuration of the tympanum usually precedes the mastoid involvement. Such conditions are seen in the course of typhoid fever, scarlatina, tuberculosis, syphilis, and especially in influenza (grippe). It is fair to conclude that pus will rarely develop in the mastoid process if the antral orifice is large or if the pus is not confined under pressure within the middle ear. Mastoid disease will develop rapidly, if the pus is blocked by granulation tissue in an otherwise large orifice. There are instances, however, where this seems not to be true, as where from the invasion of the disease there is a severe infection of the entire lining of the middle ear, including the mastoid antrum, and the mastoid cells.

When this disease is set up after a nasal operation as the result of a septic complication, it is apt to run a very acute course. It is frequently caused by the improper use of the nasal douche, as well as by the injection of therapeutic agents into the cavity of the middle ear.

The probabilities of a cure of suppuration of the mastoid process without surgical interference must never be forgotten. The tendency of the present day is to operate upon this disease very early, but experience has shown that many cases of suppuration of the mastoid undergo cure by resolution without operative procedure.

It is about thirty-five years, since opening of the mastoid cells began to be generally performed by surgeons. Of late years there has been a tendency to overdo the matter of early operation in cases where a timely use of leeches, douches of hot water, accompanied by wet applications to the mastoid, are sufficient to effect a cure without opening the bone.

CLINICAL PICTURES.

1. *Typical Acute Inflammation of the Mastoid Process.*—The clinical picture of this condition presents

tenderness on pressure at the tip of the mastoid and sometimes over the location of the mastoid antrum and the emissary vein; there are radiating pains in the mastoid extending upward over the parietal region; local heat and swelling are present; sometimes the integument of the mastoid region is œdematous; the bodily temperature is usually from 101° to 102°, occasionally reaching 105°, there is often some displacement of the auricle outward—this as well as the swelling, may be more easily detected by comparison with the unaffected side. It is rare that both mastoid processes are invaded at the same time. Very rarely a facial paralysis, due to a complicating neuritis, is present. Acute inflammation of the mastoid process continues in this way for one or two weeks. It may then become subacute or may terminate in complete recovery. A few cases of infection following influenza develop necrosis of the mastoid and a large abscess cavity forms, which ruptures and the pus invades the tissue of the neck or the temporal region.

Local Appearances.—The external auditory canal is filled with pus. A fair indication of the severity of the mastoid involvement is obtained from the rapidity with which the pus reappears in the external canal after it has been removed and the middle ear cleansed by irrigation through the perforation of the drum-head. The pus will immediately reappear within the middle ear if the mastoid cells contain a considerable quantity. The perforations of the drumhead may occur in any part, but appear most frequently in its posterior half. The drum-head protrudes into the canal, is glazed, reddened, and swollen. At the junction of the drum-head with the posterior wall of the external canal a marked bulging will always be seen, thus destroying the obtuse angle formed by the surfaces of the drum-head and the canal. The posterior superior quadrant of the drum-head is bulged into the canal. This is a very important diagnostic feature.

2. *Cases becoming Subacute.*—After the acute inflammation of the mastoid process has continued for a week or ten days, many of the symptoms disappear, the general condition of the patient improves, he is no longer confined to bed, and sometimes may resume his daily occupation. The discharge from the ear continues in small quantity, but it remains purulent. The pain is intermittent and varies in severity. There is usually a very slight increase in the evening temperature, and sometimes the morning temperature is subnormal. The tenderness in the region of the mastoid remains, and may be excited by rather firm pressure.

Such cases are prolonged from week to week, and the improvement is slow even under treatment. They are liable, moreover, to slight relapses without a moment's warning. All of the acute symptoms sometimes reappear and last for one or two weeks, when they may again become inactive, and the inflammation subside. Such a subacute condition may continue for eight or ten weeks, and is very apt to occur in overworked or poorly nourished individuals or in old people. In the course of time such cases may recover completely; but if they suffer from relapses, the mastoid cells should be opened.

With the abatement of the general symptoms there is a corresponding improvement in the local condition, the drum-head clears up, but the injection by the blood-vessels usually remains; the swelling disappears, and the bulging of the posterior superior quadrant subsides. Some pus is usually found.

3. *Cases Tending to become Chronic.*—After the symptoms of typical acute inflammation of the mastoid process have continued for a few weeks the case tends to become chronic. In such instances the discharge is purulent and flows through a wide opening in the drumhead. If the external canal is cleansed from the discharge and the pus within the middle ear is removed by catheterization of the tube, the discharge reappears immediately. Ordinarily when this procedure is instituted, if the mastoid is not involved the pus does not at once reappear, therefore in the prompt reappearance of the discharge we have an indication of mastoid involvement. Such cases can only be explained by assuming that the mastoid cells are full of pus under some pressure, and that the overflow takes place through an antrum of large calibre. Usually there is no increase in temperature, or it is rarely above 100°. Local pain is usually absent, but intermittent neuralgic pains may be experienced. A mild degree of headache, usually parietal, is also apt to be present, and tenderness at the tip of the mastoid can be induced only by very firm pressure. These patients become anæmic, lose flesh, and are usually in a poorly nourished condition. Such a case as this usually results in a gradual absorption of the temporal bone by necrosis or caries, the pus cavity enlarging and tending to rupture through the compact walls of the mastoid, possibly entering the brain; or the discharge makes its way through the external surface of the mastoid and invades the skin in this region or the

tissues of the neck. Chronic cases do not always terminate in this way, but may persist for an indefinite time, with the discharge making its way through the tympanum and external auditory canal.

4. *Relapsing Cases.*—These cases have run the course of an acute mastoiditis, the symptoms have subsided, and the patient is considered well, but after being about for several weeks without pain and probably without increase of temperature, the symptoms suddenly reappear, the temperature rises to 100–101°, pain returns, slight tenderness is present over the mastoid, the auricle is displaced outward, from periostitis or œdema of the mastoid, and the skin reddens. The discharge from the ear which had ceased reappears, or if the perforation in the drum-head has healed the membrane blocks up the pus and perforation again occurs. When these conditions have continued from five to fourteen days, the symptoms again subside. The relapses may be repeated several times. During the intervals between the attacks the pus remains in the mastoid cells, softens the bone, burrows in the direction of least resistance, and finally escapes from the mastoid and appears in one of several localities. It may emerge through the external cortical layer of the mastoid and produce a fluctuating tumor behind the ear and above the tip; or it may perforate the apex of the mastoid and invade the skin of the neck; or break through the *incisura mastoideus* and infiltrate the deep fascia of the neck and the region of its great vessels; or present itself upon the posterior superior wall of the external auditory meatus, where it occludes the external auditory canal by pressing forward the tissue, or creates a fistula through which it discharges. In-

stead of appearing externally it may remain within the mastoid until freed by operative procedure, or may rupture into the labyrinth and through the internal auditory canal invade the covering of the brain; or, following a different route, may burrow through the compact internal bony surface wall and invade the brain or its covering; or involve the lateral sinus.

5. *Cases Developing Cerebral Complications.*—At any time during the course of a mastoid abscess cerebral complications may develop. These are always septic in character and are produced by the entrance of infective matter into the brain tissue or its coverings. The route of infection is through canals in the bone, especially those which conduct blood-vessels, or most frequently through the thin roof of the middle ear—the *tegmen tympani,* or through the roof of the mastoid antrum. Undoubtedly in a few cases the pus finds its way into the cerebral fossa after having traversed the labyrinth and the external auditory canal.

The Symptoms of cerebral complication developing from mastoiditis are headache, nausea and vomiting, stiffness of the muscles of the neck, contraction of the pupils, perhaps double vision, and a slow full pulse. After the cerebral complications are well developed, stupor or coma supervenes, and either convulsions or a paralytic condition develop. These cases run their course with much the same symptoms for all the forms of cerebral complication. Infected cranial cavities may develop a pachymeningitis, a serous or purulent meningitis, an intra or extra dural abscess, or an abscess of the brain tissue. The symptoms of all these conditions, except that of the abscess of the brain, have been already described.

When a cerebral abscess develops the case shows all the symptoms of a pyæmic condition, together with symptoms of pressure upon the brain. These are headache, projectile vomiting, all grades of mental disturbance from stupor to profound coma, and a slow pulse. Other symptoms are dependent upon pressure over localized cerebral areas. There may be disturbance of speech, pain in the joints, facial paralysis, tetanus, or ptosis.

Cerebral complications may prove fatal within a few hours after their appearance, but this is not usual. They never recover unless they are relieved by a surgical operation and up to the present time only a small percentage of operations have saved life.

Cases Developing Sinus Thrombosis.—This condition of the lateral sinus may arise by direct infection of the walls of the sinus, or the infection may be indirect through the lymphatics about the sinus and the blood-vessels which enter it. A septic phlebitis results and thrombosis of the sinus follows.

The *symptoms* in Sinus Thrombosis are somewhat different from those cases developing cerebral complications. They are the appearance of severe and repeated chills accompanied by a moderately high fever, the pulse is feeble and rapid from the invasion of the disease, and contrasts markedly with the character of the pulse in the early stages of meningitis. Prostration and sweating are present. Tenderness along the course of the jugular vein on the affected side can be made out and aids in the diagnosis. Other symptoms are headache, muscular relaxation or partial paralysis, convulsions or coma. The lateral or sigmoid sinus is most often affected, but the superior or inferior petrosal sinus, or the jugular vein may participate in the infection and likewise produce thrombi.

Course.—These cases may prove fatal within a few hours or they may extend over months, when they develop metastatic abscesses in the lungs, spleen or kidneys, and terminate fatally, from chronic pyæmia.

Cases Terminating in Sclerosis of the Bone Accompanied by Neuralgia.—After the usual course of acute disease of the mastoid process, the patient may recover entirely except that pain and tenderness are present for a long time over the region of the mastoid, sometimes extending upward to the temporal region or downward into the neck, while the bone becomes sclerosed. The mastoid cells are obliterated by an over-production of bone. This stage continues for a long time without the production of any more pus. The pain becomes neuralgic in character and is generally severe. It may last for several months, and slowly disappear.

DIAGNOSIS OF MASTOID DISEASE.

A. *Displacement of the Auricle.*—This is a very important symptom of Mastoid Disease, and is produced by a swelling within the external auditory canal, or in the skin and subcutaneous tissue covering the mastoid. It can best be seen by looking at the patient from behind, and slight differences of displacement are detected by comparison with the unaffected side. If the displacement occurs slowly, it is a very valuable diagnostic sign of mastoiditis, as sudden displacement of the auricles indicates rather that the periosteum of the canal of the ear is involved rather than the mastoid cells.

B. *Swelling in the region of the Mastoid* aids in the diagnosis of this affection. It is always necessary to compare the locality with the same area on the uninvolved side. The swelling may be from cellulitis or œdema. A sudden swelling in the mastoid which is superficially painful under pressure indicates periostitis. A swelling which fluctuates, occurring some time after the mastoid involvement, indicates an invasion of the skin by pus which has burrowed through.

C. *Pus in the Neck.*—The presence of pus in the cervical tissue during the course of a mastoid disease is indicated by redness, swelling, bogginess, and cellulitis of the soft tissue. Its presence may be confirmed by fluctuations or by puncture with a hypodermic needle. It usually indicates that the pus has burrowed through the mastoid tip and invaded the region of the neck, or that pus is confined beneath the deep fascia of the neck, having found its way through the incisura mastoideus.

D. *Pus in the Ear.*—The characteristic features of purulent discharge in mastoid cases has already been described, but it is desirable to repeat here that pus appears early in the external auditory canal and continues to discharge throughout the whole course of the mastoid disease. The drum-head is perforated and usually remains so, but occasionally this may heal, though it reappears if there is any active discharge. The quantity and character of the discharge indicate the degree of activity within the mastoid process. Pus may be assumed to flow from the mastoid antrum when it immediately reappears in considerable quantity after the middle ear and the external auditory canal have been thoroughly cleansed. If the pus lessens in quantity and takes on a serous character, it is a fair indication that the mastoid condition is improving. It is also a good sign if the discharge entirely ceases without the coincident development of mastoid periostitis. On the other hand, an increase in the quantity and thickness of the pus generally indicates a renewed activity.

E. *Examination of the Discharge for Bacteria* is supposed to furnish some idea of the seriousness of the lesion. Some otologists claim that a discharge containing streptococci indicates a more serious condition and one which requires earlier interference than when the discharge contains staphylococci or other bacteria of suppuration. In the authors' opinion this is an insignificant distinction. It is not at all proven that the danger of the condition can be known from the presence or extension of the streptococci.

F. *Bulging of the Posterior Superior Quadrant of the Membrana Tympani.*—This is a very important diagnostic sign and invariably indicates involvement of the mastoid cells. Most otologists lay great stress upon the importance of this, for if it is absent the involvement of the mastoid may be doubted. Periostitis of the posterior wall of the external auditory canal, at the angle formed by this wall and the membrane, produces the displacement forward of the posterior superior quadrant of the drum-head and the tissue of the wall of the canal immediately adjacent to it. In this way the drum-head and wall are pressed outward and slightly forward, and the obtuse angle which they normally form is obliterated. The canal is narrowed and frequently the edge of the drum-head presents a small conical prominence with a perforation in the centre.

G. *Fever.*—Fever is present throughout the entire course of mastoid disease. In children, it is apt to be high, occasionally reaching 104 degrees. In adults it varies from 101° to 102° and sometimes when the disease is subsiding is subnormal in the morning. Chills are never present in uncomplicated suppuration of the mastoid. Their appearance indicates possible development of serious complications.

H. *Pain.*—Is usually experienced throughout the entire course of mastoid abscess or periostitis. It varies in different individuals, as well as at different times in the same patient, and is apt to be worse at night. It is located in the region of the mastoid and is diffuse in the early stages of the disease. A constant pain experienced in a different locality over the mastoid and accompanied by tenderness upon pressure, is a fair indication that an abscess is forming at that point. Diffuse and transitory pains in the temporal region extending to the parietal or even the frontal region are frequent. Anodynes even in large doses are powerless to relieve the pain of this otitis media purulenta.

I. *Pain upon Pressure* is a very important diagnostic sign of mastoid involvement. There are three different localities where this pain may be excited by firm thumb pressure. These are: 1, the tip of the mastoid; 2, over the location of the mastoid antrum just behind the auricle and on a level with the upper surface of the external auditory canal; 3, over the emissary vein which emerges one and a half inches behind the external auditory canal and on a level with its upper wall.

If pain be produced by pressure in any two of these localities is an almost certain indication of mastoid involvement. Yet it may not be involved to the extent of suppuration.

TREATMENT.

1. *Rest in Bed.*—It is of the greatest importance that

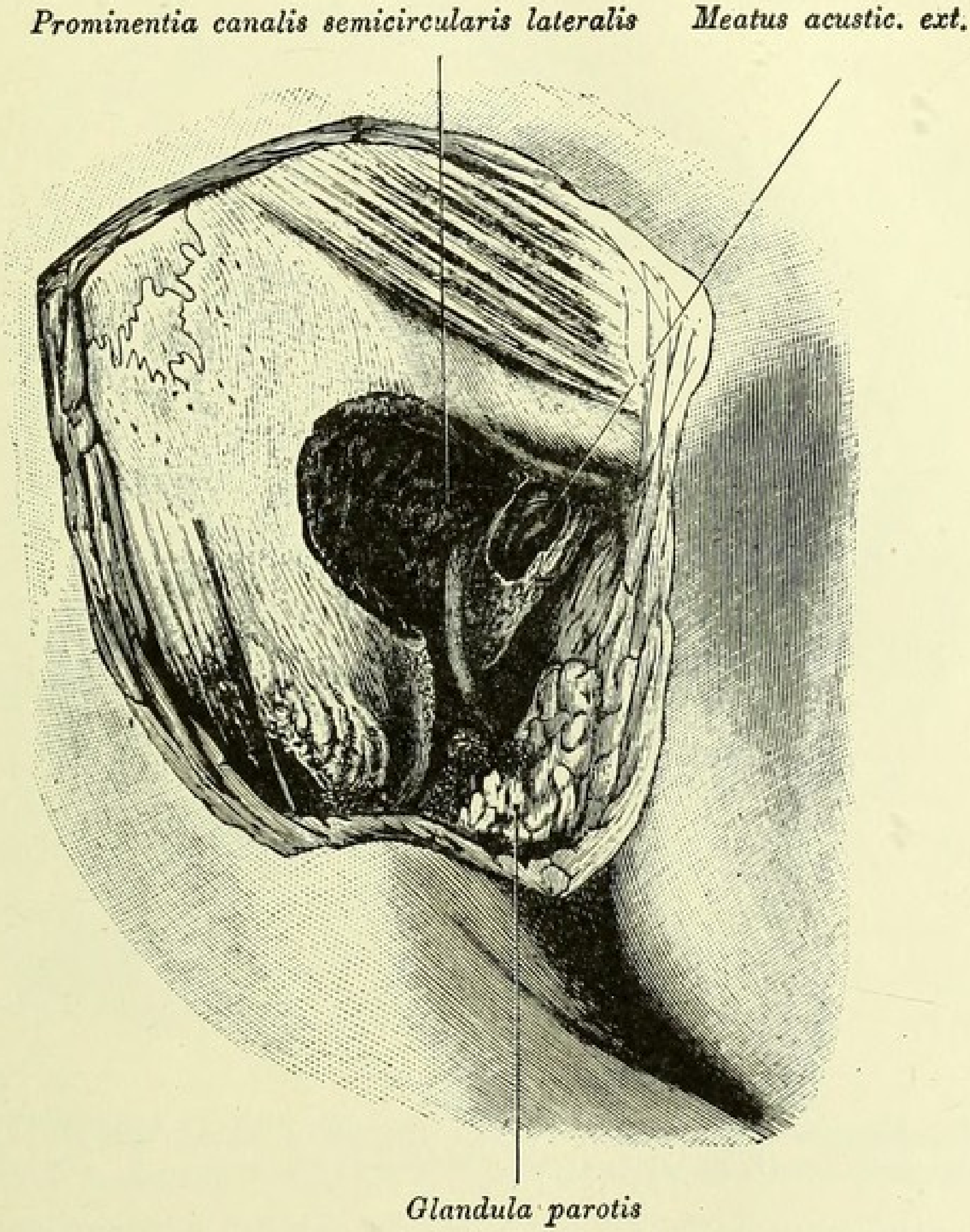


Fig. 65.—Mastoid Cavity with Antrum Tympanicum and the Facial Nerve (Zuckerkandl's Atlas.)

these cases remain in bed. Patients who are not very ill from mastoiditis are sometimes allowed out of bed and about the house, but this results in prolonging the case for several days, or even weeks, and in preventing its complete cure. Patients who remain quietly in bed dur-

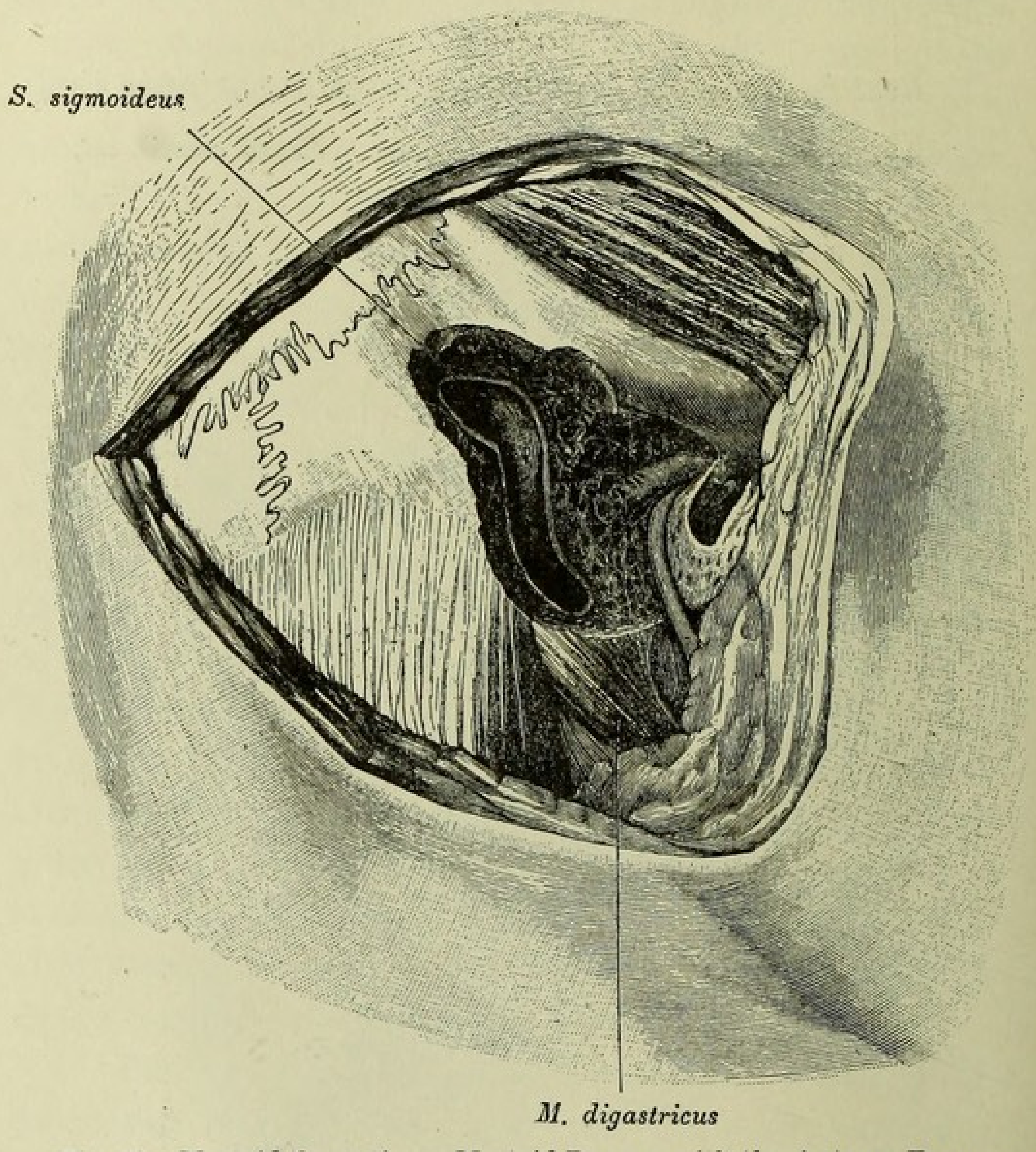


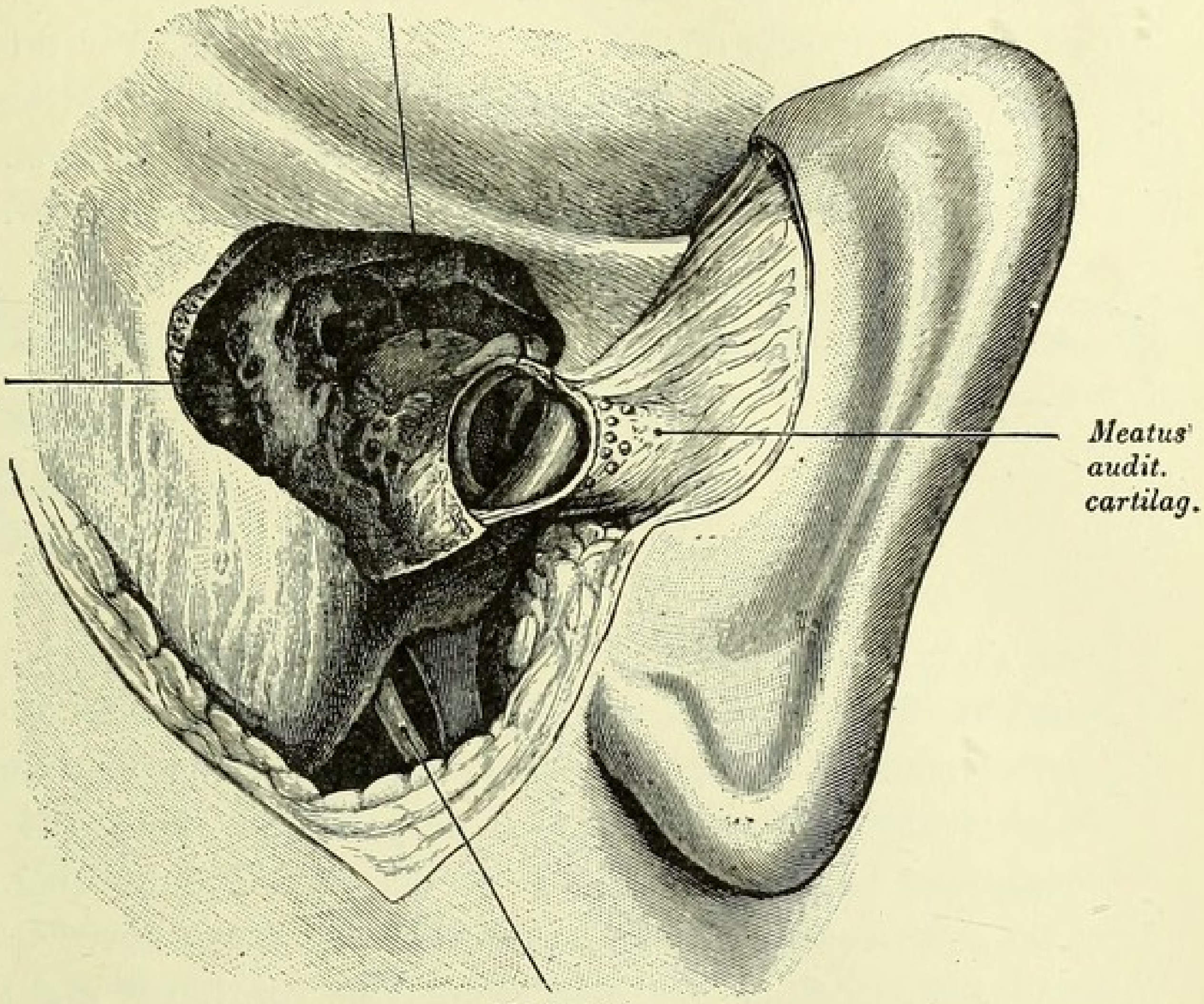
Fig. 66.—Mastoid Operation.—Mastoid Process with the Antrum Tympanicum and Sinus Sigmoideus (Zuckerkandl's Atlas.

ing the course of a mastoid inflammation recover sooner, and less frequently require operative interference.

2. *Leeches.*—Should be used early and if beneficial repeatedly during the treatment of this disease. Upon

the first indication of any mastoid involvement, from four to six leeches should be applied over the mastoid region, and others subsequently used every second day if the symptoms do not subside.

3. Cold may be applied as soon as the presence of the disease is suspected. For this purpose a Leiter's



Fig, 67.—The Finished Mastoid Operation.—Recessus Epitympanicus Antrum Tympanicum Mastoid Cells Sinus Transversus (Zuckerkandl's Atlas.)

coil of block tin tubing arranged to surround the auricle is adjusted over the mastoid and connected with a tube which rests in a reservoir containing water and ice. By syphonage the water is allowed to flow slowly through the coil and thence to a proper receptacle on the floor. This should be applied intermittently for two days. If the symptoms do not subside in this time, the treatment must be suspended. Some specialists, of whom the senior author of this volume is one, do not use cold applications.

4. *Heat.*—This is used if cold proves unsuccessful or sometimes from the inception of the disease. It may be applied by means of the hot water bag placed over the ear, but a better way is with poultices, which should be an inch thick, six inches long, and four inches wide. They are conveniently made of flaxseed meal enclosed

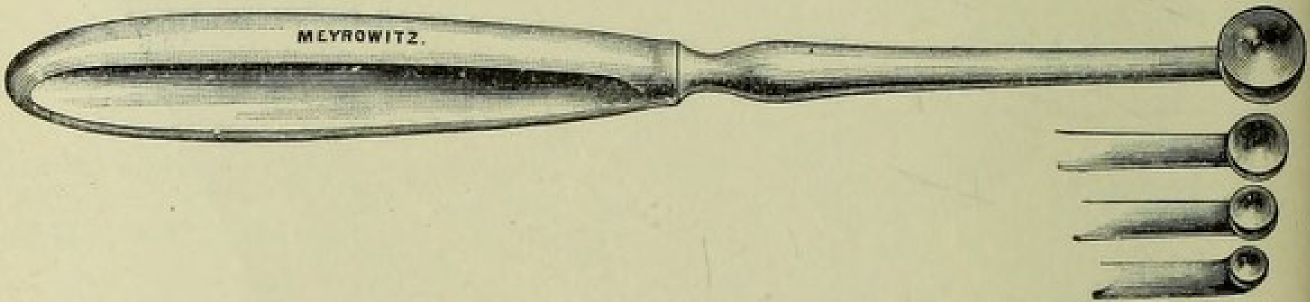


Fig. 68.—Sharp Spoon Curettes.

within a double fold of gauze. The poultices are placed over the ear and retained in position with a loosely applied bandage. They should be used at hot as possible without blistering the skin of the patient. The heat is conserved by putting a hot water bag over the dressing. The poultices should be renewed about every three or four hours. This treatment should be continued night and day unless the skin becomes sensitive or blistered, when it may be omitted for 24 hours and vaseline applied to the skin. If, however, proper care is used in controlling the temperature, the treatment need not be intermitted. The application of poultices should be continued until the symptoms have subsided and the discharge is thinner and less abundant. When they are discontinued, the affected side should be protected from cold by a thick covering of absorbent gauze retained in place with a gauze bandage.

In mild cases applications of a saturated solution of acetico-tartrate of alum are better than cold or poultices.

5. *Irrigation of the External Auditory canal.*—This is one of the most valuable forms of treatment if pursued regularly for several days or weeks, according to the progress of the case. The ear is irrigated from a foun-

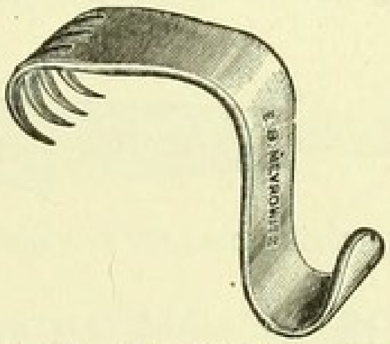


Fig. 69.—Mastoid Retractor.

tain bag connected with a small nozzle. It may be filled with aseptic hot water or with a normal salt solution, preferably the former; the solution should be used as hot as can be borne by the patient. The therapeutic effects of the irrigation are derived from the heat and the removal of the discharge. The irrigation should not be left in the hands of the patient, but entrusted to a nurse or other reliable person. The nozzle is introduced within the external auditory canal and the water allowed to flow into the ear and thence into a basin held under the head. It should be performed every two hours, or even every hour, by day and at night according to the patient's sleeplessness, during the continuance of acute symptoms. After the bodily temperature subsides, the pain diminishes, and the discharge decreases, the intervals may be lengthened to three or four hours, and finally the irrigation may be omitted entirely during the night. The bag should not be held higher than three feet above the patient's head, and two or three quarts of the solution should be used at each irrigation. The temperature must be kept constant.

Anodynes, morphia, codein, and so forth, are of very little value in mastoiditis or in acute otitis media. If the pain be not easily subdued by leeches, irrigation and

Fig. 70.—Periostrotome for Mastoid Operation.

applications over the mastoid, an operation should be undertaken without delay.

METHODS OF SURGICAL TREATMENT.

1. *Paracentesis of the Membrana Tympani* should be performed as soon as the drum-head is much pressed forward by any discharge in the middle ear. If the drum-head is already perforated but the drainage is insufficient, the opening should be enlarged.

Anæsthetization of the drum membrane is produced by filling the canal with a 10% solution of carbolic acid in glycerine, or with a 50% solution of cocaine. If general anæsthesia is desired, nitrous oxide is the most satisfactory agent, but in a few cases ether or chloroform may be used. When the drum membrane is viewed through an aural speculum under good illumination a paracentesis knife is passed through its posterior inferior quarter, beginning from the middle of the drum and extending downward to the skin of the canal. The incision should be prolonged one-quarter of an inch past the drum into the skin of the canal.

2. *Wilde's Incision.*—This operation has cured many cases of serious mastoid disease, but now that otologists everywhere deem it insufficient when disease of the mastoid cells has advanced to the stage of suppuration, it has been generally abandoned. Leeches will accomplish its work in cases of periostitis without sup-

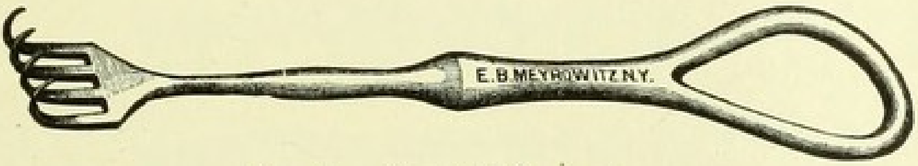


Fig. 71.—Mastoid Retractor.

puration. It is a mistake however to assume that this ancient operation has not accomplished the most beneficent results.

3. *Opening of the Mastoid Cells.*—This may be accomplished by

(*a*) An operation which opens the cells without reaching the Mastoid Antrum.

(*b*) The Schwartze Method.

(*c*) The Stacke Method.

(*d*) The Roosa Method.

(*e*) A modified operation when cerebral complications are present.

(*f*) Operation for the involvement of the lateral sinus.

(*g*) Operation when pus is present in the tissues of the neck.

(*a*) *Opening the Mastoid Cells without reaching the Mastoid Antrum:*—The instruments for this operation are:

A broad and narrow scalpel,
A sharp curved bistoury,
Thumb forceps,
Artery clamps,
Periosteal elevator,
Wide and narrow gouges and chisels,
A Mallet
Drills,
Trephine.
Various bone forceps and rongeurs,
Mastoid and surgical retractors,
Fine probes,
Sutures,
Catgut,
Needles,
Needle holder,
Hypodermic needle.

Sterilization of Instruments.—All cutting instruments and the hypodermic needle should be placed in pure carbolic acid for five minutes and then transferred to absolute alcohol. They may then be washed in sterile water and placed upon the operating table. The remainder of the instruments are sterilized by boiling or by steam. The sterilization should occupy twenty or thirty minutes.

Preparation of the Patient.—The field of operation is prepared by douching the external auditory canal with peroxide of hydrogen, followed by an irrigation of saline solution. A piece of cotton or a strip of gauze is then introduced into the meatus and left there. Above and behind the ear the hair is shaved for an area of three inches, and the entire region of the ear is then scrubbed with green soap and water, rinsed with sterile water, and again scrubbed with a solution of bichloride of mercury, 1 to 1000. When this is dried, the parts are washed in ether, and then wet bichloride gauze and a bandage applied. This remains in place until the patient is upon the operating table, when the field of operation is exposed and a rubber bathing cap is placed upon the patient's head and sterile towels are placed so as to cover all but the field of operation.

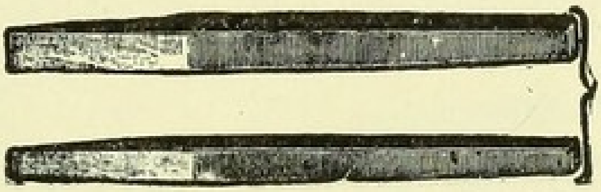


Fig. 72.—Chisels for Mastoid Operation.

The further preparation of the patient consists in producing a movement of the bowels by means of a saline administered 24 hours before the operation, or by giving a rectal enema an hour before. The patient should have no food for six hours preceding the time of operation, and for the preceding twelve hours he should be allowed only a cup of broth and a dry cracker. If food has been taken during this period, it is necessary to wash out the stomach. One hour before the operation an adult patient should receive an injection of a ¼ grain of morphine with 1/100 grain of atrophine sulphate. This may be omitted with children.

Anæsthesia is best produced by the inhalation of nitrous oxide gas followed by ether. Some authorities prefer ether alone: one assistant should have no other duties than the administration of the anæsthetic and noting the condition of the pulse and respiration.

The operator should wear a sterile cap and suit, and all persons concerned in the operation must sterilize their hands by washing and scrubbing with green soap and water and a sterile brush, their finger nails should be carefully cleaned. The hands may then be rendered absolutely sterile by either the oxalic acid and permanganate of potash method, or with carbolic acid followed by alcohol, or with chloride of lime and carbonate of soda (Weir method). These three methods are so well known that they need not be described, or if information is needed it may be obtained from any text-book on surgery.

Fig. 73.—Periosteotome for Mastoid Operation.

The Operation.—The patient is laid upon the table with the affected ear uppermost, and an incision made with a scalpel following the curve of the auricle one-third of an inch behind it and extending above from an imaginary line which runs through the external auditory canal downward, backward, and then forward in a curved direction until the anterior tip of the mastoid is reached. This incision is generally 4 or 5 c. m. long, and must be carried through the skin fascia, and periosteum, with the point of the knife touching the bone throughout the whole length of the incision. The periosteal elevator is now used to separate the anterior and posterior lips of the incision from the mastoid process. When the external surface of the mastoid is exposed the hæmorrhage from the soft tissues may be checked by the application of artery clamps and torsion, but vessels which cannot be controlled by this way must be ligated with catgut. In some cases not even artery clamps or torsion are required. Two ordinary surgical retractors may be introduced into the wound and the soft tissues drawn apart, but a better method of accomplishing this is by using a specially devised self-retaining mastoid retractor, which separates the wound quite as well and does the work of two hands. The tendinous fibres of the sterno-mastoid muscle are separated from the tip of the mastoid with a pair of scissors, care being taken not to wound the fibres of the muscle.

Fig. 74.—Sharp Spoon for Mastoid Operation.

The operator then places a gouge obliquely upon the bone about midway of the exposed area and on a level with the external auditory meatus, and with a few taps of the mallet drives the instrument through the layer and removes about a square c. m. of the bone. Care must be taken to use the gouge obliquely and not perpendicularly, for otherwise, if the sigmoid sinus is abnormally placed it may be perforated with the gouge. Often pus will escape as soon as the external layer is removed, but should this not happen the operator must explore through the opening which he has made, or curette away more of the bone. As soon as the abscess is reached it must be carefully cleaned with gauze tampons or sponges, and the mastoid cells curetted wherever they are affected. The difference between the healthy and diseased parts are indicated by the resistance which the bone offers to the curette and by the presence of granulation tissue, or pus. The curette should remove all of the soft bone; the chisel, all the overhanging edges of the external plate; and the probe should be constantly employed to detect openings leading to other diseased cells which otherwise would escape the operator's notice. The cavity thus produced should be of an irregular cone shape. The wall of the sigmoid sinus will often be encountered in this operation and if normally placed it should lie at the pos-

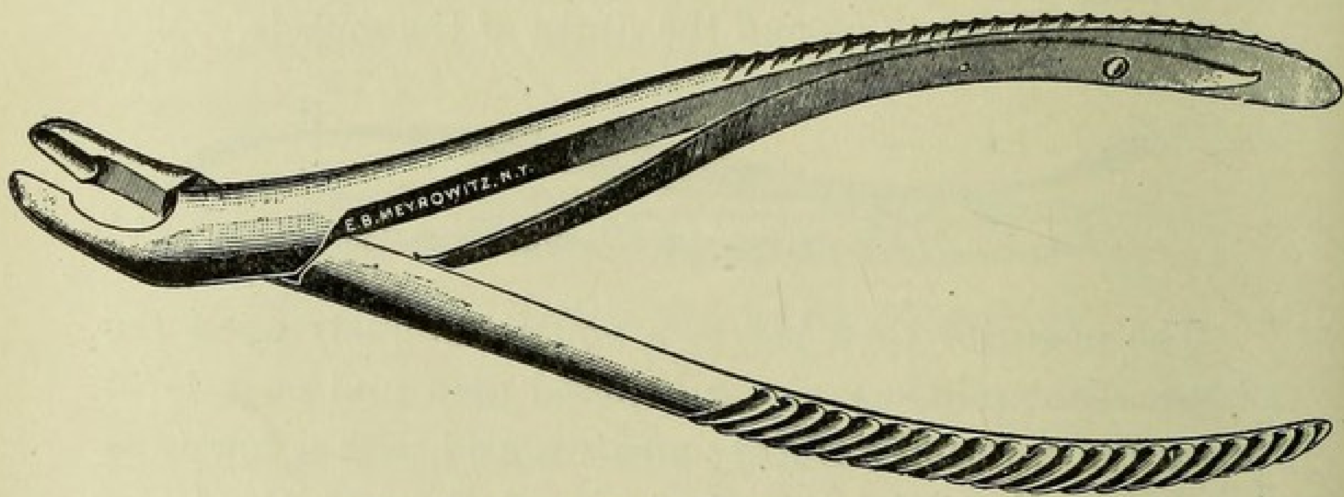


Fig. 75.—Rongeur Bone Cutting Forceps.

terior and upper angle of the bone cavity, but it is often displaced forward and outward until it lies adjacent to the posterior wall of the external auditory canal. The location of the sinus may be suspected if the operator reaches a second compact layer of bone, and is confirmed if the plate of bone is perforated and a bluish-white wall found which indents upon pressure with the probe and immediately recovers. Sometimes the bleeding from large veins in the mastoid, especially from the emissary vein, may be mistaken for a hæmorrhage from the sinus. It is differentiated by removing more of the bone in the region of the hæmorrhage, when the characteristic bluish-white wall of the sinus will not be observed, and instead a mass of granulation tissue or some pus will be found. At other times a mass of granulation tissue bulging from the hidden mastoid cell may simulate the appearance of the sinus. This difference is detected by gentle curettage, which will remove the granulations and generally open another

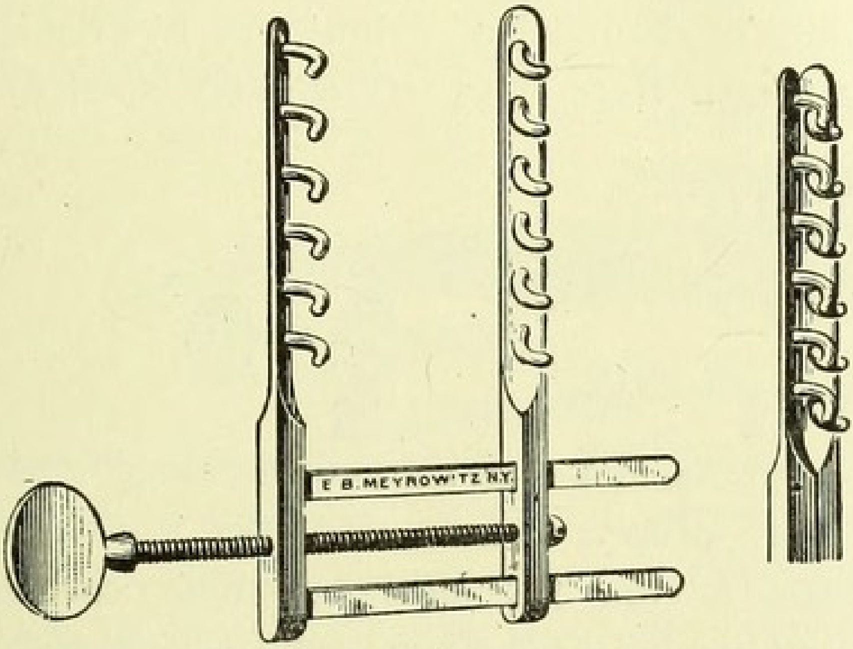


Fig. 76.—Instrument for Holding Wound Open.

small pus cavity, and expose the bony cell walls. It is difficult to describe the difference between granulation tissue and an unhealthy sinus wall, but this is readily learned by observation.

When the operation has reached this stage, it is generally not necessary to proceed further. In a few cases, however, it may be necessary to continue the operation upward and forward toward the mastoid antrum, but in this operation one does not expect to approach the antrum. The operation may be considered finished when all of the carious bone and granulation tissue have been removed. All hæmorrhage from the wound should be checked by packing it with gauze dampened with peroxide of hydrogen solution. If such gauze is left in the wound for a few moments all capillary oozing will cease. The peroxide products may then be removed by gentle irrigation or by wiping out the cavity with a wet cotton tampon. After the wound has been dried, the entire bony cavity is packed with iodoform or aristol gauze, and the external incision is sutured with silk or chromicized catgut, except over the cavity in the bone. Here it is left entirely open and

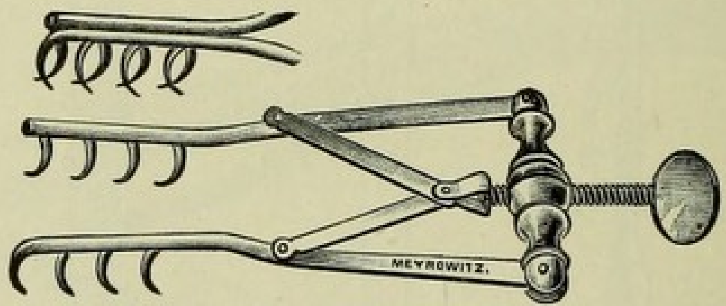


Fig. 77.—Instrument for Keeping Lips of Wound Apart.

packed with more gauze. Some authorities use simple sterilized gauze, having previously applied carbolic acid followed by alcohol to the bone cavities. The skin is then covered with crescent-shaped gauze pads about 5 inches long and 3 inches wide—the concavity being against the auricle—over which is placed a quantity of loose gauze and a liberal layer of absorbent cotton, the whole being retained in position with a figure 8 bandage which surrounds the forehead and the affected side, and the lower jaw, but does not cover the opposite ear.

THE METHOD WITH THE TREPHINE OR DRILL.

The senior author of this volume performs the simple mastoid operation, that is to say, the operation in which it is only necessary to secure free drainage from the tympanum and remove any granular tissue or necrotic bone that may exist,—in a different way from the German method, now generally practised. He uses a drill or trephine to make the external opening into the antrum, making the external incision in the classical way,—always beginning at the tip of the mastoid, and making the incision upward. After thoroughly baring the bone, the opening is made on a line with the meatus *auditorius externus,* about a quarter of an inch from the junction of the auricle with the auditory canal. When the cellular structure is reached, the further operation is performed according to indications. If the bone is

Fig. 78.—Instrument for Scraping the Bone.

scarcely diseased, except in the antrum, where it communicates with the tympanum, a good funnel-like opening is made, and any necessary curetting of the tympanic cavity performed, when the operation is ended. If, however, the bone is extensively diseased, gouges, bone forceps and stiff curettes are employed wherever possible, and the use of the chisel and hammer avoided. The chisel and hammer are only used when it is found that a larger opening than that made by the drill or trephine is needed.

There are indications that there is a revival of this method. Dr. Sohier Bryant, of this city, has recommended the use of a large gouge, in order to prevent the use of the hammer wherever possible. The senior author thinks there has been too slavish adherence to the

German method of practice, and that each mastoid operation is a case by itself, for which no positive rules can be laid down until the bone is opened. Conservatism, in removal of sound tissue, is to be earnestly recommended, for the purpose of avoiding a large and disfiguring cicatrix.

After Treatment: The patient should be kept in bed for at least seven days following the operation, and then may be allowed about the room only if the symptoms of the mastoid involvement have subsided and the wound is in a healthy condition. After operation a subsidence

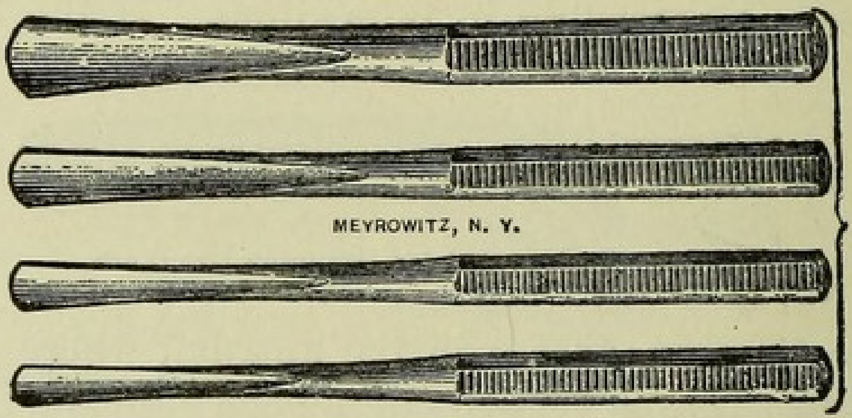


Fig. 79.—Chisels.

of the mastoid disease is indicated by a decrease of pain and lowered temperature, by improvement in the general condition of the patient, and by a lessening or cessation of the discharge. The temperature generally subsides soon after operation, although there may be an evening rise for a few days. Sometimes the morning temperature is subnormal, while the afternoon or evening temperature reaches 99° or 99½°. The patient, while in bed, should be restricted to the use of soups, milk or other form of liquid diet. After he is out of bed, an unstimulating but solid diet may be given, and when it is certain that there is no danger of a recurrence of the mastoiditis, the ordinary diet may be resumed.

Dressings: Absolutely aseptic conduct must be observed by the physicians and assistants with each mastoid dressing. The dressing applied at the time of the operation need not be changed for four or five days, unless the temperature suddenly rises, pain reappears or the dressing is soaked with discharge. The wound should afterward be dressed every third or fourth day until it has healed. After the fourth or fifth dressing, the bandage need no longer be applied, but a specially ar-

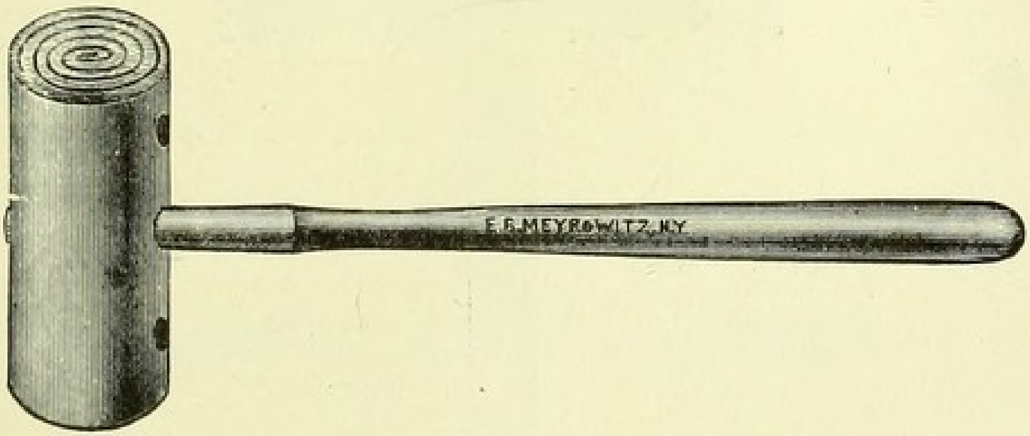


Fig. 80.—Mallet.

ranged covering or pad, secured over the mastoid with tapes tied around the head and neck may be substituted. At each dressing the old packing should be removed and the entire cavity examined for foci or pus, or exposed bone. If loose bone is found, it should be gently removed with the forceps. At each dressing the wound should be washed and dried, packed with plain gauze, and the usual dressings applied. Unhealthy granulations may be subdued with carbolic acid and alcohol. The dressings are necessary for from three to six weeks, the wound generally healing in that time. When the wound is healthy the gauze packing will be moistened with the discharge, but the coverings will usually be dry. The sudden appearance of an unusual quantity of pus within the cavity; the presence of exposed areas of bone which may persist after the tenth or twelfth day; a sudden rise of temperature or the presence of a prolonged and persistent low temperature; the development of headache, photophobia, or vomiting, which can only be referred to the ear, indicate the development of complications which require

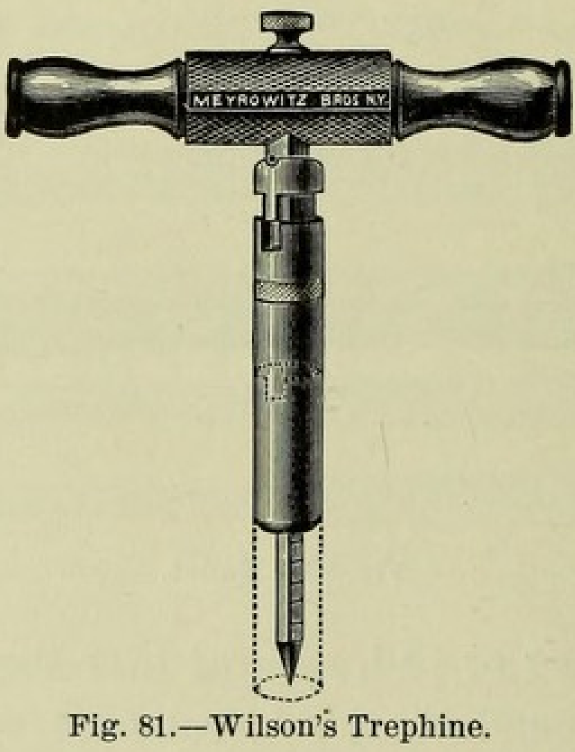


Fig. 81.—Wilson's Trephine.

immediate further surgical interference. There are cases in malarial subjects in which the temperature rises at a fixed time which are cured by the administration of quinine.

(*b*) THE SCHWARTZE RADICAL OPERATION

In this operation not only is the cortical layer of the mastoid removed and the cells destroyed, but the mastoid antrum is opened, its external wall obliterated and the tympanum made to communicate with the external wound by removal of the outer wall of the attic and of the *aditus ad antrum*. In this way all of the cavities of the ear are laid bare for inspection and treatment.

Instruments:—The instruments for this operation are the same as those named under the preceding operation. In addition, the operator should use an antrum protector (of which Stacke's protector is a model) to prevent injury to the horizontal semi-circular canal and the facial nerve. The preparation of the instruments, the patient, and all concerned in the operation has also been described in the previous operation.

Operation, 1st Step:—An incision is made one-third of an inch behind the attachment of the auricle, extending from over the top of the auricle on a line with the external auditory canal, in a curved direction downward,

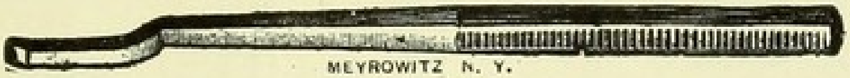


Fig. 82.--Chisel.

backward and then forward half an inch past the mastoid tip. The incision should be carried through the skin, fascia and periosteum.

2d Step:—The soft tissues are separated from over the external wall of the mastoid process—the posterior flap backward and the anterior flap forward—until the mastoid process is fully exposed. The anterior flap is further displaced forward and the posterior and superior walls of the external auditory canal come into view. The flap is then pulled still further forward, while the operator continues to expose the deeper parts of the posterior and superior wall of this canal, which is conveniently done with a small periosteal elevator or with the handle of a scalpel. Thus the soft tissues are separated from the walls of the canal as far as—and sometimes past—the junction of the posterior wall of the canal with the membrana tympani. Surgical retractors or a specially devised mastoid retractor are now introduced, and the whole of the exposed surface of bone is inspected after the hæmorrhage is controlled in the usual way. A stiff probe is used to examine the

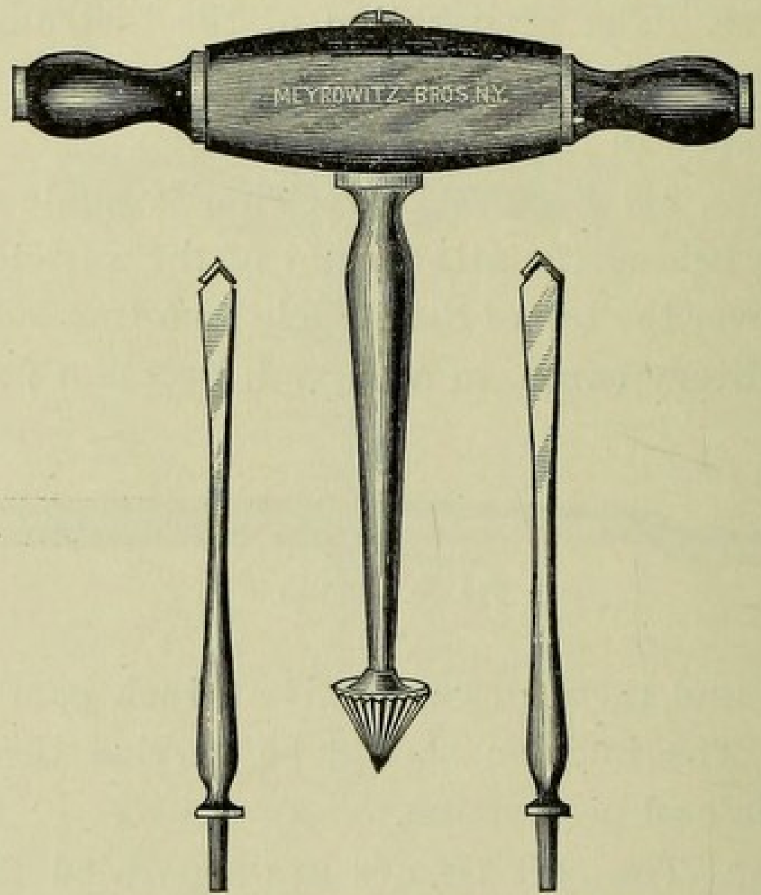


Fig. 83.—Buck's Trephine and Drills.

bone, and if any fistulous openings or softened areas of bone are found, the bony layer over this region is removed and the cells exposed and curetted. The operator may continue the removal of the bone upward and forward until the antrum is exposed. Ordinarily, however, no fistulous openings or softened areas will be discovered, in which case the operator must proceed to find the mastoid antrum without exposing the cells.

3d Step: Finding the Mastoid Antrum: Anatomical Land-Marks:—One half an inch below the zygomatic ridge and at the curve formed by the conjunction of the posterior and superior wall of the bony external auditory canal, the spine of Henle is invariably found. It is recognized by its position and by a slight depression behind it. A triangle is now marked upon the bone, its apex being the lower end of the spine of Henle, its base, the zygomatic ridge, and its equilateral sides being 3/8 to 1/2 of an inch. The mastoid antrum lies exactly 5/8 of an inch internal to this surface.

The head of the patient must now be held absolutely

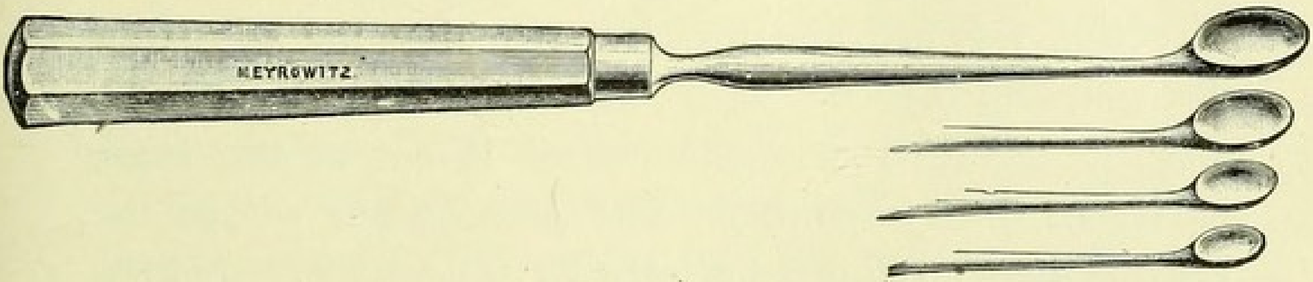


Fig. 84.—Spoons.

horizontal upon the table. This position is facilitated by placing a small round bolster under the neck, the head resting upon the table. The operator then with a mallet and chisel chips away the surface of the bone within the triangle and continues the removal of the bone directly inward. As the hole deepens, great care must be used to maintain a direct course inward, for a slight deviation from this would lead the operator away from the antrum. If the operator departs from the exact inward direction and the chisel is allowed to work slightly upward, the brain cavity will be reached; if the direction taken is slightly anterior, the canal of the ear or the middle ear cavity will be entered; if the chisel works slightly downward, the antrum will not be found; and if posteriorly, the lateral sinus may be reached. The operator must therefore constantly verify his direction while removing the bone.

When the cavity is $\frac{5}{8}$ of an inch deep, the mastoid antrum will invariably be reached. It is not always placed so deep as this, but observations upon many temporal bones confirm this measurement. Sometimes superficial mastoid cells will be reached before the antrum, and these may be mistaken for it. They are, however, to be differentiated from it by probing. It is characteristic of the antrum that when a curved probe is introduced, it may be carried $\frac{1}{4}$ to $\frac{1}{2}$ an inch in a direction forward and upward, reaching the *aditus ad antrum,* and then taking a course still further forward, slightly outward and downward, it enters the large cavity of the tympanum. The probe when within the antrum is surrounded entirely by bone. The direction which the probe takes, the characteristic sensation experienced when it enters the middle ear, and the fact that it is surrounded by a bony wall, serves to identify the antrum. The probe will not take this direction if the superficial mastoid cells are entered instead of the antrum. If the coverings of the brain have been reached instead of the antrum, they can be distinguished by the absence of the bony wall about the probe, and the yielding sensation when the dura is pushed aside. If the sigmoid sinus has been perforated it will be distinguished by the characteristic hæmorrhage. If the operator has reached the external auditory canal instead of the antrum, this may be distinguished by examination with the speculum.

When the antrum has been certainly identified, the Stacke protector or a probe should be reintroduced through the antrum into the middle ear and held in this position by an assistant during the remainder of the operation, for when the antrum is found the rest of the operation is much simplified, and the facial nerve and the semi-circular canal cannot be wounded. Besides this, the antrum serves as a landmark for the location of the lateral sinus.

The operator next removes the whole remaining outer table of the mastoid process, working with a chisel or gouge from above downward and backward to the tip of the mastoid. When this has been done the cell walls, granulation tissue, and infective *debris* are removed by the alternate use of chisel and bone cutting forceps, and the curette. During this stage of the operation the probe is useful to discover hidden cells or the openings into the diseased cells which may be covered by granulation tissue. During the whole of this procedure the operator bears in mind that the sigmoid sinus is located posterior to the mastoid antrum, and when he reaches the compact layer of bone he should pause until his locality in reference to the sinus is determined. If the bony sinus wall is carious and softened, its membranous wall will oftentimes be exposed before the operator realizes that he is near it. The sinus is usually located at least 3/4 of an inch posterior to the mastoid antrum, but it occasionally lies much nearer, and has been seen even knuckling into the antrum. If the bony wall of the sinus is removed, and the membranous wall exposed, no harm results. In fact, this should always be done in order to obtain information about the condition of the interior of the sinus. A normal sinus is bluish-white; a diseased one will be covered with soft granulation tissue and may contain between its bony and membranous walls a small quantity of pus. A normal sinus also yields to pressure from the finger, while if it is thrombosed it loses its shining appearance and presents greater resistance. If there is any doubt about its condition, a hypodermic syringe may be used to perforate the wall and obtain some of its contents. If the sinus is normal, blood only will be obtained, if abnormal, pus may be detected microscopically; or if the thrombosis entirely fills the sinus, the needle will remain empty.

If the sinus is perforated during the operation, hæmorrhage from it is very active, but may always be controlled by firmly packing the opening in the bony sinus wall, with strips of gauze. When the hæmorrhage is controlled the operation may be continued. After the sinus has been located any remaining mastoid cells must be examined. Sometimes the cells extend forward into the zygomatic process, or backward over the temporal region, and in order to reach them it may be necessary to enlarge the skin incision by a cut at right angles to it. The entire cellular contents of the mastoid must be removed as well as every overhanging edge of bone, so that at this stage of the operation there is a conical bony cavity, the base corresponding to the external surface of the mastoid and the apex to the mastoid antrum containing the probe. The anterior part of the surface of this conical cavity, is formed by the posterior and superior wall of the external auditory canal, which has now become a prominent and curved ridge separating the cavity of the external auditory canal from the cavity which has been made by the operator. This ridge runs from above downward and backward toward the tip of the mastoid.

The mastoid antrum is next widely opened by the removal of the projecting ridge of bone continuous with the posterior wall of the external auditory canal and forming the outer wall of the aditus ad antrum. A review of our knowledge of the boundaries of the antrum and the aditus will bring to mind that they are bounded above by the *tegmen antrii,*—a thin plate of bone separating the antrum from the cranial cavity; on the inside by the internal wall of the petrous portion of the temporal bone and the perpendicular semi-circular canal; and below, by the projection which marks the location of the horizontal semi-circular canal and the *aqueductus Fallopii,* which conducts the facial nerve. Externally, they are bounded by the part of the posterior and superior walls of the external auditory canal which at the same time forms the external wall of the attic.

Thus it will be seen that the external wall of the antrum is the only part which may be safely removed—the part which is formed by the external wall of the attic and the posterior and superior part of the external auditory canal. In obliterating this wall of the antrum, there is danger of wounding the horizontal semi-circular canal and the 7th cranial nerve, as has been already mentioned, these lie on the inferior and internal wall of the aditus ad antrum. This danger may be entirely avoided by not removing the anterior wall of the antrum without first fitting a proper protector within it, for if the protector rests within the antrum it must cover the bony wall of the semi-circular canal as well as protect the facial nerve. A small chisel is necessary to remove the external antral wall, which should be chiselled away until the opening is level with the roof of the antrum and the protector may be lifted through it without encountering any bony irregularity. After this the opening is still further enlarged by the removal of more of the bony wall which forms the external wall of the attic. This is as far as it is safe to venture, on account of the danger of wounding the facial nerve, except that the more superficial parts of the posterior wall of the external auditory canal may be smoothed down.

When this portion of the operation is completed, the tympanic communicates with the external wound through a wide trough which formerly was the closed mastoid antrum. The ossicles lying in the tympanum can be seen with good illumination. A small curette should now be used to remove granulations from the antrum and the tympanum. The curette should first be used to remove the granulation tissue, then be introduced into the middle ear removing the malleus and with it the remaining portion of the drum membrane. The incus is next removed, but the stapes remain attached to the membrane of the oval window. Care must be exercised not to curette the inner wall of the middle ear for fear of removing the stapes or perforating the internal ear. The curette must also be carried well forward and downward to the anterior inferior angle of the middle ear until it enters the Eustachian orifice. This will usually be found filled with infected granulation tissue, which should be removed. Some care is necessary when using the curette on the floor of the middle ear chamber to prevent wounding the internal carotid artery.

4th Step.—The wound should now be irrigated with a small quantity of sterile salt solution or plain sterile water, or it may be cleansed with pieces of wet gauze. All chips of bone and clots of blood must be removed. If the operation has been properly performed the water syringed into the external auditory canal will flow freely through the external incision, thus furnishing evidence that the drainage is satisfactory. After the wound has been dried, the external auditory canal is packed with a strip of gauze. The wound cavity is then dusted with xeroform, or a small quantity of iodoform or aristol, and is firmly packed with strips of 10 per cent iodoform gauze. Generally one or two catgut sutures may be used in the upper part of the skin wound. The lower part of the incision is left widely open, and crescent-shaped gauze pads are placed over the entire region. A liberal supply of absorbent cotton covers this, and the whole is retained in place with a figure-8 bandage.

After Treatment.—The wound is first dressed on the fifth day after the operation unless sepsis or brain complication indicates immediate further interference. All of the dressings must be carried out under strictly aseptic conditions. The wound is usually dressed three or four times each week for from three to eight weeks. During the course of healing exuberant granulations may spring up along the edges of the wound or within the bone cavity. Those within the bone cavity are controlled by firmer packing and occasionally by cauterization with silver. If necrosis or caries complicates the healing, their presence will be indicated by a considerable quantity of pus and uncovered areas of bone. Gentle curettage is advisable for such cases. At each dressing care must be taken to thoroughly pack the cavity from the bottom. This, with strict aseptic precautions, facilitates healing.

(c) STACKE'S RADICAL MASTOID OPERATION.

1*st Step.*—An incision is made as in the Schwartze operation, extending to the bone. The posterior lip of the wound is not retracted, but the anterior lip is separated with the periosteal elevator from the bone, and together with the auricle is strongly retracted forward. When the bony wall of the external auditory canal comes into view the skin and periosteal covering of this wall are separated from the bone with a long narrow periosteal elevator, the auricle is retracted still further forward, and at this stage of the operation the entire auricle with the soft tissue of the posterior wall of the canal is separated from the temporal bone. When this has been done, the soft parts of the posterior wall of the external auditory canal are cut obliquely from below upward and as near the membrana tympani as possible. The middle ear contents are now exposed, and under a strong illumination—the bleeding having been checked with gauze tampons soaked in peroxide of hydrogen—the malleus with the remains of the membrana tympani are removed with a delicate pair of forceps or scissors.

2*d Step.*—The Stacke protector is introduced into the middle ear and rests in the attic, its tip within the aditus ad antrum. With the protector in this position, the triangular external wall of the attic is chiselled away as far upward as the tegmen tympani. The incus is then removed and the protector pushed into the mastoid antrum. Here it protects the semicircular canal and the facial nerve while the triangular mass of bone which forms the superior and posterior wall of the external auditory canal is removed. Forceps or chisels are employed to remove this very hard bone which is usually five-eighths of an inch thick and one-half an inch long at its base. The chiselling is continued backward and outward, never upward, for fear of perforating the brain plate. After this has been done, the operation is completed by the removal of all the projecting parts of the posterior wall of the external auditory canal, so that a single smooth cavity of considerable size results, including the former cavity of the middle ear, the mastoid antrum, and the external auditory canal.

3d Step.—This consists in the formation of flaps of skin which are used to fill in the bony cavity and hasten cicatrization. With a small sharp knife the membranous posterior wall of the external auditory canal is incised from where the tympanum formerly joined it, horizontally outward to the concha. Then a second incision is made at right angles to the first and parallel with the edge of the concha, thus producing a single rectangular flap. This flap is pushed posteriorly against the wall of the operation cavity and held in place by firm packing. The external wound is sutured.

The dressings are changed as in the previous operations, except that the external auditory canal is packed firmly in order to hold the flap in place until it is united to the bony wall by granulations.

The operation of Stacke should never be performed when complication of the lateral sinus is suspected, or any extensive abscess has developed within the mastoid cells. It should be performed when the mastoid process is sclerosed and when the mastoid antrum cannot be found during the course of the Schwartze operation. It is always a useful operation to remove Cholesteatomata from the middle ear and antrum, and when necrosis of the ossicles and attic are present without the production of an abscess in the mastoid cells.

OPERATION FOR CEREBRAL COMPLICATIONS.

This operation is performed for an epidural abscess or abscess of the brain. The method of reaching the abscess may be either through the mastoid process or by direct exposure of the temporal lobe through a trephine opening half an inch above the external auditory meatus, but the latter operation is rarely done, for in the class of cases which we are considering the abscess is otitic in origin. The temporal lobe of the brain may be exposed during the radical mastoid operation by removing the tegmen tympani and the roof of the mastoid antrum. This exposes the dura over the region of the temporal lobe. If the dura is normal it is not discolored and does not bulge into the opening. If it presents abnormality from pus, granulations, exudate, or slight bulging, or if it is darker in color in some places than in others, these localities should be further examined. If there is an extradural abscess present, the pus is most often found over the region of the roof of the tympanum or the roof of the mastoid antrum; but if it is not found here then it is a good rule to work forward over the tympanic cavity, for the pus tends to burrow anteriorly. Fistulae, if present, aid in discovering the suppurating focus. If these are found they should be examined with a probe to ascertain their direction. If the dura is perforated by fistulae it must certainly be incised and the brain condition examined. The dura must also be examined if it bulges or if there is any reason to suspect that pus is present within the brain tissue. If an accumulation of pus has been found between the bone and the dura, and examination shows that it has been confined within a circumscribed area, shut off from the rest of the dura by strong adhesion, the probabilities are that the only focus of infection has been drained and that no further complication need be apprehended.

When the epidural abscess has been drained it should be packed with iodoform gauze after it has been gently irrigated. If the dura is incised in order to explore the brain, the lips of the wound should be retracted with a silk suture passed through each flap and used to draw them aside. Then the finger, or aspirating needle, or scalpel is used to discover the locality of pus, and when this has been determined the cavity is drained and subsequently irrigated. All manipulation must be exceedingly gentle and rapid. After the abscess cavity within the brain has been cleaned a gauze drain is introduced and the brain allowed to resume its normal position. The usual mastoid dressing is then applied. In such cases the dressing is changed about every third day and each time a smaller drain is introduced through the dura. It is sometimes necessary to operate again upon these cerebral abscesses if the pus re-accumulates.

OPERATION FOR CEREBELLAR ABSCESSES.

A cerebellar abscess may be reached by a trephine opening one and one-half inches behind the centre of the external auditory meatus, but in the class of cases we are considering, it is usual to expose it during or after the performance of the radical mastoid operation. In order to expose the cerebellum the inner wall of the mastoid antrum as well as the bone behind it is removed, care being taken to avoid the posterior semi-circular canal in front and the lateral sinus behind. The abscess is usually located at this point. As soon as the bony plate has been removed, the operator must search carefully for granulation tissue or a fistula which will aid him in locating the pus; should more space for exploring the abscess be necessary the operator should proceed to remove the bony wall of the sigmoid sinus. If a cerebellar abscess is present but is within the tissue of the cerebellum the operator must incise the dura and examine the cerebellar tissue. If the pus still escapes detection, it is necessary to chisel away the bone behind the lateral sinus, incise the dura, and examine the cerebellum with the needle, knife or finger. If in the attempt to find the cerebellar abscess it is discovered that the lateral sinus is thrombosed, then the operator should split the wall of the sinus, clean it out, and incise its posterior wall in order to obtain access to the cerebellum.

OPERATION FOR SINUS THROMBOSIS.

When during the course of a radical mastoid operation the bone over the lateral sinus is found to be softened and necrotic it should always be removed and the condition of the membranous walls of the sinus investigated. A normal sinus pulsates and its walls are bluish-white. If these walls are yellow or covered with exudate, present hæmorrhagic spots, or show the presence of granulation tissue, thrombosis of the sinus may be suspected. If besides this, ulcerated areas in its membranous wall or fistulae leading to its interior are found, the probabilities are that the sinus contains a large thrombus. If such a sinus is opened its inner wall will be found swollen, covered with clots of blood of various sizes, or it will be entirely occluded with one large thrombus. This may extend upward or downward, but it usually extends downward as far as the bulb of the internal jugular vein.

The operation for sinus thrombosis is performed during a radical mastoid operation when any of the above conditions are observed or secondarily when septic conditions point to this invasion. If the sinus does not pulsate, or if any of the above described appearances are noted, or if it offers resistance to pressure of the finger, it must be further examined. In order to do this the bony walls of the sinus are removed downward past the knee and as far as the jugular bulb. Then a hypodermic needle and syringe may be used to explore the sinus at various places. The needle is introduced through the walls of the sinus and the contents drawn into the barrel. The liquid which is removed must be examined with a microscope for evidences of pus or microbes. If some of this is smeared upon a cover glass and dried, then stained with a solution of methyl blue, the examination may be completed within a few minutes. If the examination shows any reason to suspect an involvement of the sinus, its external wall should be incised with a bistoury. If a thrombus fills the sinus no hæmorrhage will occur; if the thrombii are small, they will be washed away by the very profuse hæmorrhage which results from opening the sinus. The hæmorrhage from either end of the sinus may be checked by packing the end with strips of plain sterile gauze. If blood flows from both ends, sinus thrombosis can be excluded, and when a pad of gauze has been placed over the sinus to check the bleeding it will not need any further treatment.

If, on the other hand, the interior of the lateral sinus is found filled with a septic thrombus, the incision through its walls is enlarged and the thrombus carefully removed. The upper end of the sinus must then be curetted gently until blood flows freely through it. The hæmorrhage is checked by packing, and next the curette should be used in the lower part of the sinus, as far down as the jugular bulb, and an attempt should be made to remove all of the thrombus from the region of the bulb unless there are symptoms of involvement of the internal jugular vein. Even if the circulation is not re-established through the jugular bulb and there is no indication of thrombosis of the jugular vein, no further operative interference is required, the gauze controlling the hæmorrhage is removed, and the bleeding allowed to recur for a short while. It is then controlled by repacking, the wound cavity wiped out, and then packed loosely with gauze. Over this the ordinary surgical dressing is adjusted.

If there is a thrombosis of the internal jugular vein indicated by swelling and bogginess of the cellular tissue along its course, then the vein must be exposed throughout its entire length, ligated near the clavicle, and slit open from the ligature to its bulb, the thrombosis removed, all infected glands dissected away, and the wound closed except at the upper and lower parts, which are kept open with gauze drains.

For the great advance in cerebral and cerebellar operations, consequent upon aural disease, the profession is chiefly indebted to the epoch-making work of Professor MacEwen, of Glasgow.

PLASTIC OPERATIONS ON THE EXTERNAL AUDITORY CANAL.

These operations are performed subsequent to mastoid operations in order to promote healing and to cover exposed bone, and also to prevent stricture of the meatus. Plastic operations should not be performed if there has been an extensive opening of the mastoid cells, or if the cells which have been opened are unusually large. The best results are obtained in those cases where only the tympanum and the bony antrum have been opened by Stacke's operation; when there are intracranial complications, or cholesteatomata are present, the operation is contra-indicated, although some otologists—notably Jansen—close up the wound with plastic methods if the dura has been exposed and found uninvolved or the sinus found healthy.

Pense's Method—is used when the retro-auricular wound is kept open.

Step 1:—The posterior membranous wall of the external auditory canal is slit with a knife horizontally from behind, so as to form an upper and a lower flap. This incision extends from the membrana tympani outward to the posterior edge of the external auditory meatus. At its external end a perpendicular cut is made at right angles to this, forming a T-shaped incision.

Step 2:—The flaps are thinned by cutting away the tissue on their posterior surfaces.

Step 3:—The lower flap is then turned downward and its corner sutured into the inferior angle of the incision which uncovered the mastoid process, and the upper flap is turned upward and sutured into the upper part of the same incision. These flaps and the auricle are then pressed backward and the flaps held firmly pressed against the walls of the cavity formed by the mastoid operation and held in place by gauze packing.

Korner's Method:—is used when the retro-auricular wound is sutured and closed by a primary union.

Step 1:—After the radical mastoid operation is completed the membranous posterior wall of the external auditory canal is split with two horizontal incisions, extending from the tympanic end well outward into the cartilage of the concha, thus forming three flaps, an upper one, a lower middle one, and a lower one.

Step 2:— The subcutaneous tissue of the middle flap is removed with scissors and the thin flap is pressed against the bony wall of the operation cavity and held in place with a split drainage tube which exactly fills the meatus, the split portion lying against the anterior wall of the meatus, while the uncut portion is pressed against the flaps. The tube is then packed with gauze, thus forcing the integumental flaps posteriorly by pressure from the surface of the tube. In this way good approximation of the flaps and the bony cavity is obtained.

Step 3:—The posterior auricular wound is entirely closed by suture.

Berens' Method:—This operation is a modification of the Korner method and has been found very useful in lessening the time of healing and in producing an unstrictured meatus. Berens describes his plastic operations as follows: " The first incision is made at the hairline; the skin and superficial fascia is then dissected from the periosteum to the posterior attachment of the auricle, where the periosteum is divided and the auricle is pushed forward. After the radical operation on the bone has been performed, a Korner flap is cut from the posterior membranous canal wall in the usual manner. An inverted comma-shaped flap is then cut from the tissues previously dissected from the soft parts behind the auricle. The *tail* of the comma forms a pedicle from which the skin is removed, leaving a thick mass of sub-cutaneous tissue. The skin remains on the *head* of the *comma,* but the superficial fascia is removed from it. Thus a large growth of skin is nourished by a pedicle of superficial fascia. The skin portion of the flap is then used to cover in the middle ear, the attic, and the antrum, and it is stretched to the cut edges of the superior wall of the membranous canal.

This skin graft is then packed firmly into the cavity, and it should be sufficiently large to cover the whole cavity. It is held in place by a very tight gauze packing. The Korner flap is then placed backward and is used to cover the auricle beneath the concha. The wound posterior to the auricle is then sutured. The dressings are not disturbed for ten days or more. They are renewed once or twice only; and in successful cases the after treatment extends over a week or ten days after the permanent removal of the dressings."

NECROSIS OF THE TEMPORAL BONE.

Necrosis occurs in any part of the temporal bone as a complication of otitis. It most frequently appears in the region of the tympanum, the Eustachian tube, or the mastoid process, the whole of the internal ear may be involved and removed as many cases attest.[1]

Symptoms.—Pain is always present and is generally severe and entirely out of proportion to the local appearances. Besides this, there are subjective noises ex-

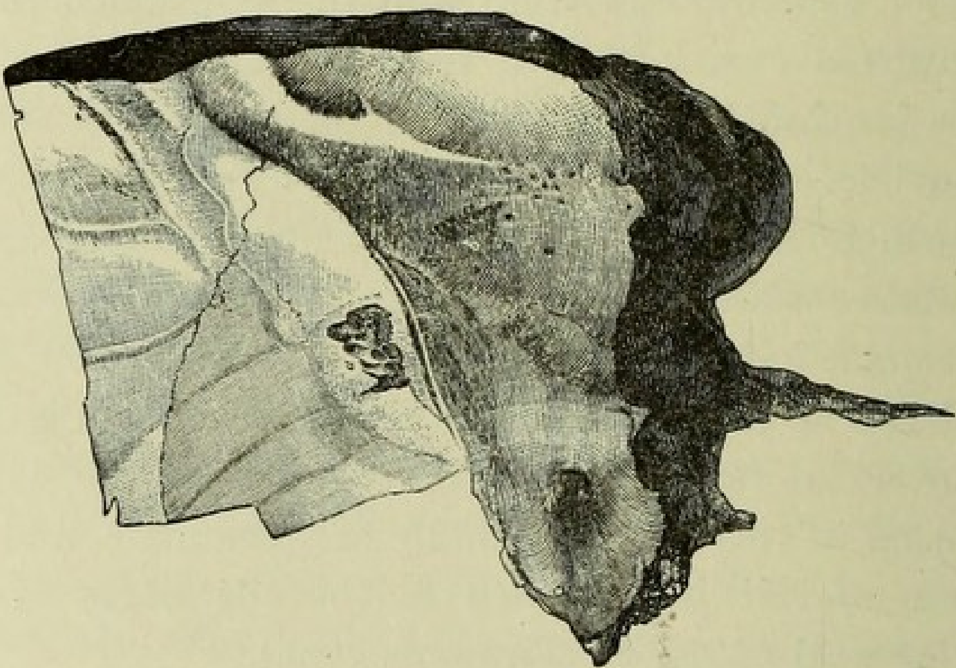


Fig. 85.—Caries Occurring in Case of Meningitis from Acute Suppuration.

perienced within the head, accompanied sometimes with vomiting, persistent hiccoughing, or cerebral symptoms. The necrotic area always produces discharge. There may also be a swelling of the canal of the ear, the formation of fistulae, and the presence of aural polypi. The lymphatic glands enlarge if there is any septic absorption.

[1] Roosa on the Ear, 7th Edition, p. 549.

Diagnosis.—The presence of rough bone in the external auditory canal or in the middle ear indicates necrosis. If fistulae are present, the probe introduced into them will invariably detect bare bone. The presence of a purulent discharge and granulation tissue within the neighborhood of the necrosis are further local appearances and confirm the diagnosis. The most important single sign is the presence of bare bone which is felt with the probe.

Treatment.—It is impossible to give any specific rules for treating caries and necrosis of the temporal bone.

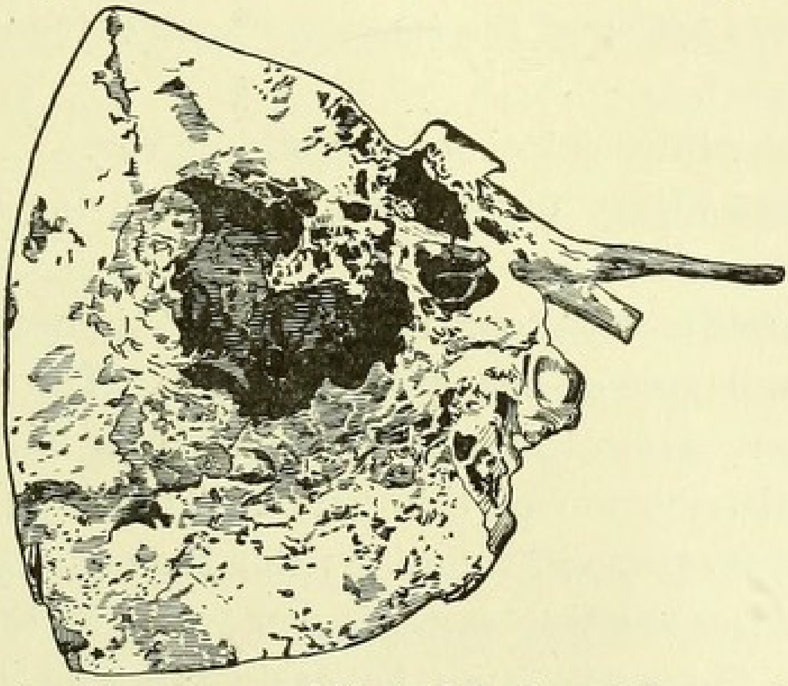


Fig. 86.—Caries of Squamous and Mastoid Portion of Temporal Bone.—For Case see Roosa on the Ear, 7th Edition, p. 555.

Each case must be judged by itself, under the general rules of treatment that have been given as appropriate for chronic suppuration; the chief of these rules, we may venture to repeat, are a thorough removal of the accumulating pus before it has time to produce its corroding and destructive effects, and careful attention to the general health and habits of the patient.

It will often be necessary to open the mastoid, and to cut into the bony wall of the canal to remove dead bone that is obstructing a free outlet of pus.

PARALYSIS OF THE FACIAL NERVE.

Paralysis of the 7th nerve as the result of disease of the middle ear may arise in one of various ways:—

1. As a result of neuritis from a middle ear inflammation.

2. Or from neuritis from the presence of pus within the mastoid antrum.

3. From caries of the temporal bone extending to the facial canal.

4. From tuberculosis of the middle ear.

5. From injury to the facial nerve during a mastoid operation.

The results of a paralysis of the 7th nerve depend upon the degree of injury to the nerve. The immediate results are partial or complete paralysis in the region of the distribution of this nerve. This is usually followed by a return of function after the neuritis has subsided, if the exciting cause is removed. If the neuritis persists, the nerve may be destroyed and there will be a permanent facial paralysis. Cases in which the nerve is slightly injured during the mastoid operation usually recover in the course of a few weeks, but if a section of the nerve has been torn away the facial paralysis is generally permanent. A paralysis developing a few days subsequent to a mastoid operation indicates the presence of neuritis from which the patient will probably recover in a few weeks. If facial paralysis appears during or immediately after an operation, it indicates that the nerve has been wounded. The possibilities of a regeneration of the nerve are fair after many weeks of paralysis unless too large a section of the nerve has been wounded or destroyed.

NEURALGIA OF THE MIDDLE EAR.

Neuralgia is usually understood to be a disease of the sensory nerves, characterized by paroxysmal pain, without the objective appearances of inflammation, which occurs along the distribution of nerves. In this sense neuralgia of the ear is a rare disease. Yet it does sometimes occur, and then the pain is generally referred to the tympanic cavity and the osseous portion of the auditory canal. Its origin is usually to be found in carious teeth and in the existence of malarial or syphilitic poisoning.

The practitioner should, in the absence of inflammatory symptoms in the drum-head or pharynx in cases of neuralgia of the ear, see that the teeth are examined by an expert.

Acute inflammation of the middle ear, of a catarrhal or even of a purulent form, was formerly often mistakenly supposed to be neuralgia.

The supply of sensory nerves to the tympanum, Eustachian tube and auditory canal, is so large, that it would be strange if we did not occasionally meet with a case of pain referred to these parts, without any redness of the drum-head and canal, or swelling of the tube. Neuralgia of the ear may occur in debilitated and overworked persons, and also in chronic catarrhal and chronic proliferous inflammation, as well as in chronic suppurations in anaemic subjects and in the course of secondary syphilis. In neuralgia of the middle ear from diseased teeth, like that of the eyeball and eyelids, there are no inflammatory symptoms, but in the earache occurring from difficult dentition, either the reflex process leads very rapidly to trophic changes, or the pain in the ear, like that of the gums, is of inflammatory origin from the start. The continuity of the mucous membrane of the mouth with that of the bony Eustachian tube and tympanum, which is especially close in young children, is sufficient ground for suspecting that the pain in the ear in such subjects, is simply an inflammation that has extended from the gums to the middle ear. Infantile earache, occurring in dentition, is practically an inflammation and not a neuralgia.

Neuralgia rarely attacks both ears at once, but it readily passes from one to the other, in consequence of the sympathy between the two sides of the fifth pair. The seat of otalgia may be in the auditory nerve, the chorda tympani, or the nerve supply of the tympanic cavity.

Cases of neuralgia of the middle ear are sometimes of malarial origin. Each case of neuralgia of the ear should be studied for itself. The diagnosis is of great importance, for one of the most valuable of remedies for neuralgia, quinine, is usually very harmful when administered in the course of catarrh or suppuration of the middle ear. Indeed in large doses, it is also harmful in all the inflammations of various parts of the ear. Its use should be avoided in all persons who have hyperaemia of the auditory apparatus, or in those who readily suffer from inflammation of the middle ear. Neuralgia in the ear may be seen in the course of syphilis, usually as one of the later manifestations. Here of course the usual anti-syphilitic treatment by means of mercury and potash will be of service.

If the cause of neuralgia be once found, whether it be a decayed or inflamed tooth, the poison of syphilis or malaria, or general anaemia, the treatment will be simple enough. It is not very rare to find a neuralgic disease added to a chronic suppurative process when there is no active inflammation going on, and also in the course of the non-suppurative disease of the same part.

THE INTERNAL EAR — ITS ANATOMY AND DISEASES.

CHAPTER XV.

ANATOMY AND PHYSIOLOGY OF THE INTERNAL EAR.

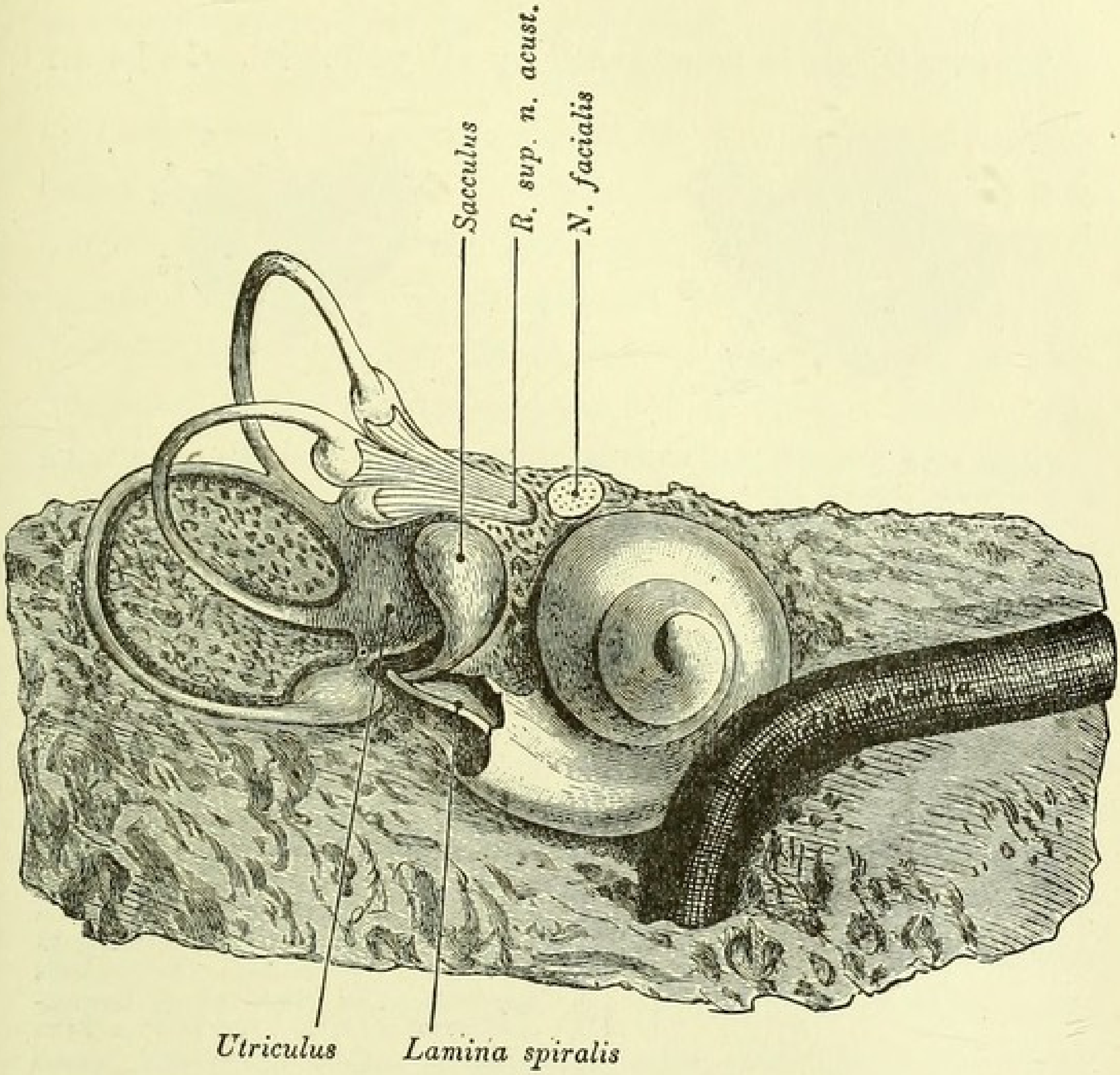


Fig. 87.—Labyrinth with Cochlea seen from External (Zuckerkandl's Atlas.)

GALEN named the internal ear the labyrinth, although he did not attempt to describe its various parts.

1. The vestibule.
2. The semi-circular canals.
3. The cochlea.

4. The auditory nerve.

We shall first study the osseous envelope of these parts, and then consider their contents.

THE VESTIBULE.

The vestibule is considered by all authorities to be an

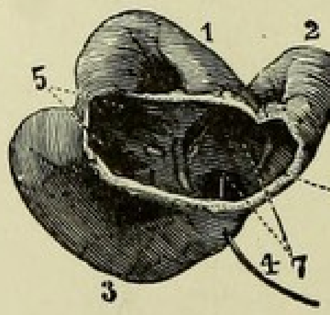


FIG. 88.—The Left Vestibule, with the Semi-circular Canals from an Adult, seen from within (Rüdinger). 1, The horizontal semi-circular canal; 2, the upper semi-circular canal; 3, the posterior semi-circular canal; 4, a bristle is passed through the aqueductus vestibuli, and passes into the opening of two canals, and appears on the upper wall of the vestibule; 5, the mouths of the osseous ampullæ of upper and horizontal semi-circular canals; 6, the opening of the lower ampulla of the posterior semi-circular canal, below the numbers 6 and 7; 7, the lower opening, in which the bristle is seen, represents the opening of the common passage for two semi-circular canals.

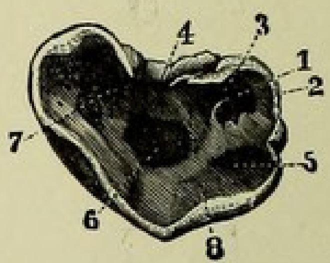


FIG. 89.—The Vestibule (after Rüdinger.) 1, The osseous lamina spiralis of the cochlea, beginning below and posteriorly on the wall of the vestibule; 2, the scala tympani and the fenestra rotunda; 3, the scala vestibuli; 4, fenestra ovalis; 5, the posterior inferior wall of the lower ampulla, with the inferior macula cribrosa, which serves as a passage for the fibres of the vestibular nerve to the lower ampulla; 6, fovea rotunda, or recessus hemisphæricus; in its centre are a number of fine openings, the macula cribrosa media; through these the fibres of the middle branches of the vestibular nerve pass to the round saccule, which is the blind vestibular end of the scala vestibuli; 7, the upper portion of the recessus hemillipticus, in which is the upper macula cribrosa; 8, the lower portion of the recessus hemillipticus, which passes without any distinct dividing line into the semi-circular canals.

essential part of the internal ear. A part answering to the vestibule is to be found in all animals in whom an auditory apparatus can be detected. It is the seat of the principal expansion of the auditory nerve upon the saccule. This saccule floats in the perilymph, and communicates through that fluid with the membrane of the fenestra ovalis, and consequently with the air in the tympanic cavity.

The vestibule is an irregular-shaped osseous cavity, the diameter of which from above downward, as also from behind forward, is about one-fifth of an inch. It is about one-tenth of an inch between its inner and outer wall. The semi-circular canals open into it by five orifices behind the cochlea, by a single one in front. The fenestra ovalis is on its outer wall; above this is the anterior opening of the horizontal semi-circular canal; on its inner are several minute holes, making up the maculæ cribrosæ for the entrance of a portion of the auditory nerve from the internal auditory canal. At the posterior part of the inner wall is the orifice of the aqueductus vestibuli, a fine canal penetrating the vestibule from the posterior surface of the petrous bone, and contains a tubular prolongation of the lining membrane of the vestibule, ending in the cranial cavity, between the layers of the dura mater.

The maculæ cribrosæ on the inner wall of the vestibule, are to be seen with the naked eye on the newly born, but in the adult they are found by means of the microscope. Henle describes four little groups, each having five openings, and each series of foramina make up what is known as a macula cribrosa. Through the macula cribrosa superior, the nerves pass to the utricle and to the ampullæ or flask-shaped openings of the anterior vertical and the horizontal semi-circular canals. The nerve-fibres to the posterior semi-circular canals pass through the inferior macula cribrosa, and those to the saccule through the macula cribrosa media. Finally, through the fourth macula cribrosa, passes the twig of the small branch of the cochlear nerve. The scala vestibuli of the cochlea begins on the anterior apex of the vestibule.

The outer wall of the vestibule is interrupted by the fenestra ovalis, but it is so completely and smoothly closed by the base of the stapes bone, that the inner surface of this wall of the vestibule appears even. On the inner wall are two depressions, called respectively the recessus sphæricus and the recessus ellipticus. A minute elevation between them is called the crista vestibuli.

The crista vestibuli runs above into the pyramidal elevation—*pyramis vestibuli;* below it divides into two branches, which enclose a space called *recessus cochlearis.*

Just above the recessus ellipticus opens the ampulla or flask-like orifice of the anterior vertical semi-circular canal. The recessus ellipticus is partly bounded below by a shallow furrow, *sinus subciformis.* The two vertical canals open at the junction of the posterior and inner wall. On the same line, but a little higher in the middle of the posterior wall, is the posterior opening of the horizontal semi-circular canal. The lower opening of the posterior vertical canal is in the angle formed by the posterior, lower, and inner wall of the vestibule. The anterior ampulla of the horizontal canal lies on the outer wall between the fenestra ovalis and the ampulla of the anterior vertical semi-circular canal.

THE SEMI-CIRCULAR CANALS.

The semi-circular canals are half-elliptical or C-shaped canals which proceed from the vestibule and return to it again. They are three in number. The horizontal lies with its convexity directed laterally. The other two are vertical in position, forming a right angle with each other. The two openings of the anterior verti-

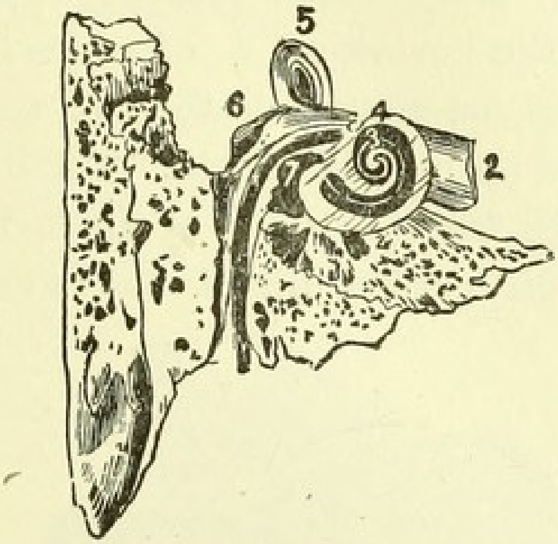


FIG. 90.—Section of Temporal Bone of Right Side through the Cochlea (anterior view, actual size). 1, Mastoid cells; 2, internal auditory canal: 3, modiolus and lamina spiralis; 4, cochlea; 5, superior semi-circular canal; 6, horizontal semi-circular canal.

cal semi-circular canal are near each other and at about the same height. The openings of the posterior vertical canals are above each other. The horizontal canal is surrounded, as it were, by the two vertical ones.

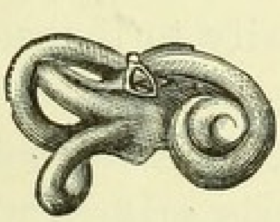


FIG. 91.—Osseous Cochlea and Semicircular Canals, with Stapes Bone. Left Ear of Adult (after Rüdinger).

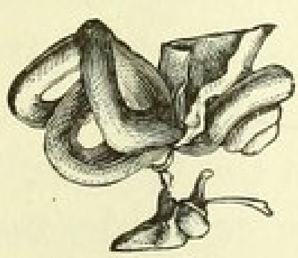


FIG. 92.—Right Osseous Vestibule Semi-circular Canals, Cochlea, and Ossicula Auditus of Newly Born (after Rüdinger).

There are considerable variations in different individuals, in the length and curvature of the semi-circular canals, yet the general shape of these parts remains the same.

The length of the anterior vertical canal, measured on the convex border, with the ampulla and the common crus, is about $\frac{4}{5}$ of an inch; that of the posterior is $\frac{2}{5}$ of an inch, of the horizontal $\frac{1}{5}$ of an inch. The common part (canalis communis) to the two vertical canals is from $\frac{1}{12}$ to $\frac{1}{8}$ of an inch in length. The diameter in a grown man varies from $\frac{1}{20}$ to $\frac{P}{15}$ of an inch. Wharton Jones makes their calibre about one-twentieth of an

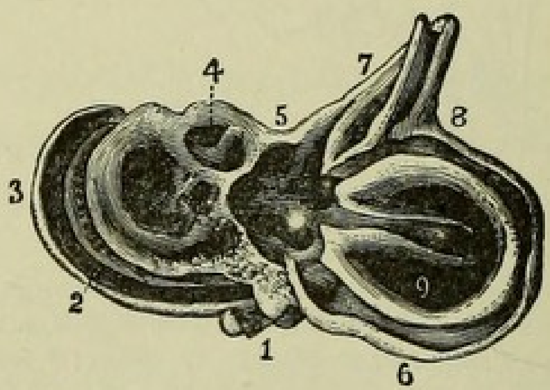


FIG. 93.—The Right Osseous Labyrinth of a Newly Born Subject opened on its Posterior Surface (after Rüdinger). 1, Cochlear fenestra; 2, the osseous spiral; 3, the osseous spiral canal of the cochlea—canalis spiralis cochleæ—divided by the spiral into two parts, scalæ, or stairways, the lower the scala tympani, the upper the scala vestibuli; 4, the basis of the internal auditory canal, with the entrance to the Fallopian canal and the maculæ cribrosæ. The latter receive the fibres of the auditory nerve, and the vessels entering with it into the labyrinth; 5, the osseous vestibule, opened on its posterior wall; 6, the posterior semi-circular canal; 7, the upper semi-circular canal; 9, horizontal semi-circular canal.

inch in a direction from the concavity to the convexity of their curve.

Since the semi-circular canals all open at both ends into the vestibule, there would be six orifices were not one of the orifices common to two of the canals. There are, consequently, five. These openings are called ampullæ (flasks) from their shape, and are more than twice the diameter of the tubes. The inner extremity of the superior vertical canal has a common opening into the vestibule with the posterior vertical.

According to Henle, in the later years of life the semi-circular canals increase in length; the horizontal canal increases the most, and the anterior vertical the least. The canals also increase very slightly in width; about 0.7 mm. according to Hyrtl.

THE COCHLEA.

This part of the internal ear is so named from its resemblance to a common snail.

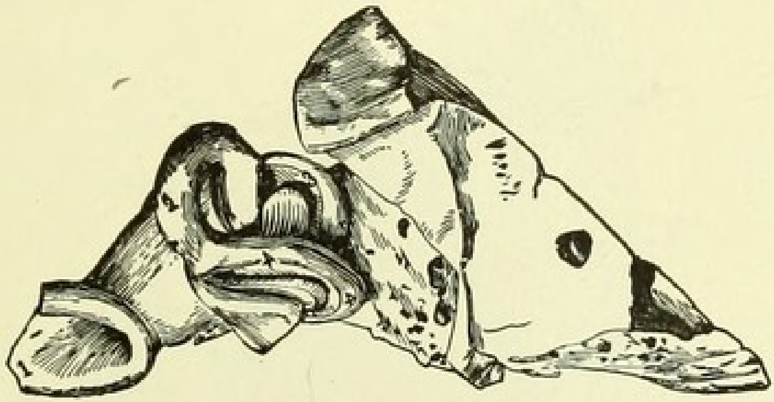


FIG. 94.—Section of Right Temporal Bone, showing Osseous Semi-circular Canals (actual size). 1, Internal auditory canal; 2, superior semi-circular canal; 3, external semi-circular canal; 4, posterior semi-circular canal.

The osseous cochlea lies in front of the vestibule, and behind the carotid canal, and forms the promontory by pressing out, as it were, the bone toward the tympanic cavity. Inward it strikes upon the blind end of the internal auditory canal. The cochlea is aptly compared to a tube tapering toward one extremity where it ends in a cul-de-sac, and which is coiled like the shell of a snail round an axis or central pillar. Then we must suppose this tube divided into passages by a thin partition running throughout its length, and spirally around its axis.

The tube of which the cochlea is formed—the canalis spiralis cochleæ, is about an inch and a half long, about one-tenth of an inch in diameter at its commencement, and about one-twentieth at its termination. It makes two and a half turns, in a direction from below upward, from left to right in the right ear, and from right to left in the left ear. The apex of the coil is directed forward and outward. The base of the spiral tube runs into the vestibule. The cul-de-sac at the apex forms a kind of vaulted roof called the cupola.

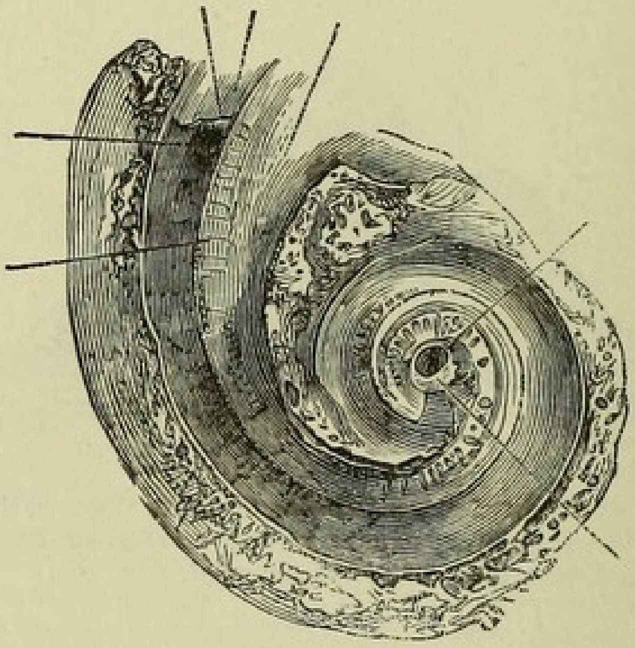


FIG. 95.—Osseous Cochlea (Right) of the Newly Born, opened from the Outer Surface (after Henle). *s v*, Scala vestibuli; *s t*, scala tympani; *l s*, lamina spiralis; *c s*, crista semilunaris; *a c*, inner opening of the aqueductus cochlea; *c m*. canalis centralis: *s m*, canalis spiralis modioli.

The first turn of the cochlea has a circular sweep of a quarter of an inch, and is wider than the rest. It is separated from the second turn by a soft bony substance, which extends a little way between the second and third. The axis is composed of the internal walls of the tube of the cochlea and the central space circumscribed by their turns, in which space are the filaments of the cochlear nerve running in small bony canals. The axis is about one-seventh of an inch in thickness at the first turn, but it becomes thinner from the second turn, on to its termination. The axis terminates within the last half coil or cupola, in a delicate bony lamella, which resembles the half of a funnel, divided longitudinally, and called the infundibulum (*funnel*).

The cavity of the cochlea is divided into two parts or passages, called *scalæ*, by a thin osseous and membranous spiral lamina, *lamina spiralis ossea*. The lower one communicates with the cavity of the tympanum through

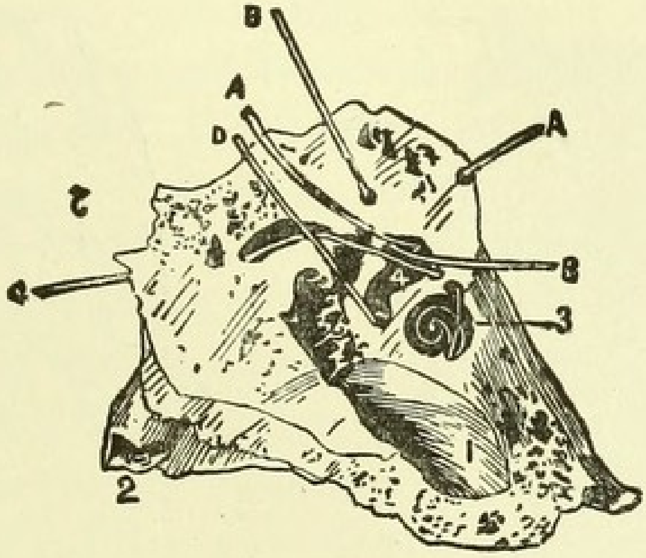


FIG. 96.—Section through Cochlea and Vestibule (left side, actual size. From Professor Darling's museum). 1, Carotid canal; 2, broken styloid process; 3, first turn of cochlea; 4, vestibule, *A*, *A*, superior semi-circular canal; *B*, *B*. external semi-circular canal; *C*, aquæductus Fallopii; *D*, auditory nerve channel.

the fenestra rotunda, the upper with the recessus hemiphæricus of the vestibule. The lower space is therefore called the *scala tympani*, the latter *scala vestibuli*. In the scala tympani, just above the membrana tympani secondaria, which closes the fenestra rotunda, is an opening, called the entrance of the aqueduct to the cochlea. The two scalæ communicate at the apex of the cochlea by a common opening called the helicotrema (*a twisted foramen*). This communication exists in consequence of the want of a lamina spiralis in the last half coil of the canal.

Two very small canals called aqueducts open by one extremity into the labyrinth, and by the other on the surface of the petrous portion of the temporal bone.

PERIOSTEUM OF THE LABYRINTH.

The periosteum that covers the walls of the osseous

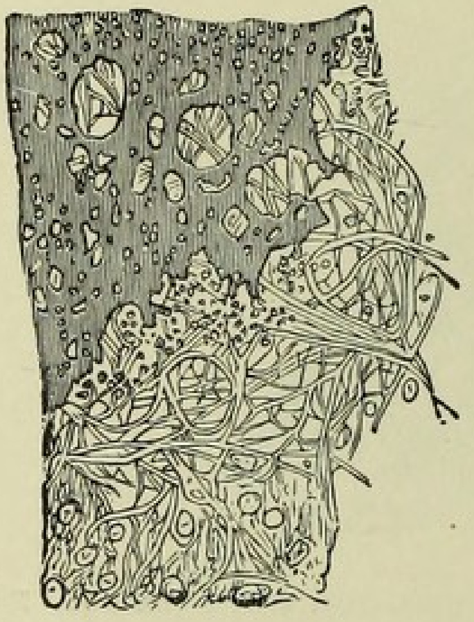


Fig. 97.—Periosteum of the Labyrinth (after Henle).

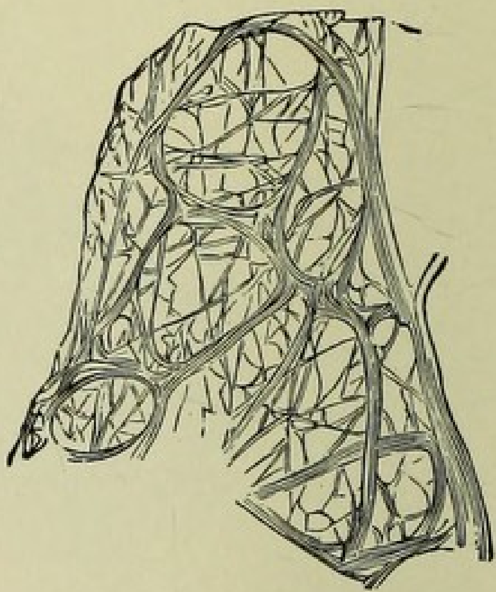


Fig. 98.—Periosteum of the Outer Wall of the Cochlea (after Henle).

canal is, with the exception of that on the outer wall of the cochlea, very delicate. Henle compares the periosteum of the labyrinth to one of the parts of the choroid, because it is strewn with nucleated pigment cells. There are also calcareous deposits. It is very difficult to separate the periosteum of the labyrinth without also detaching bits of bone. The periosteum is abundantly supplied with blood-vessels.

THE MEMBRANOUS LABYRINTH.

Utricle and Membranous Semi-Circular Canals

The utricle is an elliptical tube, situated on the median wall of the vestibule. Its longest diameter corresponds to the height of the vestibule. By means of a fine vascular and nervous net-work, and a very delicate connective tissue, it is fastened to the recessus ellipticus of the vestibule.

The membranous semi-circular canals are but the lining of the osseous canals, and, of course, of the same shape. The membranous canals open into the utriculus with five openings, just as do the osseous tubes in the vestibule. At the ampullæ, the membranous canal fills up the osseous very completely; but there is some space between the other parts. The walls of these structures are transparent, as clear as water, and of great delicacy. After the endolymph is removed, they fall together and arrange themselves in rigid folds. There is, however, a point that is firmer, called the macula acustica, situated on the median wall of the utricle, where a twig of the auditory nerve reaches this wall. The portion of the ampulla that contains the termination of the nerve, and which is detected by the naked eye as a whitish-yellow spot, is also of firmer consistency. This point is called the *crista acoustica* by Max Schultze. It comprises about one-third of the wall of the ampulla. It is sometimes surrounded by a pigmented line and also receives nerve-twigs.

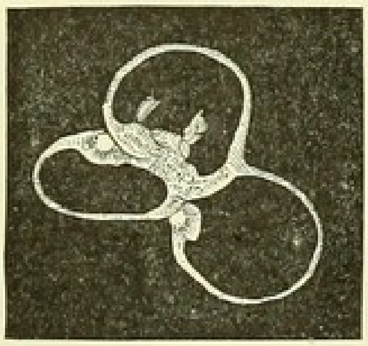


FIG. 99. — Utricle and membranous semi-circular canals of the Left Side.

The wall of the membranous semi-circular canals is from 0.02 mm. to 0.03 mm. in thickness, and is composed of various layers.

The membrana propria is of reticulate and nuclear fibrous tissue, of which the periosteum also consists. It is perforated by blood-vessels. There is a basal membrane next the membrana propria, and on the inner surface pavement epithelium.

The macula and crista acustica that have been men-

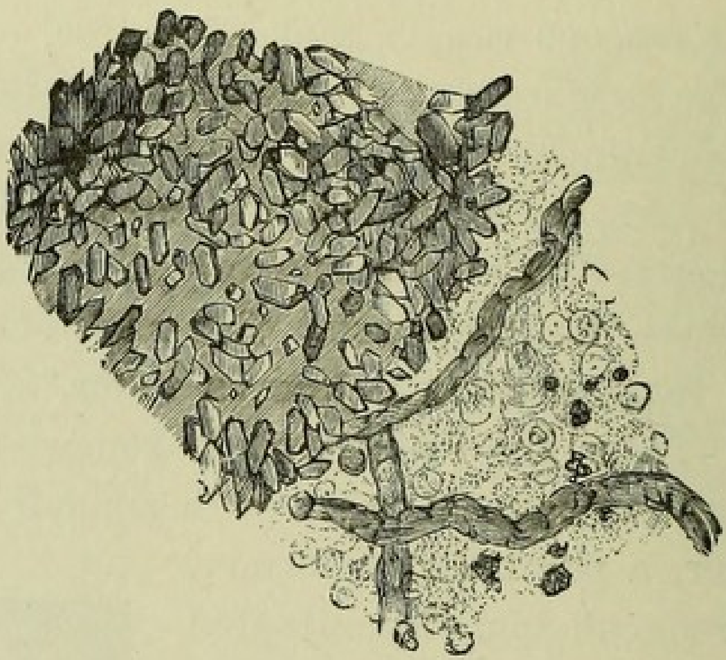


FIG. 100.—A Piece of the Wall of the Utricle, with the Otoliths (after Henle).

tioned, are thickenings of the membrana propria, caused by the mingling of connective tissue, and the ending of the nerves.

The otolith of the utriculus of the mammalia is a smooth, irregularly demarcated and uneven mass of chalky white powder. It was called otoconia by Breschet, ear-sand by Lincke, and ear-crystal by Huschke. The powder is held together by an almost mucous substance, and consists of crystals of carbonate of lime, of varying shape and size. The largest are only 0.012 mm.

long and 0.008 mm. broad. They are too small to allow the crystal form to be recognized. Henle says it is unknown how the otolith is fastened on to the wall of the utricle.

SACCULE.

The saccule is of the shape of a broad flask with narrow neck. Its body (about 15 inch in diameter) lies in the recessus sphæricus of the vestibule. The neck (*canalis reunicus,*) about 125 inch long and 120 inch in diameter) of this bottle or flask proceeds from the lower wall, downward and backward, and sinks into the upper wall of the vestibular end of the ductus cochlearis, at nearly a right angle, so that a blind sac is formed at the junction of the two parts. Henle compares it to the passage of the œsophagus into the stomach, and of the small intestine into the sœcum.

THE DUCTUS COCHLEARIS.

The ductus cochlearis begins with the blind sac in the vestibule that has been described, and passes through the whole cochlea to the apex, in which it ends again as a blind sac. The lower end rests in the recessus cochlearis, and the upper in the cul-de-sac of the cupola. The ductus cochlearis is attached on one side to the lamina spiralis ossea, and on the other to the outer wall of the osseous cochlear canal. On a transverse section the ductus cochlearis is seen to be triangular in shape, and has, of course, three walls or sides. Two of these walls diverge from the edges of the lamina spiralis, and the other corresponds to the portion of the cochlear wall, between which the insertion of the two others is made. The lower wall of the ductus cochlearis, which is turned toward the scala tympani, is called the tympanal; the upper, which separates the ductus cochlearis from the scala vestibuli, is called the vestibular wall.

On the osseous border of the lamina spiralis is a soft structure, only to be seen in the uninjured specimen of the cochlea, which lengthens the lamina spiralis toward the calibre of the ductus cochlearis. It is called by Henle the limbus laminæ spiralis. It is developed from the periosteum of the lamina spiralis. This structure gradually decreases in breadth and height from the base to the apex of the cochlea. The edge of the osseous lamina recedes more and more at the same time from the free border of the limbus. This free border becomes a furrow, called by Huschke the *sulcus spiralis,* having, of course, two lips. The upper lip is the labium vestibulare; the lower, the labium tympanicum. The vestibular wall of the ductus cochlearis passes off from the upper surface of the lamina spiralis in a line nearly corresponding to the inner attachment of the limbus laminæ spiralis, so that the latter is almost completely drawn into the ductus cochlearis.

The upper surface of the vestibular lip of the limbus lamina spiralis is covered by striæ, which on front view resemble the anterior surface of the incisor teeth, and hence Huschke calls them the auditory teeth. These furrows, or striæ, are filled by small rounded cells. Their number may run as high as 2500. The limbus is composed of connective tissue, running in a radiate direction in the furrows, or striæ; beneath these furrows the connective tissue is reticulate.

Henle compares the labium vestibulare to a roof over the sulcus spiralis, and the labium tympanicum to a floor. Within the labium tympanicum run very fine nerve-fibres from the tissue of the auditory nerve to the ductus cochlearis. The labium tympanicum consists of two layers, which include the nerve-fibres between them, and then unite beyond it in a sharp border, from which the *membrana basilaris* proceeds. This membrana basi-

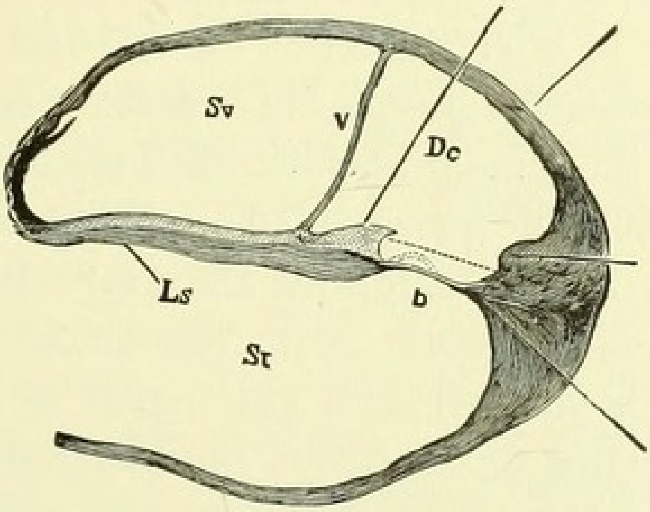


Fig. 101.—Transverse Section of a Cochlear Spiral, from a Cochlea softened in Hydrochloric Acid (after Henle). The dotted lines indicate sections of the membrana tectoria and the auditory rods; *l s.* lamina spiralis; *l l s*, limbus laminæ spiralis; *s v*, scala vestibule; *s t*, scala tympani; *d c.* ductus cochlearis; *l s p*, ligamentum spirale; *v*, membrana vestibularis; *b*, membrana basilaris; *e*, outer wall of ductus cochlearis; *, bulging of this wall.

laris, according to Henle, appears as a process of the upper layer of the labium tympanicum. There is, however, a structure between them, which corresponds to the periphery of the nerve bundles.

On the outer portion of the upper surface of the labium tympanicum are four radiate striæ, which Henle considers as marks of the nerve bundles running on the lower surface of this layer. At the periphery of these there are other openings.

The membrana vestibularis is attached to the beginning of the upper border of the ridge of the spiral and to the outer cochlear wall. There are three layers in this membrane, which by Kölliker is called Reissner's membrane. It is epithelial tissue, which in embryonal life seizes upon the vestibular side of the cochlear canal. This membrane has a number of blood-vessels.

The membrana basilaris is well shown in the preceding figure, and being the part upon which rests the organ of Corti, has attracted very much attention from anatomists. It is a continuation of the labium tympanicum. It gradually increases in breadth from the base to the apex, in the same proportion that the lamina spiralis with its limbus decreases in size. Its breadth in the newly born, in the middle of the first turn or coil of the cochlea, is 0.17 mm.; at the end of the second, 0.45. This space is divided into two parts or zones. The inner was called by Kölliker, the habenula tectu, and the outer by Todd and Bowman, the zona pectinata. Henle gives the two parts the simple names of inner and outer zone. On the inner zone are found the structures making up what is known as Corti's organ, from their discoverer, Marchese Corti.[1] The outer zone is rather broader than the inner.

The basis of the membrana basilaris is a structureless membrane. On the outer zone especially are peculiar knobby points. Upon this structureless membrane are the parts known in their totality as Corti's organ. The fibres of this structure are arranged along the whole length of the membrana basilaris. There are spaces

[1] Corti was prosector to the late Professor Joseph Hyrtl, and made the first exact microscopic examination of the lamina spiralis ossea, and membranacea.

between them, so that they have a certain resemblance to the keys of a piano.

The ligamentum spirale is the means of attaching the membrana basilaris to the outer wall of the cochlear canal. The fibres of which it is composed are like those of periosteum.

The cavity of the ductus cochlearis is divided into parts by a membrane running parallel to the membrana basilaris. The upper part is filled with endolymph, the lower contains what Henle calls the terminal auditory apparatus. The membrane which divides the ductus cochlearis into two parts is called the membrana tectoria by Claudius, Corti's membrane by Kölliker. The membrana tectoria is divided into three zones. The middle zone is the denser; the inner is structureless and has numerous openings. The outer zone is made up of a very fine and friable network. It is probable, according to Henle, that the membrana tectoria is firmly fastened, and that it is not possible for it to press closely upon the parts covered by it.

TERMINAL AUDITORY APPARATUS.

The most important, physiologically speaking, of this terminal apparatus are the auditory rods, called also Corti's teeth, or Corti's fibres. They are arranged in regular order, very like the cords, hammers, or keys of a piano. They are shaped like a Roman S, having slender cylindrical bodies and broad ends containing granular protoplasm. There are two rows of these fibres, an inner and an outer. The inner rods arise from the membrana basilaris, on which their internal extremities are fastened, more or less abruptly, toward the membrana tectoria, without, however being united to the latter. The outer rods or fibres join, with their inner extremities, the outer end of the inner fibres. Their external terminations rest on the membrana basilaris. There are two varieties of the inner row of fibres or rods; one is smooth and elliptical in shape, the other cylindrical and broader at each end.

The outer row of rods is cylindrical in shape, and they stand at a greater distance apart than the inner. The

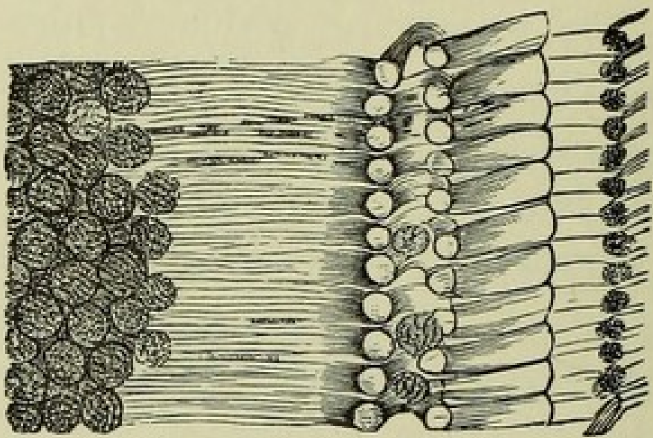


Fig. 102.—From the Terminal Auditory Apparatus of a Cat (after Henle). *i*, Outer ends of the inner fibres; *e*, outer fibres; 3, outer covering cells; 4, epithelial cells. (500 x 1.)

estimated number of inner pillars is 6000, of the outer, 4500. The inner row of fibres is always shorter than the outer. They join together and form a roof over the inner zone of the membrana basilaris. The base of this roof is 0.1 mm. in breadth. The structure of these rods, as shown by the action of reagents, is a tissue as hard as cartilage.

Henle calls the terminations of the two rows of rods upon the membrana basilaris, the lower extremities; and the extremities which join to make the roof, the upper extremities. The cells found in the ductus cochlearis, auditory cells, are nucleated, round, and cylindrical. A layer of them covers the *sulcus spiralis,* Reissner's membrane, and the outer wall of the ductus cochlearis. Upon the inner pillars lies a single row of conical cells with large nuclei. They send processes into the rows of small cells lying next toward the sulcus spiralis, the granular layer. The ends turned toward the heads of the rods bear tufts of stiff immovable cilia. These cells are called inner hair-cells. Their number is computed at 3300. On the outer rods lie three or four rows of double

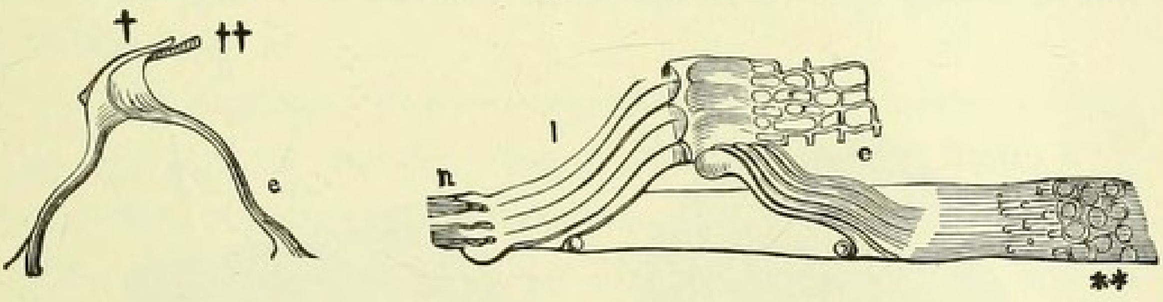


Fig. 103.—Profile View of Outer and Inner Rods.
Fig. 104.—Membrana Basilaris (*b*), with the terminal nerve-fibres (*n*) and the inner and outer rods; and 1, inner; 2, outer floor cells; 4, attachment of the roof cells **, epithelium.

nucleated cells, connected by slender processes to the membrana basilaris and membrana reticularis, and bearing also tufts of cilia. Their number is computed at 18,000. The cilia of the cells are received in the lamina reticularis in corresponding rows of openings. Waldeyer regards the cells, as also the rods of Corti, as epithelial structures. Henle describes another layer of cells lying on the membrana basilaris as floor cells.

The membrana reticularis is the second of the component parts of the terminal auditory apparatus. It arises from the articulation of the rods or fibres, and extends to the outer wall of the cochlea parallel to the lamina basilaris. It is supposed to be a ligament to bind the rods together. The tissue of the lamina reticularis is not less firm than that of the rods, but it is delicate.

AUDITORY NERVE.

The Auditory Nerve (*Nervus acusticus*).—The auditory nerve, or *portio mollis* (soft part of the seventh nerve), is the nerve of the sense of hearing, and is distributed exclusively to the internal ear. The auditory nerve arises by two roots in the medulla oblongata. One

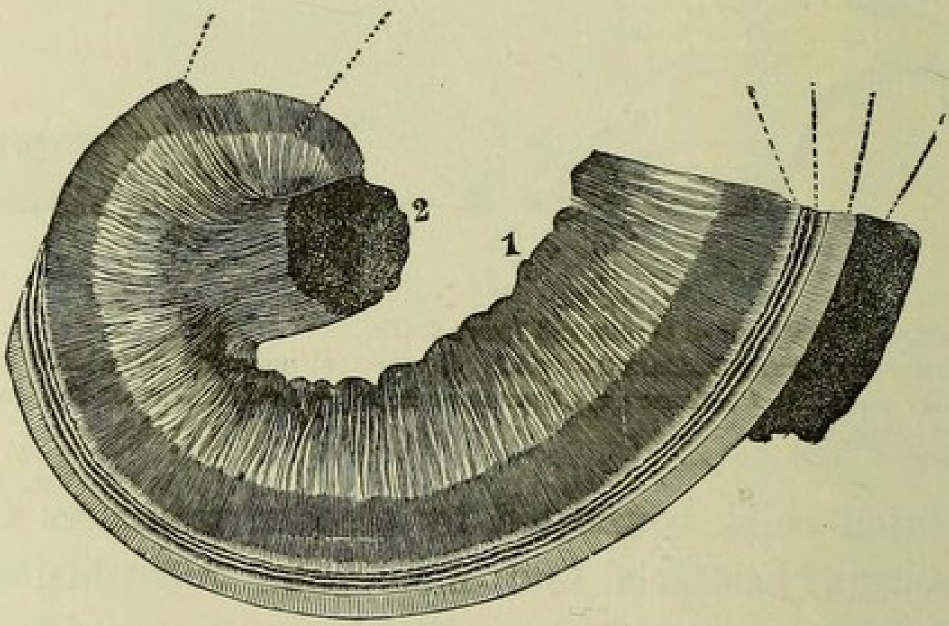


FIG. 105.—Expansion of the Right Cochlear Nerve, seen from the Base of the Cochlea, from a Labyrinth softened in Hydrochloric Acid (after Henle). 1, The branches entering through foramina; 2, twig passing into the modiolus; 3, network in the osseous lamina spiralis; 4, network on its border, *l t*, labium tympanicum; *z i*, zona interna; *z e*, zona externa of the membrana basilaris; *l s*, ligamentum spirale. (15x1.)

ganglionic nucleus of origin is in the floor of the fourth ventricle. The other is in the *crus cerebelli ad-medullam*. The roots of the nerve are connected, on the under surface of the middle peduncle, with the gray substance of the cerebellum, with the flocculus, and with the gray matter at the border of the *calamus scriptorus*. The nerve winds around the restiform body, from which it receives fibres, and passes forward across the posterior border of the crus cerebelli, in company with the *portio dura*, or facial nerve, from which it is partly separated by a small artery. It then passes into the meatus auditorius internus, where some minute filaments connect them together.

The auditory nerve is remarkable for the delicacy of its structure, which caused the older anatomists to give it the name of portio mollis. It has only a very thin neurilemma.

At the bottom of the meatus the facial nerve enters the Fallopian canal; the auditory divides into two branches, vestibular and cochlear.

The cochlear nerve gives off a small branch, which passes to the vestibular extremity of the ductus cochlearis, and through the fourth macula cribrosa, to the partition wall of the two saccules in the vestibule. From the trunk of the nerve a number of fine twigs arise, which pass through foramina direct to the lamina spiralis of the lower coil of the cochlea. The remainder of the cochlear nerve enters the modiolus, and is divided into anastomotic divisions. The fibres become separated from the trunk in a line corresponding to the course of the canalis spiralis modioli, and permeate this canal. Here, by the addition of ganglion cells, they become gangliose striæ, and finally end, at almost a right angle to the trunk, in the osseous lamina spiralis.

The vestibular nerve, after a slight gangliose expansion, divides into three branches:

1. *Superior.*—This passes through the macula cri-

brosa superior, and ends by three branches to the utricle and ampulla of the superior vertical and horizontal semi-circular canals.

2. The *middle* passes through the macula cribrosa media to the saccule.

3. The *inferior* passes through a bony canal of its own to the ampulla of the inferior vertical semi-circular canal. The terminal nerve-fibres pass from the lamina spiralis through fine holes in the labium tympanicum, and in the membrana vestibularis into the ductus cochlearis.

They run in a radiate direction, pass through the granular layer, where some end in inner hair-cells and others run between the rods of Corti and across the tunnel formed by them, to end in outer hair-cells. There are probably other nerve-fibres running in a spiral course among the granular layer and the outer hair-cells.

Todd and Bowman regarded the vestibular nerve as direct prolongation of the white matter of the brain.

In the internal auditory canal, the portio mollis forms a connection with the portio dura by means of a few fascicles of fibres, which constitute what Wrisberg called the "portio intermedia." It is not decided whether the connecting link proceeds from the auditory to the facial nerve, or from the latter to the former. Todd and Bowman believed it probable that the facial nerve sends some filaments to the blood-vessels of the labyrinth and the muscular structure of the internal ear.

The internal auditory canal (*meatus auditorius internus*) begins at about the centre of the petrous portion of the temporal bone by a large orifice with smooth rounded edges, and runs directly outward about one-eighth of an inch to end in a blind fossa.

There are four depressions in the fossa. These are perforated by fine foramina, through which the fibres of the acoustic nerve enter the labyrinth. Three of them correspond to the *maculæ cribrosa.* The fourth lies opposite the base of the cochlea. It is spiral-shaped, has spiral-shaped openings, and is called the *tractus spiralis foraminosus.*

BLOOD-VESSELS.

The blood passes to the internal ear through the auditiva internal artery, which is a branch of the basilar, according to Hyrtl the basilar comes from the vertebral and the vertebral from the subclavian. After the internal auditory artery has entered into the meatus auditorus internus, it divides into a vestibular and cochlear branch. The cochlear branch divides in numerous branches which pass through the foramina of the tractus spiralis foraminosus into the modiolus, and then go on between the layers of the lamina spiralis, and are finally lost in the spirals of the cochlea. The vestibular artery passes through the posterior wall of the vestibule in numerous fine twigs to the soft structures of the vestibule and semi-circular canals. The stylo-mastoid artery is said to give several small branches to the labyrinth. It is important to observe the fact to which Tröltsch calls attention—that the blood supply of the labyrinth and of the middle ear are separate and independent of each other. This may explain the relative infrequency of the extension of disease of the middle ear to the internal ear.

THE PHYSIOLOGY OF THE INTERNAL EAR.

The vibrations of the atmosphere are conveyed through the ossicles and fenestra ovalis to the perilymph of the labyrinth. They pass as waves over the vestibule, semi-circular canals, and other parts of the labyrinth, and are there transmitted to the endolymph. A vibration passes from the vestibule into the scala vestibuli of the cochlea, and passing down the scala tympani ends as an impulse against the fenestra rotunda. The variations in pressure of the fluid of the labyrinth, which is surrounded by particularly firm bony walls, thus excited by the motions of the foot-plate of the stapes bone, are compensated for by a movement of the membrane of the fenestra rotunda. The helicotrema, the small opening through which the two scalæ of the cochlea communicate, allows the membrana basilaris with the parts lying upon it (Corti's organ) to be set in motion.

The exact function of the individual portions of the labyrinth, in spite of the investigations of the physiologists, is not yet positively settled. According to Helmholtz, the vestibule and ampullæ are adapted to the perception of noises, irregular vibrations, while the cochlea perceives periodic vibrations—tones. Helmholtz also showed that it is probable, that the part of the cochlea near the fenestra rotunda vibrates more easily to high notes, or those with many vibrations in a second, while that in the cupola vibrates more readily to low tones. The membrana basilaris of the cochlea increases in width from the lowest winding of the cochlea to the cupola. Helmholtz says that the membrana basilaris has a system of cords corresponding to its stripes, of which, for certain tones, only a limited number vibrate. The perception of the high tones is caused by the lower section of the membrana basilaris, and of the low or deep ones by the superior parts. This corresponds with the clinical experience, that patients deaf from exudations in the middle ear, encroaching upon the labyrinth, hear low tones, when they cannot at all perceive high ones. The case of atrophy of the acoustic nerve in the first whorl of the cochlea, reported by Moos and Steinbrugge,[1] is also strong evidence in support of this view. The patient was sixty-three years old. His ears were examined fourteen days before his death. He suffered from loss of hearing and constant tinnitus. The loss of hearing is said to have occurred suddenly. He could not hear the voice at all on the right side, and 3 metres on the left. He died of carcinoma of the right anterior central convolution, he also had carcinoma of the stomach. In the ear was found, as has been said, atrophy of the nerve-fibres of the first cochlear whorl. The external ear, and middle ear, except the junction of the stapes with the vestibule, were in a normal condition. There was rigidity of the articulation. There was also sclerosis of the cells of the mastoid process. The patient during life was found very deficient in the power of hearing high notes. It has been shown by Moos and others, that the power of hearing conversation well, involves capability of hearing high notes.

Although Helmholtz's theory of the function of the cochlea is not everywhere positively accepted, the weight of evidence seems to be in favor of the view, that it has

[1] *Zeitschrift fur Ohrenheilkunde*, Bd. X., p. 1.

a higher function than the vestibule, and that by it an analysis of tune is made. The place that Corti's rods long held as the terminal organs of hearing must, however, be abandoned, for Hasse found in birds that possessed the power of hearing musical tones and speech, that while Corti's cells were developed the rods of Corti were wanting.

The view that the cochlea alone is for the perception of tone, is put somewhat in doubt by Ranke's and Hensen's experiments. On microscopical examination of living heteropodes, Ranke found the auditory cilia vibrating rapidly and moving toward the otoliths, in the aural vesicle. Hensen, in experimenting upon crabs, showed that when tones were produced a certain number of cilia vibrated to certain tones.

The semi-circular canals seem to have nothing to do with the hearing function, but since the experiments of Flourens the view is generally, although not universally, accepted that they are the parts chiefly concerned in maintaining the equilibrium of the body.

The greater number of authorities regard them as the organ of the sense of equilibrium, but this view is not everywhere accepted. Böttcher, on the basis of experiments like those of Flourens, believes that the symptoms seen after injury of the semi-circular canals are due to a simultaneous injury of the cerebellum. Moos agrees with this author from clinical observations made upon patients. In accordance with the views of Lussana and Berthold, he thinks that the disturbances of co-ordination after injury of the semi-circular canals are excited by a reflex transmission of the irritation from the ampullar nerves to the cerebellum.

Hogyes, quoted by Politzer,[1] says that the terminations of the auditory nerve in the vestibule are a peculiar apparatus to regulate the movements of the eyes and probably also those of the muscles for the preservation of the equilibrium of the body. Lussana separated the semi-circular canals, without at the same time irritating the nerves of the ampullæ or vestibule, and even after the labyrinth was entirely destroyed, no disturbances of co-ordination were seen. Politzer's experiments with the superior semi-circular canal, showed that the fluid of the labyrinth could be influenced by pressure or exhaustion of the air in the auditory canal or tympanum. A manometric tube was placed in the superior semi-circular canal after having been filled with fluid. On pressure from the canal or tympanum the fluid arose, and on exhaustion it sank. These experiments were verified and amplified by Helmholtz and others.

Sensory Centre of the Auditory Nerve.

Ferrier[2] finds the sensory centre of the auditory nerve in the temporal lobe of the cerebrum. Its anatomical connection with the nuclei and roots of the nerve has not been proven. Ferrier observed on electric irritation of the superior temporal convolution on the exposed brain of cats, dogs, and monkeys, a sudden elevation of the auricle of the opposite side, and on destruction of the temporal lobe deafness of the opposite ear. Munk, quoted by Politzer, got the same results, by experiments on dogs. He thinks they indicate a decussion of the fibres of the auditory nerve in the brain.

[1] Text-book, translation, p. 682.
[2] *The Functions of the Brain*, p. 171.

Munk believes, as quoted by Politzer, that if the parts of the temporal lobe, termed "hearing spheres," were removed, and the ear of the same side destroyed, the animal would be deaf. Munk also believes that the posterior part of the hearing sphere perceives low tones, and that the anterior section in the neighborhood of the fissure of Sylvius is for the perception of high tones.

Determination of the Direction of Sound.

It was formerly supposed that the direction of sound was determined by the aid of the semi-circular canals. It seems, however, from clinical experience, that the direction of sounds is determined by the two ears acting together, for many patients have observed that simultaneously with the loss of one ear, they have lost in great if not complete measure, the ability to tell from whence sounds came. Both ears are not necessary for the determination of the quality of tones. There is no advantage in binaural stethoscopes (Roosa), other than that which may be gained by having both ears closed to distracting external sounds.

CHAPTER XVI

DISEASES OF THE INTERNAL EAR.

THE diagnosis of diseases of the various parts of the internal ear, is not always an easy task. We have not the same advantages for thorough inspection as those which obtain in the external and middle ear. The great barrier to our accurate knowledge of the diseases of the labyrinth—such a knowledge as we have in studying the affections of the optic nerve and retina—is found in the fact, that the otoscope as yet only enables us to see the tympanum and mouth of the Eustachian tube, while the otoliths, the semi-circular canals, and the whorls of the cochlea, remain hidden by an apparently impenetrable bony case. But since the discovery of the Roentgen ray, we may not despair of seeing the labyrinth in the living subject. Clinical and pathological study are gradually giving us access to what was once as much a maze to the therapeutist as to the anatomist. A certain class of diseases of the internal ear, can now be made out with as much accuracy as diseases of the heart, lungs, or kidneys. We can in some instances, even classify the diseases of the semi-circular canals and cochlea, for some of them are to be plainly distinguished. We are in the infancy of our knowledge of this subject. Just as explorations in an hitherto scarcely traversed country, have a great attraction for the enthusiastic traveller, so will the medical explorer find very much to interest him in the diagnosis of diseases of the labyrinth and acoustic nerve, for this field is the *ultima Thule* of aural territory.

PRIMARY AFFECTIONS OF THE INTERNAL EAR.

The affections of the internal ear may be classified in a general way, as follows: *Primary* and *Secondary* diseases. The latter class has been somewhat discussed in the various chapters on Diseases of the Middle Ear. They are generally recognized and do not often excite discussion.

Primary affections of the auditory nerve, or what is called cases of nervous deafness, were at one time supposed to be very common. This was chiefly due to the teachings of Kramer and the preceding authors. Wilde, Toynbee and Tröltsch gave us more correct notions as to the relative frequency of the diseases of the central apparatus, and proved that the diseases of the middle ear were more common than those of the labyrinth—that so-called nervous deafness was comparatively rare.

Clinical experience, however, shows that the rebound from the ideas of Kramer, who at one time classified the majority of cases of aural disease under the head of nervous affections, to those of the later writers, who traced almost all cases to an inflammation of the middle ear, has been excessive, and that there is a larger proportion of cases, which are primarily affections of the labyrinth than has generally been believed by the profession.

Before we discuss the symptoms and causes of affections of the nerve of hearing, a few words may be said, as to what in general terms is understood by impairment of hearing, dependent upon diseases of the central apparatus, or by nervous diseases. When a patient is debilitated and unstrung, unsteady in muscular movement, anxious and despondent, and is at the same time affected with a chronic affection of the middle ear, he is often supposed to have a *nervous* disease of the ear. In most of these cases the auditory nerve is not at all affected. There are certainly no symptoms of derangement of the auditory nerve, in the general debility, unsteadiness, and anxiety that are popularly denominated nervousness. Affections of this nerve make the subjects deaf and sometimes cause them to stagger in their gait, but they do not always render them nervous or unsteady in the ordinary acceptation of these terms. Besides, it cannot be said that nervous people are especially liable to deafness from lesions of the labyrinth any more than they are to atrophy of the optic nerve. So-called nervous people are not especially apt to have a disease of the acoustic nerve, but their impairment of hearing often depends upon chronic inflammations of the tympanum, its ossicles, muscles, and lining membrane. The nervousness in some instances result from the distressing tinnitus, and the impairment of hearing, for there is no affliction more depressing than impairment of hearing. There are, however, symptoms more or less objective, that enable us to diagnosticate with tolerable exactness a disease of the internal ear. It is not wholly an undiscovered country.

PRIMARY DISEASE OF THE COCHLEA OR OF THE TRUNK OF THE ACOUSTIC NERVE

There is one symptom of this affection that is pathognomonic, and that is, absolute deafness. There is no disease of the external ear, and none of the middle ear, which will make a patient deaf to all sounds. No matter what may be the pathological condition, how firmly the auditory canals or the tympana may be plugged, how much the Eustachian tube may be narrowed, sounds conducted through the bones will still be heard; but when the cochlea and the vestibule with their contents are destroyed, no vibrations are perceived, and absolute deafness exists. But such cases are very rare. There are relatively very few absolutely deaf persons in the world. Hence this pathognomonic symptom is seldom observed. When it is, of course, a diagnosis is easily made. But the labyrinth may be invaded by disease, and even the terminal filaments of the nerve in the cochlea, or the nerve-trunk itself be diseased, and yet considerable hearing remain. Reasoning by analogy, this would appear to be true, for we may have even advanced atrophy of the optic nerve and retina, and yet a fair degree of vision. It has been too hastily assumed, that because considerable hearing power remained, therefore the cochlea could not be invaded. We must go much deeper in symptomatology than absolute deafness, if we desire to find the causes of disease of the acoustic nerve.

1. *The ability with impairment of hearing to hear the tuning-fork better and longer through the air than through the bones of the head, is a symptom of disease*

of some part of the labyrinth, either of the vestibule, the cochlea or acoustic nerve.

But this symptom is not pathognomonic of primary disease of the labyrinth. It is always found when the labyrinth is invaded, but in many instances it is a temporary phenomenon dependent upon abnormal pressure exerted upon the labyrinth by the ossicles or the drumhead. If we add to the above symptom the word constantly, so that it shall read, the ability to *constantly* hear the tuning-fork better through the air than through the bones, we shall be nearer to a definition of a symptom of primary disease of the cochlea. Even then we must exclude cases where the pressure has become permanent, and where, after all, the disease of the labyrinth is secondary to one of the stapes bone, or other part of the tympanum. This much we may say, however, that better aerial than bone conduction indicates either primary or secondary disease of the central apparatus of hearing.

2. *The ability of a person with impaired hearing to hear better in a quiet place, when all distracting noises are absent, is a symptom of disease of the labyrinth.* It must be taken, however, when applied to primary disease, with the same limitations as to constancy as the test by the tuning-fork.

3. *The ability to hear conversation relatively farther than the tick of a watch, is also a symptom of disease of the cochlea or nerve.* These symptoms, namely better aerial than bone conduction, better hearing in a quiet place, relatively better capacity to hear the human voice than the tick of a watch, when found grouped together in the same patient, unmistakably stamp the case as

one of disease of the acoustic nerve. It will be observed that nothing is said of vertigo, of double hearing, of incapacity to hear one's own voice, which are generally considered to be symptoms of disease of the labyrinth. Any enumeration of these more marked symptoms at this point is purposely omitted.

There is a class of cases of affections of the cochlea, or vestibule, or trunk of acoustic nerve, whether of one or of all, which have no very marked symptoms, such as absolute deafness, vertigo or double hearing. In diseases of the labyrinth, noise not only impairs the hearing power, but it often also distresses and annoys the patient, whereas persons who are very deaf from disease of the middle ear, are delighted when they can be in a noise. Whenever the following train of symptoms occurs in a case of impairment of hearing, we may conclude, in the light of our present knowledge, that we have to do with disease of the internal ear.

1. Tuning-fork C^2 is heard better through the air.
2. Hearing is better in a quiet place.
3. Conversation is heard relatively better than a watch.
4. Noise is annoying to a more marked degree than is usual to people whose hearing is impaired from disease of the middle ear.
5. Inflation of the tympanum renders the hearing worse.

To make a positive diagnosis these symptoms must exist together. Some cases with this chain of symptoms may be secondary affections of the sensory apparatus, although these symptoms generally indicate that the primary lesion is in the labyrinth. It is no proof that a disease of the ear is situated in the tympanum because the drum-head has not a normal appearance. This fact has been lost sight of, and occasionally cases of disease of the nerve have been put down to the middle ear simply because a drum-head was sunken or opaque. How few so-called normal membrana tympani are to be found, only he who has searched for them among people with good hearing power can certainly know. A disease of the tympanum in childhood may leave its traces upon the membrana tympani without sensibly impairing the hearing power. The condition of the ossicles and of the lining of the tympanum have the most to do with determining the hearing power, when the nerve is sound. To them and not to the drum-head should we look for information as to the middle ear. Besides, changes may occur in the drum-head, secondarily to disease of the membranous labyrinth and trunk of the acoustic nerve. Disease may travel outward as well as inward.

PRESBYKOUSIS.

Acoustic atrophy or anemia occurs in many persons after middle life and many of the patients preserve the power to hear conversation addressed especially to them, lectures, sermons and so forth, up to an advanced age. They hear badly in a theatre, however, where the dialogue is animated. Persons who, after middle life lose much of their hearing from disease of the tympanum, and Eustachian tube, soon become unable to hear conversation, and are much more disabled than those who suffer from chronic acoustic neuritis or atrophy. It is possible that there is a failure of the power of the tensor tympani and of the stapedius muscle in advancing life, which renders it impossible to properly regulate or focus, so to speak, the sound image upon the terminal apparatus. In such cases the patient's hearing for his range, is as good as that of those with active muscles and young crystalline lenses. There is indeed a presbykousis as well as a presbyopia (Roosa).

As was said, when *absolute deafness* exists, we certainly have disease of the acoustic nerve. We may, it is true, have mere impairment of the hearing and yet find disease of the labyrinth; but if the deafness is absolute, or nearly so, we must conclude that the essential part of the organ of hearing is invaded. It is a very rare thing, indeed, that the impairment of hearing from disease of the middle ear becomes so profound that words spoken into the ear through a tube cannot be distinguished; but in many of the cases of deafness from cerebro-spinal meningitis, from fevers, from apoplexy of the labyrinth, from injuries, no words, however conducted to the ear, can be made out by the patient, he cannot hear his own voice, and total deafness, not merely great impairment of hearing, exists. The auditory nerve may have some perception of sound in these latter cases, but these perceptions can only be compared to the flashes of light seen by amaurotic patients.

This is in accordance or in analogy with what we observe in diseases of the eye. When absolute blindness occurs, we know that we are dealing with an affection of the central or perceptive apparatus. Opacities of the cornea, cataract, iritis, do not destroy the perception of light. This is only done by diseases of the retina, optic nerve or brain.

SYMPTOMS OF COMBINED DISEASE OF THE MIDDLE EAR AND LABYRINTH.

Other symptoms of disease of the internal ear, such as vertigo, vomiting, tinnitus aurium, double hearing, are also seen in affections of the middle ear, when the nerve expansion in the labyrinth is involved by undue pressure. A staggering gait, or loss of equilibrium, is also a symptom of disease of the internal ear, and especially of the semi-circular canals. But even when this symptom occurs, it is not possible to determine from it alone whether the disease of the internal ear is a primary or secondary affection.

THE TUNING-FORK.

As has been already said, the tuning-fork is a valuable means of diagnosis in suspected nerve-deafness. As we have seen in the second chapter, the tuning-fork is heard more distinctly in the ear which is stopped with the finger or the like, when the vibrating tuning-fork is placed upon the forehead or teeth. If a person be affected with disease of the internal ear, such a stoppage of the meatus does not usually at all intensify the sound of the tuning-fork. Besides if one acoustic nerve be diseased, while the other is sound, or if one be affected much more than the other, the tuning-fork is heard more distinctly on the sound or better side, just the contrary from what is found in disease of the middle ear.

If a tuning-fork (pitched in bass C) be placed on the vertex or on the mastoid process, and allowed to vibrate until the notes are no longer heard, and its prongs be then brought close to the ear, if the ear be normal the tone will be heard again. This is called Rinne's positive experiment. According to Lucæ, in those cases of impairment of hearing, where the fork is heard again after having ceased to be heard on the vertex or mastoid, when placed close to the ear, there is disease of the internal ear. When it is not heard again there is disease of the external or middle ear. This test is a good one. But like many other methods of using the tuning-fork, for a differential diagnosis when employed alone, it is not sufficient to enable us to speak positively as to its diagnostic value.

Dr. J. B. Emerson made a series of examinations of persons with normal hearing power, by means of the tuning-fork. The results he obtained are a positive contribution to the subject. It is to the tuning-fork that we must look, for that much-to-be desired means of making a diagnosis between chronic affection of the middle ear and a similar one of the acoustic nerve. Fifty persons with normal hearing were carefully chosen from a hundred, said to have normal hearing. Two forks were used, one 32-½ ctm. long with cylindrical prongs and handle giving a note more than an octave below the middle C. C.=264 double vibrations. This tuning-fork is called " A," in Emerson's test. Another fork, about 17 ctm. long with rectangular prongs and conical handle giving a note one octave above middle C. and called " C^2 "=528 vibrations. The average duration of time in seconds during which these forks were heard is shown by the following table. The table was made up from fifty cases of persons who had no disease of the ears.

"In every case the A fork was *louder* when heard through *bone*, and the C^2 fork, when heard through *air*.

"The average *duration* in seconds was as follows:

A fork—	
Air conduction	31
Bone conduction	18
Excess in air conduction	13
C^2 fork—	
Air conduction	36
Bone conduction	16
Excess in air conduction	20
A and C^2 forks—	
Air conduction	34
Bone conduction	17
Excess in air conduction	17

The difference between air and bone conduction is less for the A note than for the C^2 note; A being heard about 1.75 times longer through *air* than through *bone;* while C^2 was heard about 2.25 times longer through *air* than through *bone*.

For both A and C^2, the average duration is twice as long through the air as it is through the bone.

Emerson also examined fifty persons suffering from disease of the middle ear, with the same tuning-fork and he concludes as follows:—

"1st: Relying on the statements of patients in regard to the *loudness* of tuning-forks, as a test in ear troubles, will lead to error unless account is taken of the fork used. As a rule, in normal ears, high notes are heard louder through aerial conduction, and low notes louder through bone conduction. This is true, to a limited extent, in diseased ears, as verified by the thirty-nine cases cited.

"2d: The relative duration of aërial and bone conduction is a better test. In normal ears, in all cases, the tuning-fork is heard *longer* through air than through bone, the proportion being greater for high than low notes; and for the *middle* C (C^2) it should be heard about twice as long through air as through bone, the average duration in my cases being for bone seventeen seconds, and for air thirty-four seconds. Any *marked* departure from this indicates disease.

"3d: In external or middle ear disease this proportion is reduced and in well-marked cases the average bone conduction remaining the same or being increased, the aërial conduction will be reduced until it becomes equal to, or much less than bone conduction. In one hundred ears tested, the average duration was for bone seventeen seconds, for air thirteen seconds, or 1.3 longer through bone than air. This reduction obtained also in the thirty-nine cases in which air conduction was louder than bone, the average duration in those ears being equal.

"4th: When the bone conduction is longer than aërial conduction, and yet much less than the average duration of bone conduction for normal ears, it is an indication not only of middle ear trouble but that the nervous apparatus is involved.

"5th: If the proportion between bone and air remain the same, and the hearing power much lowered, it is probably an indication of disease of the internal ear. Air conduction markedly exceeding bone conduction, the bone conduction may be entirely lost, and yet air conduction continue to a limited extent."

It is from experiments and long experience with patients that we have come to the conclusion that the best method we have of diagnosticating or of assisting in the diagnosis of doubtful cases of disease of the internal ear, is the tuning-fork "C^2," generally known as "C;" the second one described in Emerson's tests.

If in persons with impaired hearing the tuning-fork "C^2" be heard louder and longer through the air when placed near the ear, than it is when placed on the mastoid process, we probably have a disease of the nerve, while if it be heard better through the bone, we have disease of the middle or external ear. For the sake of brevity, we may say, if, in cases of impaired hearing, aerial conduction be better and longer than bone conduction, we have disease of the internal ear. If bone conduction be better than aerial, there is disease of the middle or external ear.

The test with musical tones of various heights is of importance in detecting partial defects in hearing tones, but it cannot be relied upon as an exclusive test, as some authors are disposed to make it. Galton's whistle is a good means of testing the relative capacity for hearing high or low tones.

In some cases of disease of the middle ear, of one side, the aërial conduction disappears entirely, and the conduction through the bones is so intensified by the blocking up of the tympanum and the rigidity of the ossicles, that when the tuning-fork is placed upon any of the bones of the skull, even upon the mastoid of the sound side, its vibrations seem to the patient to proceed from the diseased ear.

DEAFNESS TO CERTAIN TONES.

Deafness to certain tones is due to some affection of the cochlea, and this is an affection sometimes seen, as has been known since the experiments of Wollaston, who found that some persons were unable to hear the chirping of a cricket, which is the highest tone known. If we accept the theory of Helmholtz, that Corti's organ in the labyrinth is a resonance apparatus, and that individual fibres of the auditory nerve in the cochlea are tuned for certain notes, the pathology of such cases becomes clear. It should be remembered, however, that this symptom, as well as double hearing, like tinnitus aurium, may be merely secondary to an affection of the middle ear, which causes pressure upon and hyperæmia of the cochlea.

DOUBLE HEARING.

One of the first, if not the first, accounts of the phenomenon, is by Sir Everard Home, who described it in an article on "The Membrana Tympani."[1] His case was that of "a music master" who perceived a confusion of sounds in his ears after catching cold. He discovered that the pitch of one ear was half a note lower than that of the other; and that the perception of a single sound did not reach both ears at the same instant, but seemed as two distinct sounds following each other in quick succession, the last being the lowest and weakest.

Mr. Home naively remarks that "this complaint distressed him for a long time, but he recovered from it

[1] *Transactions of the Royal Society*, 1800.

without any medical aid." This was a case of true double hearing, corresponding fairly well to double vision. Since then cases have been reported by Gruber,[1] Moos,[2] Knapp,[3] S. M. Burnett,[4] Roosa, and others. In Knapp's case the patient heard all tones of the middle octave of a piano two tones higher than in the sound ear. The ear was affected with suppuration of the tympanum. Burnett's case was also that of a professor of music, who observed that an A tuning-fork, when held before the right ear, sounded from 3/8 to 1/2 a tone flat. Ten years after he observed that the same fork, when held before the same ear, sounded one tone higher. His hearing distance was 1/18 for the watch, and the membrana tympani was healthy in appearance. This patient seems to have been unable to detect this false hearing of one ear, unless he held a tuning-fork before the meatus. It was consequently rather a curious phenomenon than a source of annoyance to the subject of it.

It will be observed that the cases of Home and Knapp are instances of true double hearing—that is, two distinct sounds were heard simultaneously, one true and the other false. This is diplakousis, to which the addition of an adjective, *binauralis,* is only confusing. Burnett's case is one of false hearing. When the true notes are heard and then a false one, or when the last notes are repeated or echoed, we should speak of echo hearing. Double hearing and echo-hearing exist very often as symptoms of pressure upon the labyrinth from

[1] *Lehrbuch*, p. 626.

[2] *Klinik der Ohrenkrankeiten*, p. 319.

[3] *Transactions of the American Otological Society*, 1871.

[4] *Archives of Ophthalmology and Otology*, vol. v., p. 527.

disease of the middle ear, or possibly from independent disease of the labyrinth, but such symptoms are generally complained of only by people of good musical education, and affect only the higher notes of the scale.

Sometimes the same condition prevails in both ears, and all notes are heard false. This should also be called echo-hearing.

The senior author of this volume saw and treated, for a short time, a patient who presented the following curious phenomena of hearing: With the right ear he can hear the high notes of a piano better than the low ones; in walking on the sea-shore he hears the crickets in the grass, but not the roar of the waves; he can hear the chirping of insects and the movements of their bodies easily; the tick of a watch is heard normally, 48/48, and yet he cannot hear the tones of the human voice at all well. With the left ear, whose hearing distance for the watch is but 1/48, the power of hearing conversation is so good that the patient, a young man of seventeen, carries on his studies at college with no particular difficulty.

It is hardly necessary to more than allude to the symptoms of tinnitus aurium in primary disease of the labyrinth. It scarcely differs from the sounds heard by those who suffer from chronic non-suppurative inflammation, although in many cases of total deafness no tinnitus exists. Tinnitus aurium is more frequent and disturbing in chronic disease of the middle ear, than in chronic affections of the labyrinth.

PAIN AND SENSITIVENESS TO SOUNDS.

Pain is a marked symptom of acute inflammation of the membranous labyrinth. All affections of the acoustic nerve are, however, generally accompanied by extreme sensitiveness of the ear to loud, jarring, discordant, or even ordinary sounds. It is then necessary to keep the patient in a very quiet place. In all cases of this kind the auditory canal should be protected by plugs of cotton. Nausea, vomiting, and convulsions, as well as opisthotonos and delirium, may be symptoms of labyrinth disease, as well as of cerebro-spinal meningitis and of acute catarrh of the middle ear.

Voltolini believed that there was primary affection of the labyrinth that is sometimes mistaken for cerebro-spinal meningitis, and he wrote several papers,[1] illustrated by cases, to sustain his position. Although his ideas have been rejected by some other writers, the question cannot be at all considered as a settled one. After a careful consideration of the history of very many cases of supposed cerebro-spinal meningitis occurring in young children, there is at least a strong suspicion that Voltolini was correct in this view, and that an affection of the labyrinth may occur in young children, and be erroneously supposed to be cerebro-spinal meningitis. The symptoms of that form of inflammation of the membranous labyrinth that has been mistaken for cerebro-spinal meningitis, should be carefully considered in order that the practitioner may be able to clear up the doubts which have been thrown upon the existence of this disease. Gruber and Schwartze unite

[1] *Monatsschrift fur Ohrenheilkunde* Bd. I. and VI.

with the authors in believing that such a case may occur. If we find a child suddenly taken with severe vomiting, which is followed by stupor or delirium, without paralysis, and with but slight opisthotonos, such as children have with acute otitis media, and if we see this child recover in a few days, except that it is absolutely deaf, and walks with a staggering gait, it is more reasonable to think of an affection of the ear as the cause of these symptoms, than of a disease of the brain and spinal cord.

DISEASE OF THE COCHLEA (COCHLITIS) FROM SYPHILIS.

Syphilitic affections of the middle ear are perhaps more common than those of the labyrinth. For example, in the course of the earlier symptoms, among which is pharyngitis, and so forth, we often have tubal and tympanic catarrh, which is not to be distinguished from an aural catarrh arising in the course of another disease, so far as the ear is concerned. There may be also in the course of the later periods of the disease, syphilitic exudation into the tympanum, and about the ossicles. There is, however, a disease of the labyrinth and acoustic nerve occurring in syphilis. This disease has some characteristics of its own. It is analogous to certain forms of what are known as brain or nerve syphilis, such for example as lesions of the ocular motor nerves, and the medulla. The senior author gave it the name of syphilitic cochlitis, because it is chiefly a disease of the cochlea, as are certain affections of the semicircular canals of the optic nerve and retina. The cases of disease of the ear in inherited syphilis, are chiefly diseases of the peripheric and not of the central part of the organ of hearing. Just as we have disease of the cornea and iris as the more frequent lesions of the eye in congenital syphilitis, so do we have tubal and tympanic catarrh, originating from the snuffles in infantile and congenital syphilis.

Mr. Hutchinson[1] is of the opinion that all the cases of aural disease occurring in the course of inherited syphhilis, which he inspected, are " due either to disease of the nerve itself or to some change in non-accessible parts of the auditory apparatus." There are however, cases of aural disease in congenital syphilis, which are plainly due to an affection of the various parts of the middle ear—and there are also cases both of congenital and acquired syphilis, when the chief seat of the aural disease that may occur is in the vestibule, the cochlea and semi-circular canals. Such cases, if diagnosticated at all early in their course, are susceptible of relief and cure by the free use of mercury and iodide of potassium.

CONCLUSIONS.

1. Disease of the cochlea, as of the other parts of the labyrinth, usually, although not always, manifests itself suddenly. The patient can definitely fix upon a time when he became deaf, and when he began to have *tinnitus aurium.* This is true even when one side only is affected. The one-sided deafness would not be so quickly recognized were it not usually accompanied by tinnitus, vertigo, and often by unsteadiness of gait. Sudden loss of hearing and the sudden occur-

[1] *A Clinical Memoir on certain Diseases of the Eye and Ear, consequent on Inherited Syphilis*, p. 182. London, 1863.

rence of tinnitus, vertigo, and staggering, are not, however, entirely peculiar to labyrinth disease, since it is well known that we sometimes, although rarely, have the same symptoms in cases of inspissated cerumen and catarrh of the middle ear. They are therefore only of pathognomonic value in connection with the objective examination and tests.

2. The tuning-fork C^2 is heard more distinctly through the air than through the bones. But the duration of perception of sound in both channels is lessened.

3. The examination of the membrana tympani and the employment of the methods for inflating the middle ear, will usually give us reasonable conclusions as to the situation of a given disease of the ear, so that at the least we may exclude collections of fluid in the tympanic cavity in making a differential diagnosis between disease of the middle ear and of the labyrinth.

4. The piano, or any very similar musical instrument, will aid us in determining whether or not the disease of the cochlea exists. The examination of cases that were unquestionably affections of the labyrinth shows that the power of appreciating low tones is the last to suffer, and the first to recover in most cases of disease of this part of the ear, so that these will be heard when the high ones are either not heard at all, or are heard "*false*" or doubled. When these symptoms are present, we must conclude, that the cochlea is the seat of disease, even if it be secondarily affected.

5. The diagnosis of *syphilis* of the labyrinth depends in a great measure upon the same kind of evidence as that from which we conclude that a case of optic neuritis or choroiditis is syphilitic; that is to say, the history

and the presence of other symptoms such as an eruption, mucous patches, etc. It should not be forgotten, however, that the occurrence of labyrinth disease, in a person who has probably had the initial lesion of syphilis, even if no other symptoms are present, is a very suspicious circumstance, which should lead to a careful weighing of the indications for and against mercurial treatment.

We may say disease of the cochlea, instead of disease of the labyrinth, when the prominent symptoms, as in the cases now reported, are great impairment of hearing, the inability to hear certain tones, and the production of false ones. These are evidences of cochlea disease, whatever else we may have. Tinnitus is a symptom common to many forms of aural affections, while vertigo and unsteadiness of gait are chiefly to be referred to undue pressure from the base of the stapes upon the semi-circular canals, and not to disease of the cochlea. Too much stress has been laid upon increased pressure upon this latter-named part of the ear, to the neglect of disease having its origin in the tone-perceiving apparatus—the cochlea.

"Ménière's disease" is an unfortunate name, since it has been indiscriminately applied. It ought not to be used unless it refers to a case such as that in which a hæmorrhage into the semi-circular canals was found. Of late, cases in which the cochlear symptoms are, at least, the predominant ones, are sometimes styled cases of "Ménière's disease," when they have very little in common with cases of hæmorrhage. It is interesting to notice that we are always assisted in a diagnosis of supposed cochlear disease, if the patient have a musical education. All the cases of double hearing that have been reported occurred in persons enjoying a musical training. Certainly other patients have had the same symptoms, but they have been unable to appreciate them. The power of hearing certain tones can be accurately tested in all patients except young children.

The pathological investigations of syphilis of the internal ear have not been numerous, but we are not entirely without them. Moos reported a case of secondary syphilis in which deafness, annoying tinnitus aurium, and pains in the skull were complained of. The hearing was rapidly destroyed. The patient died, and at the autopsy the right external and middle ear were found intact, sclerosis of the petrous portion of the temporal bone, periostitis in the vestibule and small-celled infiltration of the membranous labyrinth, anchylosis of the stapes to the fenestra ovalis. Trunk of the acusticus unchanged.

Gruber also reported a similar case. Gruber's patient died of typhus fever. A post-mortem examination of the ear showed vascular injection of a high degree in the soft tissues of the labyrinth as well as thickness of these parts, in connection with marked hyperæmia of the mucous membrane of the tympanum. The patient, who was syphilitic, and who had been very slightly hard of hearing at times from catarrh of the tympanum, became suddenly absolutely deaf, with occasional attacks of vertigo when he first became deaf. The vertigo disappeared, but the deafness remained. The affection which is denominated cochlitis does not involve the cochlea solely, but affects that part of the ear predominantly, just as a patient may have hyperæmia, and even inflammation of the external auditory canal, quite secondary to the main trouble in the middle ear.

To give the exact line of demarcation in disease is very often impossible. It must be named from the predominance of the symptom in certain parts or organs.

Affections occur in syphilitic patients (from suppression of the perspiration, for example), which would have occurred all the same had they not been syphilitic; and yet the exposure or imprudence having once caused the attack of inflammation, it immediately assumes the character of a syphilitic infection by reason of the syphilitic blood, whose increased flow to the part, and the exudation go to constitute the inflammation. The complete failure of the anti-catarrhal treatment in these cases of syphilitic cochlitis is another striking evidence of the real nature of syphilitic cases; for we seldom meet with cases of catarrh that do not respond to some extent to the use of the catheter, Politzer's method, and so forth, while in acute or sub-acute diseases of the labyrinth, this treatment often aggravates the symptoms.

THE EFFECTS OF QUININE UPON THE EAR.

It has been established by clinical and physiological observers that hyperæmia of the labyrinth and the trunk of the acoustic nerve, are sometimes caused by the internal administration of quinine.[1] Experiments in this subject were first made upon the human subject and upon animals by Roosa and the late William A. Hammond. Many other experiments and observations followed these, which have confirmed the original observations.

[1] *American Journal of the American Sciences,* vol. lxviii, p. 400.

Large doses of quinine may cause temporary affections of the labyrinth, which are made known by tinnitus aurium and impairment of hearing. This congestion is not, however, confined to the membranous labyrinth, but it may also occur in the tympanic cavity and in the auditory canal. It is so well known that buzzing in the ear is caused by quinine, that many persons who are becoming gradually deaf from chronic catarrhal or proliferous inflammations of the middle ear, and who have taken quinine in their time, jump at the conclusion that the quinine caused the impairment of hearing from which they suffer. Exact examination often shows that many such patients have never taken quinine enough to cause, or even to cure any disease. The use of quinine in aural disease, in any considerable doses, is generally improper; experimental and therapeutical experience show that it has a peculiar power of producing congestion of the ear. In the experiments of Roosa and Hammond, the optic papillæ and the membranæ tympanorum were the parts examined, as well as the ocular conjunctivæ and auricles. "The vision was normal, 20/20. Refraction, emmetropic; pulse, 90; ocular conjunctivæ white, decidedly free from hyperæmia; palpebræ congested at outer and inner canthus. There was no tinnitus aurium. Membranæ tympanorum were entirely free from evidence of blood-vessels. (The details of the examination of the optic papillæ are omitted, since we are concerned only with the effect of quinine upon the auditory apparatus.)

Dr. Hammond took ten grains of sulphate of quinine at 8:30 P. M. At 9 P. M. the ocular conjunctivæ were congested at the outer and inner canthus; palpebræ conjunctivæ were markedly congested over the whole surface. There was no change in appearance of the drum-heads. 10 P. M.—The head feels full; left ear rings; auricles burn; face is decidedly flushed; auricles are red, especially the lobe of right, where there is a localized congestion so marked as to resemble an ecchymosis. There is now a vessel along each malleus. The optic papillæ are pinkish from apparent enlargement of lateral vessels. 10:30 P. M.—Right drum-head is very much injected along the handle of the malleus and the upper margin; left is less red, but still shows vascular injection. Both papillæ are pink, left more so than the right; face flushed, eyes suffused, ocular conjunctivæ decidedly congested, slight headache, tinnitus in both ears. 11 P. M.—The redness of the auricles is diminishing, especially the circumscribed spot on the lobe of the left one; the face still flushed; tinnitus continues; no headache; subject feels exhilarated; drum-head still injected along the malleus; vision normal. The late Dr. Hammond, the subject of these experiments, was a large and well-developed man. On May 28, 1875, Roosa repeated the experiment upon Dr. E. T. E——, aged twenty-four, a man of about five feet six inches in height, well developed, in good health and vigor. He stated that he never had had otitis. The hearing distance is 48/48 on each side; refraction emmetropic. He has no tinnitus aurium. The drum-heads are free from vessels, and normal in appearance; optic papillæ normal. At 11:05 A. M. Dr. E—— takes gr x of sulphate of quinine. At 11 : 35 there is a very fine vessel along the right malleus ; no change in the left. At 12 : 30 there is some redness at the periphery of the left drum-head, but the vessel on the right has disappeared. At 1 P. M. the redness has disappeared from both sides. No change is observed in the optic papillæ. There is no tinnitus, and no sense of exhilaration. No tobacco or other stimulant was used during the time of observation.

June 23, 1875,—Dr. C——, aged twenty-five, about five feet nine inches in height, rather spare. Refraction myopic, 1/42 v.=20/20. Drum-heads absolutely free from congestion. No vessel on or along malleus. Optic papillæ are both flushed.

At 10:16 A. M. takes gr. xv. of sulphate of quinine. 11 A. M. a vessel is seen along malleus of right membrana tympani; and left membrana tympani presents no change. There is a slight vertigo. 11:30—There is a sense of heat and tingling over the whole surface of the body. Sense of fulness in the ears and head. The handles of both mallei are injected. The hands are tremulous, and the subject gives general evidence of nervous excitement. There are sounds of a high note in the ears. The ears feel warm. At 12:30 the injection of the malleus is disappearing, as are the vertigo and tremor. At 12:50 the mallei are still injected. Motions of the jaw cause peculiar and unpleasant sense of vibration in the ears.

These experiments justified the view expressed in the *American Journal of the Medical Sciences*, October, 1874, that the effects of quinine upon the ear were due to congestion. Hammond's experiments upon animals, and, what is much more conclusive than even experiments upon animals, large clinical experience, some of which is given us by such observers as the late

Von Grafe,[1] confirm the view deduced, that the tinnitus aurium following the use of quinine is the result of overfilled blood-vessels, and is not the anemia of blood-vessels not containing the normal quality or quantity of fluid.

Roosa also experimented upon two other physicians, giving each ten grains of quinine at a dose. In one case congestion of the drum-heads and the optic papillæ followed, with tinnitus aurium, while in the other *absolutely no effect was produced.* The former subject was a full-blooded man who had suffered from congestion of the cerebral meninges. The gentleman upon whom no effect was produced had been in the habit of taking quinine, and was rather anæmic.[2]

Hammond[3] published some experiments on this subject in a paper in which he gave the literature of the subject, and particularly the experience of M. Melier. (*Experiences et Observations sur les Propriétés Toxiques du Sulfate de Quinine. Memoires de l'Academie Royale de Medicine, etc., p.* 722.) Melier is very decided as to quinine causing deafness, as are other writers; but observations as to the immediate effect of the drug upon the membrana tympani or other parts of the ear do not appear, except in the account of Hammond's own case.

The observations that have been made upon the *fundus oculi,* after the administration of large doses of quinine, indicate that the secondary effect of toxic, or large doses of this drug, is to empty the blood-vessels.

[1] *Archiv fur Opthalmologie,* Bd. 111, No. 2, p. 396.

[2] *Text-book on the Ear,* 7th edition, Wm. Wood & Co.

[3] *Physiological and Medico-Legal Journal,* October, 1874, p. 232.

It has been assumed, that ischæmia of the retina is the first consequence of a poisonous or large dose. But the fundus oculi has not yet been examined in such cases, as soon as the loss of vision occurred.

The tinnitus and impairment of hearing following the use of quinine, depend upon congestion of the ultimate fibres of the auditory nerve in the cochlea. The redness of the drum-heads is merely an index of the former condition. In the treatment of deafness from quinine, strychnia is of great benefit. Mercury and potash should not be given, nor should depletives be used in any form.[1]

Roosa also examined a patient with typhoid fever, whose hearing became very much impaired while taking quinine, during the course of the fever and who had previously had good hearing. The C^2 tuning-fork was heard better by aërial than by osseous conduction. This observation completes the chain of proof that the lesion in impaired hearing from the use of quinine is in the labyrinth.[2]

DISEASES OF THE ACOUSTIC NERVES CAUSED BY CEREBRO-SPINAL MENINGITIS.

Cerebro-spinal meningitis has been generally supposed to be the cause of many cases of disease of the auditory nerves. That it frequently causes great loss of hearing, and sometimes absolute deafness, no one with the least clinical experience will deny. A large

[1] For an interesting case see "International Congress of Otology, Brussels, 1882," and its final result, *Medical Record*, 31 Jan. 1901.

[2] Those interested in these first experiments and clinical reports as to the effect of quinine upon the ear and eye are referred to St. John Roosa's Text-book on the Ear, seventh edition, and to the papers here quoted.

proportion of the deaf-mutes of the present day are said to have lost their hearing in the course of cerebro-spinal meningitis. It is probable, however, that although the trunk of the acoustic nerve and the labyrinth may become diseased, and perhaps primarily in some cases, that the lesion of the ear that most frequently occurs in the disease is an inflammation in the tympanum. Judging from the analogous process that occurs in the eye, this seems a plausible view. We do not usually have optic neuritis when the eye becomes affected in cerebro-spinal meningitis, but choroiditis—a peripheric and not a central affection. The pathological investigations in this direction have been few, apparently because general pathologists are not much interested in the ear, and those who concern themselves with its diseases have few opportunities to make post-mortem examinations in cases of cerebro-spinal meningitis. The clinical facts are against the theory of disease of the nerves. There is scarcely ever facial paralysis in conjunction with the deafness. It is hard to conceive of suppuration of the trunk of the acoustic nerve, without any affection of the facial. The evidence furnished by the drum-heads, which are so often sunken, although not conclusive—for we may have secondary disease of the tympanum as well as of the labyrinth—is another point in the clinical evidence. Then the tuning-fork in many cases, notably in deaf-mutes, is heard through the bones, when it is not at all perceived through the air. Disease of the acoustic nerve has, however, been found in post-mortem examinations of cases of this disease. Luschka and Moos found the acoustic nerve, up to its exit from the skull, so completely embedded in masses of exudation, that Professor Luschka felt justified in supposing that the inflammation and exudation following the course of the nerves might easily, in some cases, extend into the labyrinth. Moos, in this same paper, gives a report of the necroscopy of two cases in which there was found pus in each tympanum, also in the vestibules, and ampullæ, and the cochlea. Both the acoustic and facial nerves in the meatus auditorius were surrounded by pus. The second case presented similar appearances.

It has been pretty generally assumed that these cases were cases in which the trunk of the acoustic nerve was primarily affected, but it is by no means certain that the primary trouble here also was not in the tympanum whence it may have extended to the labyrinth and nerve.

The cases reported by Heller [1] show that he considers it possible, from his microscopic examinations, that the suppuration in the tympana and labyrinth may have occurred simultaneously with the changes in the cerebral and spinal membranes. Lucae [2] reported a case which more fully supports the view of a primary affection of the labyrinth in cerebro-spinal meningitis than do any of the preceding cases. In his case there was merely congestion of the tympana, while the Eustachian tubes were in a normal condition and the labyrinths were in a state of suppuration. "The purulent inflammation of the base of the brain along the vessels of the acoustic nerve, up to the cochlea, was more exactly traced on both sides." Knapp [3] found "symptoms of

[1] *Archiv fur Ohrenheilkunde* Bd. iv. p. 55.

[2] *Ibid.* Bd. p. 188.

[3] *Transactions of the American Otological Society,* 1873.

hyperaemia or catarrhal inflammation of the middle ear, either during the febrile stage of the disease or during the period of convalescence" in many cases. Knapp also examined two temporal bones of a patient who had become deaf and died from cerebro-spinal meningitis. In one ear the outer and middle ears were normal, while the acoustic nerve was softened by suppuration. While the accompanying facial appeared to be normal, the acoustic nerve of the other side had not suffered, but numerous pus-cells were found around it. The labyrinth was not examined.

Moos,[1] however, reported the post mortem of a case of cerebro-spinal meningitis, in which the nerve was found to be sound, excepting some congestion of the sheath up to the meatus auditorius internus, while there was extension of the inflammation from the dura mater into both tympanic cavities. A few post mortem examinations show that the morbid changes causing deafness in cerebro-spinal meningitis are sometimes found in the fourth ventrical.

It is said that "inflammation of the middle ear, of a mild grade and subsiding without impairment of hearing, is common." Suppuration of the tympanum may occur. According to some statistics, (J. Lewis Smith) about one in every ten patients becomes deaf.

The authors have seen congestion of the tympanum in recent cases of the disease under discussion, and few where the labyrinth was the seat of disease, but whether primarily or secondarily so, cannot be said. It is probable that the inflammatory process generally follows the blood-vessels into the tympanum rather than along

[1] *Archives of Ophthalmology and Otology*, vol. iii, No. 2, p. 177.

the acoustic nerve, for in most of the cases there is still some hearing power by bone conduction, a positive indication that some power remains in the acoustic nerve.

INFLAMMATION OF THE ACOUSTIC NERVE AND LABYRINTH FROM MENINGITIS.

Inflammation of the base of the brain may extend to the trunk of the acoustic nerve and to the labyrinth. The following cases are examples of this form of disease of the internal ear:

Case 1.—*Meningitis—Gradual Deafness.*—W. K. J——, aged twenty-seven, complains of increased impairment of hearing. Had scarlet fever, when a child, after which he felt a diminution in the hearing power. Last winter had congestion of the brain and hemiplegia of left side. His right ear became decidedly worse at this time. He has recovered from the hemiplegia. There is no tinnitus aurium. The hearing distance on the right side, O; left 12/48. Tuning-fork is heard better on right side. The right membrana tympani is sunken, and has no light spot. The left is also sunken, and exhibits two reflections of light. Inflation of the ears improves the hearing on the left side.

Case 2.—*Basilar Meningitis—Bilateral Deafness.*—William R——, aged twenty-seven, says that seven weeks ago he could hear well, but after an attack of fever attended by delirium, he found when restored to consciousness, that he had lost his hearing. There is a roaring noise in the left ear, but no other aural symptom. He can hear the watch when laid upon the right ear, but not at all on the left. The tuning-fork is also heard more or less distinctly in the right ear. The right drum-head is somewhat sunken, the left very much so.

Case 3.—*Meningitis Inflammation of Cerebral Meninges and Labyrinth—Exposure to Direct Rays of the Sun.*— Laura——, aged twenty-two months. The mother states that when the child was eight months old, and teething, she was unduly exposed to the direct rays of the sun, and was thereupon suddenly attacked with convulsions and was ill for three weeks afterward. The physician in charge observed that she was losing her hearing, and the mother thinks that she has not heard since that period. The drum-heads are both very much sunken and have no light spots.

Case 4.—*Basilar Meningitis—Effusion about Auditory Nerve—Intermittent Character of Attacks—Epilepsy—Deafness—Recovery.*—Moses B——, aged twenty-nine, merchant, previous to July last heard perfectly well. He has had intermittent fever at different times for two years; had also an attack of sunstroke. In July he lost the hearing in one ear, and for four weeks he was deaf with both ears. After a course of counter-irritation his hearing gradually returned. He has taken a large quantity of quinia. Some weeks ago, while at Petersburg, Va., his hearing power again failed, and at the present time he cannot hear words at all; even the ticking of the watch is not perceived. He cannot hear the tuning-fork when placed upon the head, but feels it when on the teeth. The drum-heads are somewhat opaque, and there is granular pharyngitis. He complains of a severe pain in the top of his head, and of a knocking sound in the interior. His countenance is very anxious, appetite poor, but he walks well. There is no history of syphilis. He had a severe fall upon the head, striking the occipital region, when he was seven years of age.

Dr. Hammond treated the case by means of the iodide of potassium mixed with the bromide. Subsequently he administered arsenic in consequence of the intermittent type of the epilepsy. The hearing power was suddenly restored on one side and the other soon became better also.[1]

INFLAMMATION OF THE INTERNAL EAR FROM DISEASE OF THE SPINAL CORD AND MEDULLA, TYPHOID FEVER, AND SCARLET FEVER.

Impairment of Hearing in Locomotor Ataxia.—In certain cases of locomotor ataxia there is considerable impairment of hearing. In these cases the cause is not usually a coincidental catarrh of the tympanum, but an affection of the acoustic nerve. The tuning-fork is heard better through the air, the voice better than the watch, noises were distressing, and the hearing was made worse by inflation.

Typhoid fever sometimes produces disease of the middle ear, sometimes of the labyrinth, and occasionally of both parts in the same subject. There is apparently an anaemia of the labyrinth after certain cases of continued fever, for while the symptoms are those of disease of the nerve, they partially recover as convalescence goes on. In some cases it is possible that the disease of the

[1] The Ophthalmoscope should always be used to learn if there be any optic neuritis in all cases of suspected meningitis in any form of aural disease. The optic papilla is often swelled in meningitis. (C. J. Kip).

labyrinth is caused or increased by quinine which has been given during the illness.

Scarlet fever usually causes a suppuration of the middle ears, and no further disease, but in some rare instances the inflammation is not suppurative and attacks the labyrinth.

In not extremely rare instances as it appears from the tables of institutions for the deaf and dumb, pneumonia causes diseases of the internal and middle ear. A case was seen by the writer where deafness followed pneumonia, occurring after a mild attack of cerebro-spinal meningitis.

DISEASE OF THE INTERNAL EAR FROM PAROTITIS.

Of a total number of five thousand cases of aural disease, seen in private practice, only ten seemed to have been caused by parotitis. (Roosa.) Specialists in this country and in Germany have seen very few of such cases. Cases are reported by Buck,[1] Brunner,[2] Knapp,[3] Moos,[4] Harlan and others, but very little has been added to the statements of Toynbee, Hinton, and Roosa, made by the first-named author in his text-book, in 1890, by Hinton, in 1874, in his " Questions of Aural Surgery," and by Roosa in an article on " Diseases of the Internal Ear," *in the American Journal of the Medical Sciences.* Toynbee and Hinton, and later Dalby, spoke of disease of the ear after mumps as if it were a common one. In this they differ from the German and American authori-

[1] *American Journal of Otology,* vol. iii, p. 203.

[2] *Archives of Otology,* vol. xii, p. 102.

[3] *Ibid,* vol. xi., p. 385.

[4] *Ibid,* p. 13.

ties, who speak of it as a rare affection. Hinton says: "Next, or perhaps equal, in frequency to scarlatina, in this respect, stands mumps, which has an effect on the nervous apparatus of the ear which has as yet received no explanation, and affords no clue to the use of remedies; every part of the ear being normal, so far as examination can extend, but the function is almost abolished. '*But some cases* (the italics are ours) *of damage to the ear from mumps present an intermediate character, showing clear signs of a tympanic disorder mixed with the nervous symptoms. The similarity of the nerve affection that follows mumps to that which ensues upon parturition, is very striking; and the resemblance is increased by the fact that quite frequently the latter affection also is accompanied with symptoms of a catarrhal character.*'"

After all that has been written, it still remains doubtful as to how the ear is invaded, and whether the disease is generally a primary one of the labyrinth or of the middle ear. That it is occasionally at least a disease of the middle ear, cases reported plainly show.

Unfortunately the cases are not often seen by an otologist when they are in their beginning. In some cases the occurrence of infection of the ear from mumps is by direct extension from the gland.

Extension of suppurative inflammation of the parotid gland to the external auditory canal is not uncommon. Probably this extension may take place through the fissures of Santorini. If a suppuration may extend in this way, why not a catarrhal process? We are not without examples of the extension of an inflammation to the middle ear from the auditory canal and outer layer of the drum-head. Every physician at all accustomed to see much of aural disease has seen cases where from a draught of cold air, the entrance of cold water or irritating substances, an inflammation has been set up in the middle ear by extension, and where the symptoms in the auditory canal have passed away long before those in the middle ear have been relieved.

Conclusions.

1. An acute catarrh of the middle ear may occur during the course of the mumps, and be attended by fever and vomiting.

2. This catarrh may extend from the parotid gland through the auditory canal and outer layer of the drum-head, or through the mastoid process.

3. An affection of the labyrinth may occur simultaneously, or by extension from the middle ear.

4. It is probable that there are cases where the disease during the course of mumps is transferred to the labyrinth, in the same manner that an inflammation sometimes occurs in the testes and the breasts, but this cannot be considered as proven until more detailed experience is furnished of cases observed a few hours after the impairment of hearing occurs.

ACUTE INFLAMMATION OF THE MEMBRANOUS LABYRINTH MISTAKEN FOR CEREBRO-SPINAL MENINGITIS.

As has already been said, Voltolini,[1] was the first writer to call attention to the subject. The discussion which his views have excited called the attention of general practitioners to the possibility of mistaking a disease of the ear for one of the brain or medulla.

[1] *Monatsschrift fur Ohrenheilkunde, Jahrgang* I., No. 1.

The symptoms of epidemic cerebro-spinal meningitis, as given by Clymer,[1] are "great prostration of the vital powers, severe pain in the head and along the spinal column, delirium, tetanic and occasionally clonic spasm, and cutaneous hyperæsthesia, with, in some cases, stupor, coma, and motor paralysis, attended frequently with cutaneous hæmic spots." This definition is so comprehensive and guarded that it will be difficult to say that the symptoms of labyrinth disease, as given by Voltolini, may not accord with those of cerebro-spinal meningitis. Voltolini says,[2] "The children are attacked quite suddenly, and without apparent cause; consciousness is soon lost as a rule, but the head is frequently grasped with the hands. There is severe fever, a fixed countenance. They bury the head in the pillow. There are slight symptoms of paralysis, but they are never permanent; occasionally there is vomiting. Sometimes the disease has something of an intermittent character. The cerebral symptoms soon disappear, but the patient is found to be perfectly deaf, and walks with a staggering gait."

Voltolini laid particular stress upon the absence of facial paralysis in these supposed cases of cerebro-spinal meningitis, and he asked, how is it possible to have an exudation in the medulla oblongata, at the origin of the auditory nerve, without having at the same time one of the facial, when the fibres of the two nerves are so near each other? Knapp discussed the subject quite fully in a "Clinical Analysis of Inflammatory Affections of the Middle Ear."[3] The view of the writer is embraced in

[1] Reprint from the American edition of *Aitken's Science and Practice of Medecine.*

[2] *Monatsschrift fur Ohrenheilkunde, loc. cit.*

[3] *Archives of Ophthalmology and Otology,* vol.ii, No. 1.

the following question: "If the same complex symptoms in some cases produce deafness, in others blindness, and in many others neither, why should we call the first group otitis labyrinthica, mistaken for meningitis, while in the second group the dependence of the occular affection on the cerebro-spinal disease may be demonstrated?" It is no answer to Voltolini's arguments to say, as has been said, that cases of inflammation of the membranous labyrinth are "abortive" cases of cerebro-spinal meningitis. Voltolini went too far in thinking that there was no such disease causing deafness as cerebro-spinal meningitis; but because so-called "spotted fever" does exist, and transmits disease to the auditory and optic nerves, this fact furnishes no evidence that primary affection of the nerve-trunks, or of their expansions, may not occur, just as we may have primary optic neuritis. But here, gaps in our knowledge are to be filled, a task that must be performed by the post-mortem examinations.

HÆMORRHAGES AND EFFUSIONS.

From the clinical history of certain cases, it is probable that a hæmorrhage or effusion of serum into the membranous labyrinth may occur without any well-defined cause. In atheromatous degeneration of other blood-vessels of the body, we may also suppose that such a hæmorrhage sometimes occurs. The following case is a fair type of what is meant by hæmorrhage or effusion into the labyrinth:

Profound Deafness of Both Ears, accompanied by Vomiting, and loss of Equilibrium, occurring in one

Night.—A healthy young man aged twenty-two gave the following history: His occupation was that of a wagoner. He was attacked one night with vomiting and dizziness, and in a few hours he found himself completely deaf in both ears. He could not hear the loudest sounds. The nausea and dizziness continued for about two weeks. He was so weakened that he could not get out of bed, but he retained his intellect and consciousness, and he stated that there was no paralysis of any part of the body; he could lift his head, his arm, move his legs, and all parts of his body. There were no cases of cerebro-spinal meningitis in the place where this attack occurred. He had had a suppuration in the right ear some years before, and could not hear well from that ear before this attack. It is now three months since his deafness came on, and he is no better. The patient is ruddy and in vigorous health; there is no cardiac or renal disease. He has not had syphilis. He walks with a staggering gait. His intellect is unclouded. He has tinnitus aurium, which he compares to the chirping of crickets. The vision is good. He is still dizzy at times. An objective examination showed evidences of old inflammation in the right membrana tympani, but there was no inflammatory action going on. The membrane was transparent, except on the posterior and inferior quadrant, where it was sunken and adherent to the wall of the tympanic cavity. The left membrana tympani was normal. He did not hear the watch at all, nor words spoken through a tube placed in the external meatus. Air enters both Eustachian tubes. The tuning-fork was not heard better when the ears were stopped.

This was a case of hæmorrhage into the semi-circular canals and the cochlea. The senior author has seen several such, and some where no vomiting occurred, with sudden deafness with absolutely no premonition. We are still in need, however, of post mortem investigations to establish our theories founded on clinical experience. Inasmuch as such patients do not usually die of disease of the labyrinth, we have not the same facilities for clearing up a diagnosis that we have in fatal affections.

INJURIES OF THE OSSEOUS LABYRINTH.

In the chapter upon fractures of the temporal bone, it was seen that there were such injuries which involve the tympanum only, but there are also cases in which both the osseous and membranous labyrinth are injured, and absolute deafness results.

ACOUSTIC NEURITIS FROM CONCUSSIONS OF THE LABYRINTH.

Workmen employed in hammering large iron plates, such as are used in making the boilers of large steam-engines, are very apt to lose much of their hearing power. So many of these cases are seen at Ear Infirmaries, that at one time "Boiler-makers' Deafness" figured as a separate disease of the ear in the statistical reports of one of our institutions where aural disease was treated. Examination of such cases has shown that the lesion causing the impairment of hearing and deafness must be sought for in the labyrinth, and that it is probably due to concussion of the fibres of the nerve in the cochlea and semi-circular canals.

Concussions of the labyrinth from cannonading, such as are sometimes experienced by soldiers and sailors, the impaired hearing and extreme sensitiveness of the ears sometimes observed in telegraph operators, belong to this class of labyrinth affections.

There can be no hesitancy in believing that the continual recurrence of a kind of sound, that has no musical, but, on the contrary, an unpleasant character, must at last cause a hyperæmia of the ultimate nerve-fibres of the cochlea. The incessant shock of the drum-head by the blows from dozens or even hundreds of hammers upon vibrating plates must agitate these fibres in such a manner as to finally put them out of tune, as certainly as the constant use of a piano will at last loosen its strings. Clinical experience confirms this view, and Roosa's observations and investigations in reference to boilermakers' shops demonstrate the following facts:

1. Boiler-makers are nearly all hard of hearing.
2. The impairment of hearing is generally attributable to some lesion of the labyrinth, probably of the cochlea.

Superadded to this serious trouble, tympanic or middle ear catarrh or impacted wax are very frequently present, but these must be regarded as purely coincidental. Boiler-makers are constantly exposed to sudden and marked changes of temperature, and hence often catch cold, intensifying and increasing by this means the aural affections.

Should a man, already suffering from diseases of the middle ear, begin to work in a boiler-shop, he will, of course, suffer in a much greater degree, and the organ be more susceptible of additional injury, than a man who is in the enjoyment of a sound organ of hearing. In the same way, a telegraph operator who has pharyngeal catarrh and consequently a swelled Eustachian tube, which is not always capable of performing its proper function, will be more sensitive to, and suffer more acutely from, the concussions of the instrument, than he who has a healthy throat. The existence of tympanic and tubal catarrh will cause the Eustachian passage to be less pervious, or even at times entirely closed; and thus aggravate the unpleasant conditions existing when waves of sound that have to go but a short distance, and are besides inclosed in tubes, and thus increased in intensity, impinge upon the molecules that make up the ultimate fibres of the auditory nerve.

Those who work inside the boilers as riveters, and who thus have shorter waves of sound striking upon their ears, lose their hearing power most completely, as is evidenced by the testimony of all old boiler-makers. It is not easy, in the absence of post-mortem investigations, to define the exact nature of the lesion, but it may be a passive congestion of the contents of the cochlea.

Boiler-makers speak in graphic language of the effects of the din upon their ears. Said one of them: "Those heavy hammers jar every nerve in the body." They do not find much relief from wearing cotton in their ears, except when first entering the shop. An experienced workman, however, told me that all old boiler-makers had learned to equalize the pressure and reduce the shock by opening the mouth frequently. Of course, by this procedure they open the Eustachian tube more freely.

The reasons for believing that the lesion in these cases is situated in the nerve predominantly, are that the aërial conduction is always louder than the bone conduction, as tested by the tuning-fork " C^2 " and that it is heard longer than by bone conduction. The only apparent exceptions to this rule were those in which, in addition to the lesion of the acoustic nerve, there was also inspissated cerumen. When the wax was removed, however, and the cases were transposed into their proper place, of diseases of the acoustic nerve produced by concussion, the tuning-fork was heard through the air louder and longer than through the bone. All the other tests that we as yet have, for the differential diagnosis of affections of the middle and internal ear, are so much inferior to this, although of great corroborative value, that all observations upon boiler-makers that have not been made in this way, are so defective as to tell nothing of the true seat of the disease. In addition to the test by the tuning-fork, the examination of the hearing power by the voice shows that these patients hear better in a quiet place than in a noise. As has been suggested by many writers, there is no doubt that something might be done to avert the consequences of those concussions in producing disease of the acoustic nerve, if workmen could be induced to wear ear protectors; but from some reason or other, they are, as a rule, quite averse to wearing cotton in their ears, or any contrivance for protecting their ears from the effect of a great and constant concussion. Almost all boiler-makers say that they were deafer at first than after they had become accustomed to the occupation;

and they all say that they hear better after a period of rest, for example from Saturday to Monday.

That excessive sound must necessarily be as harmful to the nerve of hearing, as is excessive light to that of sight, is a natural deduction from our knowledge of the effects of the waves that produce those two senses, and all experience confirms the belief that there may be an acoustic neuritis produced by noise, as well as an optic neuritis caused by exposure to a glare.

These cases are fully reported.[1]

Conclusions.—1. The hearing power of persons working in such a din as that of a boiler-shop invariably becomes impaired.

2. The lesion caused by this occupation is one of the membranous labyrinth, or of the trunk of the acoustic nerve.

3. Persons thus affected do not hear better in a noise. Their hearing power is better in a quiet place, and becomes better after prolonged absence from the exciting cause of their impaired hearing.

4. The cases of inspissated cerumen, catarrh of the middle ear, occurring among boiler-makers, are such as occur among those employed in various occupations and only mask and complicate the fundamental primary trouble, so long known as boiler-makers' deafness.

Other occupations of a similar nature, that is, occupations amid continuous concussions, undoubtedly cause the same lesion. All persons, such as engineers working over dynamos, engaged in occupations exposing them to the sound of regular concussions from the strik-

[1] *Roosa on the Ear*, 7th edition, New York.

ing of metallic plates together become somewhat hard of hearing.

CASES OF TINNITUS AURIUM AND IMPAIRMENT OF HEARING FROM OTHER KINDS OF CONCUSSIONS.

1. *Tinnitus Aurium, without Impairment of Hearing, Occurring from Listening to a Telegraph Instrument—Hyperaemia of Acoustic Nerve?* W. G. B——, aged thirty-seven, states that he has been a telegraph operator for about twenty years; and that he has had tinnitus aurium for about two years. Hearing distance; right, 48/48; left, 48/48. Both membranæ tympani have good light spots; there is some granular pharyngitis. The patient is confident that the vibrations of the telegraphic instrument have caused the noise in his ears. The sound of the instrument is very unpleasant to him, and he is obliged to protect his ears, while at work, by cotton plugs. Indeed, his ears have got into such a sensitive condition that jarring sounds of any kind are extremely annoying to him. The patient is in good general health.

Case 2. Impairment of Hearing of One Side, ascribed to Occupation as Telegraph Operator. Mr. B——, aged twenty-seven, about a year ago discovered that the hearing power of his left ear was somewhat impaired. Three months ago he was troubled with a continuous noise in that part of his head. He is a telegraph operator, and has been accustomed to use his left ear—leaning his head over the machine on that side and intently listening. He believes that this is the cause of his loss of hearing. The drum-heads look very much alike, both exhibiting peripheral opacities, but in other respects having a normal appearance. The pharynx and nares seem to be healthy. Inflation of the ears has no effect at all upon the hearing. The watch is not heard at all on the affected side, nor is the tuning-fork.

Case 3. Exposure to Cannonading—Tinnitus—Impairment of Hearing for the Watch, but not for ordinary conversation—W. R. X—aged twenty-five, observed some difficulty in hearing ten years ago; and, after being exposed on a gunboat to severe cannonading, while an officer in the navy, he became worse, although he has scarcely any tinnitus aurium. Hearing distance; right ear $\frac{1}{48}$, left ear $\frac{1}{48}$. Both drum-heads appear to be normal. Air enters each Eustachian tube freely, but inflation causes no improvement in the hearing power.

Ample opportunity was had to test the hearing power of this patient in conversation, which he hears so well (in spite of the fact that his power of hearing the watch is much impaired), that he has never been considered, by any but his most intimate friends, as very hard of hearing. Persons who can hear the watch no better than he, are usually, if not always, very much troubled to hear conversation, even when addressed especially to them; and yet the patient in question can join in general conversation carried on in an ordinary tone, and can hear lectures, and so forth with perfect ease.

Case 4.—Loss of Hearing from a Kiss upon the Ear. Mrs. H——, aged forty-two, sent to the author by Dr. O. B. Douglas. Last winter, (1878) her husband came up behind her as she sat reading, and kissed her suddenly upon the right ear; taking her completely by surprise. She suffered a great shock and had a roaring in the ear for some time. The incident made her very "nervous for two or three weeks afterward." During the past summer she was told by her relatives that she was becoming deaf on the right side. She paid no attention to it until six weeks ago, when she tried her right ear with her watch and found she could not hear it. She gives satisfactory evidence of having heard a whisper well with the right ear during last winter and spring. Has had occasional tinnitus during the past few months after taking cold. Enjoyed music very much formerly but does not now. The piano practice of the children at home annoys her. Whistling is particularly disagreeable. All noises disturb her somewhat, so that she has "felt afraid that she was becoming nervous." General health is good. Menstruates regularly. No cardiac trouble detected. Father died of paralysis.

H. D., R. $\frac{40}{40}$; L., $\frac{P}{40}$.

The tuning-fork on teeth or vertex seemed louder in the left ear. Is slightly intensified in right by plugging, but much more in left. Aerial better than bone conduction on each side.

The drum-heads are about alike and show nothing to account for deafness. Air enters the right drum by both catheter and Politzer's method, but does not alter the hearing. All notes of the piano are heard, but she says they do not sound "clear" even with both ears open. Dr. Douglas examined the naso-pharyngeal space and the mouths of the Eustachian tubes and found nothing abnormal.

This was a case of deafness from affection of the labyrinth with no apparent cause except the kiss upon the ear. The concussion from the kiss may have caused the loss of hearing at once; or, as seems more likely, it may have produced changes in the labyrinth, which, in combination with the general nervous shock, served as a foundation for a gradual loss of hearing subsequently—as, for instance, by some atrophic process.

Mr. Hinton was inclined to think that in all instances of loss of hearing, apparently from slight causes, it might be found that some previous source of injury to the ear had existed. He quotes some cases to illustrate that view. He speaks of a concussion sometimes jarring the labyrinth, not into complete paralysis, but into a state of extreme liability to this condition.[1]

ANEURISM—TUMORS.

Aneurism of the basilar artery, cerebral tumors, and, in fact, all varieties of intracranial disease, may cause tinnitus aurium and impairment of hearing; but all such cases require special study, and hardly demand a detailed notice. Griesinger says that the symptoms of disease of the nerve, or its expansion, arising from aneurism are: Difficulty in swallowing; occasionally spasmodic deglutition; impairment of hearing, or even complete deafness, often appearing at intervals, with great tinnitus; difficulty of respiration and articulation; interference with the excretion of urine, without any impairment of the intellectual functions, and finally, paraplegia. Tröltsch states that a constant sensation of knocking in the back of the head is also a suspicious symptom.

[1] *Questions of Aural Surgery*, p. 208.

Dr. Hughlings Jackson believes that deafness excluding cases *manifestly* due to disease of the apparatus of hearing, is a rare complication of Intracranial disease. It is very much less common than optic neuritis. Dr. Jackson has not yet seen an autopsy which showed that deafness had depended upon adventitious products, nor upon "any sort of disease of either cerebral hemisphere." One case[1] is recorded, however, which Dr. Jackson quotes, of tumor of the left cerebral hemisphere, where there has been deafness of both ears. Dr. Jackson thinks that deafness does not result from intracranial tumor or other adventitious product, unless the auditory nerve is actually involved or pressed upon.

According to Schwartze [2] it has been estimated by Calmeil that impairment of hearing occurs in about one-ninth of all cases of cerebral tumors. Aural symptoms occurred in 77 cases of tumors of the cerebellum, 7 times; in 26 cases of tumors of the pons, 7 times; in 27 cases of tumors of the middle lobe, 3 times; but not once in 27 tumors of the anterior lobe, nor in 14 cases of the posterior lobe, and 4 of the fourth ventricle.

Deafness of one side, according to Gruveilhier, quoted by Schwartze, was one of the first symptoms in a number of cases of central tumors. Schwartze further says, that impairment of hearing on both sides not infrequently occurs in tumors of the cerebellum, and when from the situation of the tumor we know that it does not press directly upon the nerve-trunk of the opposite side, nor upon its origin in the medulla, and when there

[1] *Royal London Ophthalmic Hospital Reports*, vol. lv, part iv., p. 420.

[2] *Handbuch der pathologischen Anatomie*, by E. Klebs. *Gehororgan*, by Schwartze.

are no symptoms of paralysis of other cerebral or spinal nerves, Schwartze thinks that there may be a neuritis or odema in these cases.

DISEASE OF THE SEMI-CIRCULAR CANALS.

It is now possible to diagnosticate disease of the cochlea and of the semi-circular canals, as distinguished from diseases of the other parts of the labyrinth. This has been shown to be true as regards the cochlea. As to the diseases of the semi-circular canals, the late P. Ménière,[1] reported a case which has become classical. The deductions from it have not always been justified by the facts. The term Ménière's disease has been used so indiscriminately, especially by neurologists that it has confused our ideas as to the significance of vertigo, nausea and inability to walk without staggering, when they occur in connection with sudden loss of hearing. In one of Ménière's cases he found a kind of bloody exudation in the semi-circular canals, while the brain, the cerebellum, and the medulla were sound. This case was that of a young woman, who, while menstruating, took cold from riding on the top of a diligence. The other cases, nine in number, are clinical accounts of cases of sudden deafness, in which it is probable that the semi-circular canals were pressed upon or diseased, for there was vertigo and a staggering gait. Some of these cases were perhaps of tympanic origin, certainly some were cerebral rather than aural, and the pressure upon the semi-circular canals was not from any exudation within them. As has been seen

1 *Gazette Medicale de Paris,* 1861, pp. 29, 55, 88, 239, 279, 597.

in the preceding pages, aural vertigo is by no means always dependent upon disease of the labyrinth.

Ménière read his first paper upon the subject before the Academy of Medicine in Paris, January 8, 1861, and in it he claimed that the lesion causing the following train of symptoms, namely, vertigo, dizziness, uncertain gait, nausea, followed by deafness, was situated in the semi-circular canals. Whether or not cases were all to be referred to the labyrinth as their point of origin, they cannot, with our present knowledge of pathology, certainly be referred to the semi-circular canals. There is a vertigo of tympanic origin, also one proceeding from primary disease of the labyrinth, as well as one from the cerebrum. All of these forms may be accompanied by sudden deafness. The deafness from the impaction of cerumen is sudden in occurrence, so also that from exudation or hæmorrhage into the tympanum, as well as that from hæmorrhage into the labyrinth. These all may be accompanied by vertigo. A classification, then, which groups under one head of disease, all cases of vertigo attended by deafness, is crude, and should be rejected. Each case should be studied by itself when it will be possible, in many instances, by a careful study of the principles that have been laid down in this and similar works, to determine the seat and nature of the lesion. Ménière did an inestimable service to the profession in directing attention to the ear as the seat of the disease, formerly supposed to be in all cases situated either in the brain or the stomach. The profession must now go further and determine what part of the ear is affected in individual cases.

Dr. Ormerod[1] has called attention to the fact, obvious to any one who reads Ménière's cases, that "the paroxysms of vertigo and vomiting are more sudden, more violent, more definitely paroxysmal" than the vertigo from chronic disease of the middle ear, and that what Hughlings Jackson calls the "vital symptoms"—perspiration, pallor, and faintness,—are more marked. Yet, as this writer admits, the vertigo from acute disease of the middle ear may be paroxysmal and severe, although then the severity of the symptoms, taken in connection with others, may be of value in making up a diagnosis as to the seat of the lesion, it cannot be said to be a pathonomonic guide.

As has been before indicated, the most alarming vertigo may occur from syringing the ears. The proper way to describe cases of vertigo and inability to walk straight in cases of aural disease is to speak of them as of peripheric (external auditory canal), tympanic, labyrinth or cerebral origin. It is possible in many cases to make such an analysis of the cases of pressure upon, or disease in, the semi-circular canals. These cases are not of the severe type of those presented by Ménière, but they are such as are constantly, as it seems to me, improperly and insufficiently described by this name. More serious cases of the same character may be found in other parts of this book.

EPILEPSY AND AURAL DISEASE.

The relation of aural disease to epilepsy has been mentioned in the discussion of foreign bodies and ear cough, but it cannot be said that the subject has yet

[1] *Brain*, vol. vi., p. 33.

been fairly studied, except from the point of the reflex origin of epilepsy from suppuration of the tympanum, foreign bodies in the auditory canal, and so forth, although cases of epilepsy are seen apparently caused by such diseases, and there are epileptics who suffered from chronic non-suppurative disease of the middle ear. Ormerod found that of 100 cases of undoubted aural disease, as determined by Dr. Urban Pritchard and Mr. Cumberbatch of St. Bartholemew's Hospital, " seven had had *bona fide* epileptic fits." This the writer states is a large proportion, for Niemeyer, as he says, estimates, that there are only six cases of epilepsy to every 1,000 persons, while Russel Reynolds maintains that this estimate is far too high. There is no doubt, as suggested by Ormerod, that aural disease and disease situated not only in the peripheric portions, but in the labyrinth, may excite epilepsy; but more investigation is required upon this subject.

PATHOLOGY.

In passing over the subject of the causes of disease of the internal ear, we have alluded to the pathology of the affection; but it may be well to tabulate the post mortem appearances that have been found in the labyrinth. Inasmuch as very few of these appearances have been accompanied by the history of the case, they have not the importance that they would otherwise have had. Yet they may be of service as a basis for future investigation.

Absence of auditory nerve	1
Atrophy of auditory nerve	10
Suppuration	1

Tumor upon	1
Hæmorrhage upon	2
Thickened membranous labyrinth	11
Atrophy of membranous labyrinth	22
Congestion	1
Suppuration of membranous labyrinth	3
Serum in labyrinth	3
Opaque fluid in labyrinth	3
Black pigment-cells too abundant	5
Distention of blood-vessels of cochlea	3
Fluid, opaque	4
Pus in cochlea	1
Thickened lamina spiralis	1
Osseous wall of semi-circular canals incomplete	3
Enlargement and congestion of blood-vessels (Hinton[1])	4

Hyperæmia of the various parts or of the whole contents of the labyrinth, has been found in typhus and puerperal fever, in acute tuberculosis, and in cases of poisoning by carbonic acid gas; also in meningitis, and in cases of disturbance of circulation from disease of the heart, and in emphysema of the lungs. Hyperæmia of the labyrinth may result from vaso-motor disturbances of innervation.

According to Erb,[2] atrophy of the acoustic nerve occasionally occurs in tabes dorsalis.

Tumors,—sarcoma, neuroma, and gummata—may enter the *meatus auditorius internus.*

Treatment.—Before entering upon any treatment, the situation of the lesion and its cause should be made out if possible. Without this all treatment will be like working in the dark, and worse than useless. The treatment of acoustic neuritis, of the chronic form, should be based upon the general condition and habits of the patient. Care and worry, indigestion, the menopause in

[1] *Questions of Aural Surgery*, p. 255.
[2] *Ziemssen's Handbuch*, p. 142.

women, will often be found to be at the origin of many symptoms, and no special treatment can be undertaken until each case is studied by itself. *But inflation of the ears and active treatment by the Eustachian tube, invariably make these people worse, and such means are to be strictly avoided.* Muriate of pilocarpine is valuable in the treatment of acute acoustic neuritis. It is best used hypodermically, beginning with two minims of a two per cent solution at bed-time and increasing the dose each day up to 6 to 10 minims. It is necessary to produce considerable diaphoresis and to continue the treatment, occasionally allowing interruption of two or three days, for four weeks. This treatment is only adapted to cases with acute symptoms, such as vertigo. True inflammation of the membranous labyrinth should be treated by absolute quiet and rest, leeches to the mastoid and tragus, pedeluvia, and purgations. The use of quinine and of cold applications to the head should be avoided, as well as all inflations of the tympanum. Syphilitic affections of the labyrinth, if treated at an early stage and vigorously, by the mercury and iodide of potassium treatment, recover. Traumatic affections of the labyrinth are usually hopeless from the start, as far as restoring the hearing is concerned; but much can be done by quiet, leeches, counter-irritation and the like in removing the symptoms of tinnitus, vertigo, double hearing, and so forth.

Chronic affections of the labyrinth unless of a syphilitic origin are utterly hopeless. Electricity had a reputation among inexact observers, for its cure of a true inflammatory affection of the labyrinth by this agent.

The authors have never seen any improvement, in any forms of nerve-deafness, from the use of electricity in any form. We must abandon the hopes entertained by some, of the powers of this subtle agent in those as yet mysterious diseases, the affections of the internal ear.

The anæmia of the labyrinth that sometimes occurs after typhoid fever and perhaps after other serious diseases of an exhaustive character, may be successfully combated if it be not treated by the usual means for disease of the middle ear. Inflation either by the catheter or Politzer's method, should be avoided. Counter-irritation over the mastoid, and tonics will often be of service; while quinine, salicylic acid, and other agents which excite tinnitus aurium should not be used. The patient should be kept away from noisy places, and avoid any exposure to loud sounds. It is well to cause such subjects, on going into the open air during convalescence, to wear cotton or wool in the external meatus, in order to protect their ears from the shock of noises. Not enough attention has been paid to the protection of inflamed or hyperæmic ears. Boiler-makers may protect their ears from the destructive hyperæmia caused by the concussions to which their work exposes them, by plugging the meatus; and telegraph-operators may suffer from an impairment of hearing induced by exposure to the continuous clicking of a telegraph instrument. In some cases the patient experiences great relief from the change of residence from near the noisy pavements of New York to the quiet of the sea-side; and where noise produces such a degree of irritation as was complained of in this case, we should carefully select a residence for the patient with a view to keeping him out of noise. In ophthalmic therapeutics a great deal of care is often necessary to protect the eyes from the light; and in acute aural disease, and perhaps in some form of chronic affections, the same care should be exercised lest the ears be exposed to loud or continuous sounds.

LIFE INSURANCE AND AURAL DISEASES.

It is well to mention briefly the diseases of the ear for which an applicant for life insurance would undoubtedly be rejected, and where the physician should advise him not to present himself for examination, until sufficient time has elapsed to cure the disease. Any ulcerative disease upon the auricle which is not a superficial skin lesion, or any tumor formation, or the presence of lupus; chronic purulent discharge from the tympanum, perforation of the drum-head, the presence of granulations or polypi, or cholesteatomata producing the characteristic gritty or cheesy discharge, disease of the temporal bone; all affections of the facial nerve, the presence of mastoid disease, or cases in which the mastoid disease has been active within a year, as well as operative mastoid cases—especially if there have been any cerebral symptoms—are conditions the result of which may be serious enough to cause an applicant's rejection; as well as cases of attacks of vertigo with impairment of hearing.

DEAF-MUTEISM—MECHANICAL ASSISTANCES TO THE HEARING.

CHAPTER XVII.

DEAF-MUTEISM—MECHANICAL ASSISTANCES TO THE HEARING.

There is no logical reason for the discussion of deaf-muteism in a treatise upon the diseases of the ear, as a subject apart by itself, any more than there is for the consideration of blindness in a work upon the eye. But long-established custom among writers on Otology renders it proper that some attention should be given to this important theme in a text-book. We shall, however, say nothing upon the methods of instruction of deaf-mutes but refer our readers to the appropriate treatises and authorities for knowledge on this subject.

Deaf-muteism is caused by diseases of the middle and internal ears. In the latter case the primary disease may be in the cerebrum. These diseases are of various kinds, and have been fully discussed in the preceding chapters of this work. The only reason that deaf persons become mutes is that the disease of the ear occurs either before birth, or so shortly after, that its victim is unable to learn to imitate speech. There are no changes in the larynx that prevent deaf-mutes from articulating distinctly, except those that may possibly come from disuse of the organ.

Persons who become completely deaf later in life, do not lose the power of speech; but they usually speak in an unnatural tone, because they are unable to hear their own voice with distinctness. Deaf-mutes may be divided into two great classes.

1. The acquired cases, or those in whom the disease of the ear has occurred after birth, from some traceable cause.

2. The congenital cases.

It is very difficult to come to a correct conclusion as to the relative frequency of congenital and acquired deaf-muteism. The tables that are made up by the directors of schools for the deaf and dumb are not trustworthy, because they are taken from the statements of persons who are seldom exact observers—the parents or friends of the children. The late Dr. George M. Beard and Roosa [1] examined two hundred and ninety-six cases of deaf-muteism, with their histories, in the schools of New York City, and Hartford, Conn., and the result of these examinations showed that about sixty-one per cent of these cases were probably congenital, and the remaining thirty-nine per cent were acquired. The exact truth as to the time when the deafness occurred is something very difficult to ascertain. It is not easy to learn, even when great pains are taken by persons well competent to observe, whether a very young infant hears well or not, although we may easily satisfy ourselves whether or not loud sounds are perceived.

Children appear to be conscious of sounds during the first days of their life, while at the third month they show an appreciation of particular sounds, such as chirping, whistling, and the like. From the end of the first month to the third is perhaps the earliest period at

[1] *American Journal of the Medical Sciences*, vol. liii., p. 401.

whch an opinion can be formed as to the hearing of an infant. On inquiry among mothers, it is found that their opinions vary upon this point. Some affirm that they can decide whether their children have good hearing within a few days of their birth, while others say that a month or two is required. Infants seem to hear sounds conducted through solid media almost immediately; that is, within a few days after birth, while hearing the tones through the air appears much later. They will very soon notice a jar, such as a stamp on the floor, while for the human voice time is needed. Moreover, an inflammation of the ear, if not of the suppurative variety, may run its entire course in a young child, and never be recognized by a physician or friends as a case of aural disease. It is well known, and the fact has been before alluded to in this volume, that a suppurative inflammation of the middle ear, in an infant, is sometimes first recognized as such when the pus breaks through the membrana tympani. The fact that such severe processes may go on in the ears of children, and escape recognition, renders it very probable that even sixty per cent is too low a percentage of acquired cases of deaf-muteism.

It does not require absolute deafness in a young child to produce deaf-muteism. A case of chronic aural catarrh, that would only inconvenience a grown person, will make an infant so stupid that it will soon cease to attempt to imitate speech. We have all grades of hearing power in so-called deaf-mutes. Roosa and Beard saw cases of children being educated in what are called Deaf and Dumb Asylums, who could actually hear words spoken directly into the auditory meatus. In one case the parents found it too much trouble—inasmuch as no physician could be found who would treat the suppurative ear—to teach their child to speak. He was consequently losing his speech, and also having his life placed in peril by the neglect of the disease of his ears.

Some schools for the deaf-mutes in this country are not attended by physicians competent to examine and treat the ear. Many of the inmates require constant and special care of their ears; especially is this true of those affected with suppuration of the ears, of whom there are about twenty per cent in the asylums. A certain and valuable degree of hearing might be obtained in a few of these cases by intelligent local treatment.

LIP READING.

Deaf-mutes should be taught to speak by imitation of the lips of the speaker. The sign language has been for so many years the means of educating deaf-mutes in this country, that lip training has not yet obtained its proper place with us; but it is fast winning it. The next generation will exhibit many more deaf-mutes who can converse with any member of society, and who will not be limited to the comparatively few who know the language of signs.

CAUSES.

The causes of deaf-muteism as set down in the reports of deaf and dumb asylums, are usually incorrect. Thus, "colic," "a burn," "a fall," "fits," "mother marked,"[1] etc., figure in such tables as causes of deaf-muteism. Many of the so-called facts in such

[1] Reprint from *Boston Medical and Surgical Journal.*

tables have been derived from unscientific observers, who sometimes have very positive opinions as to the causes of disease, and who believe that in a severe fright to the mother, the marriage of cousins, and so forth, ample causes are found for deaf-muteism. The investigation of the proximate causes of deaf-muteism show, as has been said, that their victims have become deaf from precisely the same kinds of diseases, and in about the same proportion, as obtains in impairment of hearing or deafness occurring at a time of life that prevents the subjects from becoming dumb as well as deaf. Of the 296 cases examined by Dr. Beard and Dr. Roosa, in only twenty-two cases was the drum-head found to be normal, and in 200, or more than two-thirds of the whole number examined, there was chronic pharyngitis or tonsillitis and adenoids. Of the 114 acquired cases, the membrana tympani was perforated in 29 cases. Thus, suppurative inflammation does not seem to cause as large a proportion of deaf-muteism as is usually supposed. In some of the cases, however, the membrana tympani had once been perforated and had healed. In Blake's statistics,[1] forty per cent. of those examined, 41 in number, were classed by him as acquired cases. In 12 of these acquired cases the membrana tympani was perforated or destroyed on one or both sides. In 13 of the 17 cases, the deafness was traceable to the pharyngitis of scarlet fever or measles.

It is an open question, perhaps, whether intermarriage tends to produce disease of the ear in young subjects or not, whether it tends to lead to arrested development in young children; for there is no doubt that some cases of congenital deafness depend upon want of proper development of the auditory nerve and labyrinth. It was said at the Hartford Institute for Deaf and Dumb that a certain part of our country, which is somewhat isolated from the other parts of the Union, and where intermarriages are the rule, furnished a proportionately large contingent of cases of congenital deaf-muteism. The cases from this district were in persons somewhat deficient in intellect, and we may consider their etiology as identical with that of idiocy, feeble brains, or partial development of other parts of the body, such, for example, as spina bifidis, coloboma iridis, and so forth. It is not probable that deaf-mute parents are likely to beget children who do not hear, for the simple reason that in the large proportion of cases, the deafness depends upon inflammatory action, which is not transmitted, except possibly as a tendency or by anatomical conditions. Deafness dependent upon imperfect development of the ear or brain may be inherited.

The causes of deaf-muteism, as developed in clinic histories and in examinations on the dead subjects, are as follows:

1. Infection of the middle ear, resulting in suppuration, or adhesion with anchylosis of the ossicula auditus.
2. Infection of the nerve or labyrinth, resulting in suppuration or thickening and deposits in the membranous labyrinth.
3. Arrested development, or absence of some parts of the essential parts of the auditory apparatus.

Treatment:—There is no peculiar treatment necessary for the deafness of young children, which renders them mute, because they cannot learn to imitate speech; but we may say that attention should be directed to the ulcerated membrana tympani, and the inflamed throats of the poor mutes who suffer from chronic suppuration and catarrh of the middle ear. Although the educational wants of deaf-mutes are now well attended to, their medical treatment is still neglected in the asylums and schools of our country, as well as at their homes. It was not until the seventh century that the deaf-mutes were thought worthy of an education. The twentieth century has arrived and every school or asylum for these unfortunates has not yet in attendance a physician who knows how to examine and treat a diseased ear. These schools are not hospitals, it is true, but there is always in them quite a large proportion of young patients who still suffer from a disease which although it has fully destroyed the hearing, is not yet stayed, and which often goes on to destroy life. This reference is particularly to the suppurative forms of disease.

According to the census of 1900 there were in the United States 40,592 deaf mutes. Of these we may believe that fifty per cent belong to the acquired cases.

Since the use of the tuning-fork has come to play such an important part in aural diagnosis, it has been made available also in the examination of deaf-mutes. De Rossi,[1] of Rome, has made the most complete examinations as to the hearing power of deaf-mutes. He examined seventy individuals with the speaking-tube

[1] The tables giving a detailed account of the appearances in the ears of deaf-mutes in the New York and Hartford Institutions examined by Roosa and the late George M. Beard may be found in the seventh and last edition of Roosa's work on the Ear and in the *Archives of Otology*, March, 1884.

and tuning fork. Twenty-seven heard the voice, four the watch, thirty-nine the tuning-fork vibrating in the air. Nearly all of the seventy perceived the vibrations through the bones, eleven only had no perception by bone-conduction, and De Rossi found only three cases of what he termed total deafness. These examinations of De Rossi furnish more reliable data than the cases of Toynbee and Kramer, and chiefly because the examination by the tuning-fork and speaking-tube was not made by them.

In their first tables, Roosa and Beard classified sixty-one per cent as congenital cases. Hartmann's tables show that of 8404 deaf-mutes 5546, or more than sixty-five per cent, were considered as congenital cases. His statistics are apparently made up largely of official and not personal examinations; for in the examinations made in Berlin by Hartmann himself, one hundred and eighty-five in number, only forty-five are classified as congenital cases; and those made by Cohn, in Breslau, show about the same proportion—that is, of one hundred and thirty deaf-mutes, fifty-seven are said to have been born deaf, while in other parts of Germany, and in Ireland, the proportion of congenital cases is much larger. The official tables of all countries are valueless, except as to the total number of deaf-mutes. Those who collect them are usually entirely incompetent for the sifting of evidence necessary to get even approximate truth upon this point.

RESULTS OF THE EXAMINATION WITH THE TUNING-FORK C^2 OF ONE HUNDRED AND FORTY-SEVEN DEAF-MUTES.

There was no aerial conduction on either side, while bone conduction existed in..	74
Bone conduction on one side, both bone and aerial on the other, in....	1

No bone or aerial conduction on one side, bone conduction on the other	10
Bone and aerial conduction, both sides	7
Bone and aerial conduction on one side, bone on the other	13
Neither bone nor aerial conduction on either side	12
No bone or aerial conduction on one side, both bone and aerial on the other	1
	118

In twenty-nine cases the subjects were too young or were otherwise incapacitated for intelligent answers; hence no conclusions could be formed, except that the large majority of them probably heard the tuning-fork by bone conduction. The tuning-fork is a very important means of determining the seat of the lesion, in cases of impairment of the hearing in which muteism does not result.

ONE HUNDRED AND FORTY-SEVEN CASES OF DEAF-MUTEISM (CAUSES STATED BY PARENT OR GUARDIAN.)

Born deaf	44
Cerebro-spinal meningitis	27
Scarlet Fever	16
Brain Fever	13
Meningitis	4
Measles	7
Fall on head	7
Unknown	7
Convulsions	4
Hydrocephalus	3
Fever	3
Whooping Cough	2
Spinal trouble	1
Mumps	2
Pneumonia	2
Gastric Fever	1
Cholera Infantum	1

Intermittent Fever	1
Syphilis	1
Varioloid	1
	147

In regard to this table it may be said that it is as reliable as any that it seems possible to get from any institution. As far as the statements as to scarlet fever, measles, cerebro-spinal meningitis, meningitis, mumps, and syphilis go, it may be considered trustworthy. When we enter the domain of congenital deafness or such causes as "spinal trouble," "fall on head," "convulsions," there is great uncertainty as to the actual cause. Yet these causes are taken from blanks carefully filled out by the parent or guardians, many of them very intelligent people of the higher walks of life.

TUNING-FORK TEST.

Sound Perception:

Both aerial and bone conduction	4
Bone only	2
Bone both sides, aerial on one side	3
Bone and aerial on one side, neither on the other	1
Neither bone nor aerial on either side	8
Unreliable	4
	16

A study of the cases of deaf-mutes especially with reference to the conduction of sounds to the ears or auditory centres through bone, indicates that a large percentage of deaf-mutes lose their hearing from disease of the middle ear, and that the acoustic nerve is still capable of appreciating sound. It will be observed, the subject of examination often states that he or she "feels" it. It may be stated that to *feel* the vibrations of the tuning fork is not to *hear* them. In most instances, if not all, this perception is actually a perception of sound. A little thought as to what sound is will substantiate this view. A small contingent who did not respond in any way to the vibrations of the fork were found. In this small contingent the functions of the nerve were probably destroyed. It is natural to suppose that about the same proportion of infants and very young children would suffer a lesion of the middle rather than the internal ear, in case the organ is attacked by disease, as would be the case in adults, and this seems to be indicated by these tables.

It is interesting to notice that a larger number of the cases are attributed to cerebro-spinal meningitis, than to any one cause. There were 27 cases of this kind to 16 of scarlet fever. "Brain fever" or meningitis plays an important part in the etiology, for there were 17 cases among the total number of 147.

In the examinations made by Beard and Roosa, a large percentage of cases was caused by suppuration in the middle ear from scarlet fever. We are without means of successfully treating an inflammation of the internal ear, when it occurs in the course of cerebro-spinal meningitis. The inflammation of the membranous labyrinth, which is mistaken for this disease, is as yet not at all recognized by the profession at large.

The observations of Mr. Lawson Tait[1] upon the congenital deafness of white cats have an interesting bearing upon the situation of the lesion in deaf-mutes. Mr.

[1] *Nature*, December 13, 1883, and Jan. 10, 1884.

Tait says of a cat that lived in his house for eleven years, that he was deaf to impressions conveyed through the air, "but his intelligence could be reached by impressions conveyed through solid media." When he was wanted, he would respond to a peculiar stamp on the floor. After this interesting statement, Mr. Tait passes out of the region of facts, to state that "human deaf-mutes are those in whom deafness is cochlear as well as tympanic." He concludes that cats are not mutes because their deafness has a tympanic origin. But human mutes emit sounds of various kinds as well as animals who are deaf. The origin of the muteness is to be found in the non-ability of hearing and not in the situation of the lesion that causes the deafness. The postmortem investigation of Mr. Tait's cat was most interesting. It was made by Drs. Cumberbatch and Dr. Gibbs. *All the structures in the ear were found to be normal, save the tympanic membranes,* "in which there were triangular gaps extending from the roof to just below the centre, the bases of the gaps being directed upward, and the anterior sides being formed by the handle of the mallei. The gaps appeared to be congenital and were quite symmetrical." All the other parts of the ear were normal. The auditory nerves were of normal size and structure.

MECHANICAL APPARATUS FOR ASSISTING THE HEARING.

The hearing-trumpet in one of its various forms remains as yet the best means, in the greater number of cases, of increasing the hearing power of conversation. The audiphone is of equal value in some cases, and is preferred by those who are able to use it. It is more easily held, and less conspicuous. No one is benefited by a hearing-trumpet or audiphone, unless the loss of hearing be due to disease of the middle ear, or to want of power over the tympanic muscles and acoustic nerve changes occurring in old age, *presbykousis*. As yet, hearing-trumpets and the audiphones must be carefully tested by the patient himself before it can be certainly known that he will be materially assisted by them. Many patients speak of the fatigue of listening with a hearing-

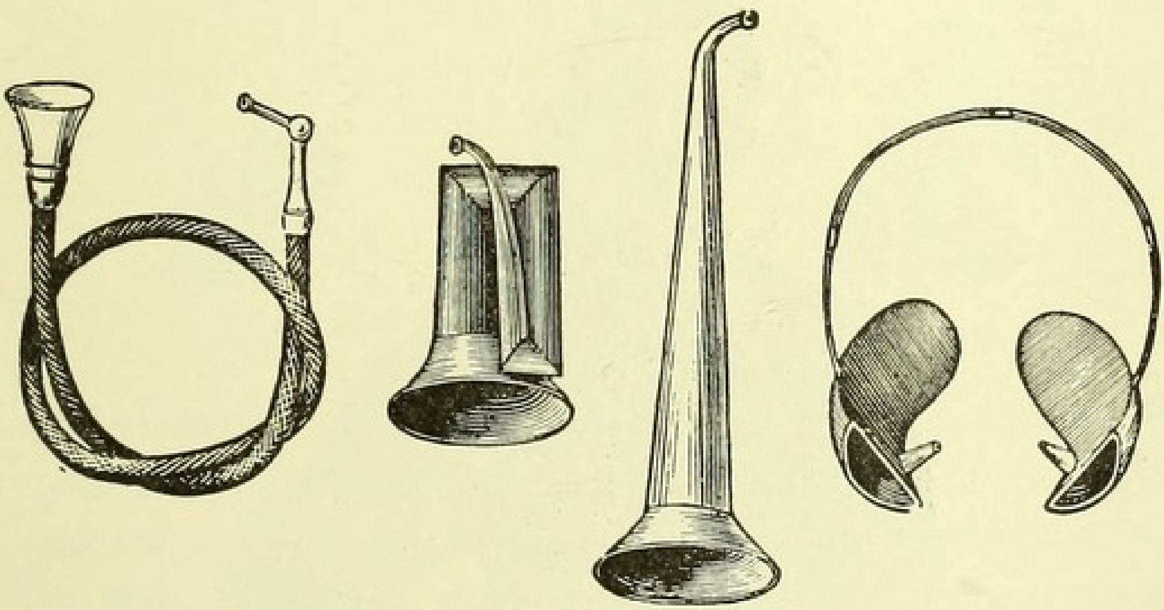


Fig. 106.—Various Forms of Hearing Trumpets.

trumpet, while others never seem to experience any such sensation.

The accompanying figures give a fair idea of the general form of the most useful hearing-trumpets, and of the audiphone.

Politzer invented a small instrument in the form of a hunting horn, whose narrower inner end is placed in the meatus, while its outer and broader parts lie on the auricle, so that its opening is directed straight back against the concha. Politzer states that the principle of his instrument is based on the physiological fact that sound acting on the ear is heard more loudly when the surface of the tragus is enlarged posteriorly by placing a small solid plate upon it.

THE ACOUPHONE.

Since the general use of the telephone, it has been observed by many people with impaired hearing that they are able to use the telephone with ease, although for

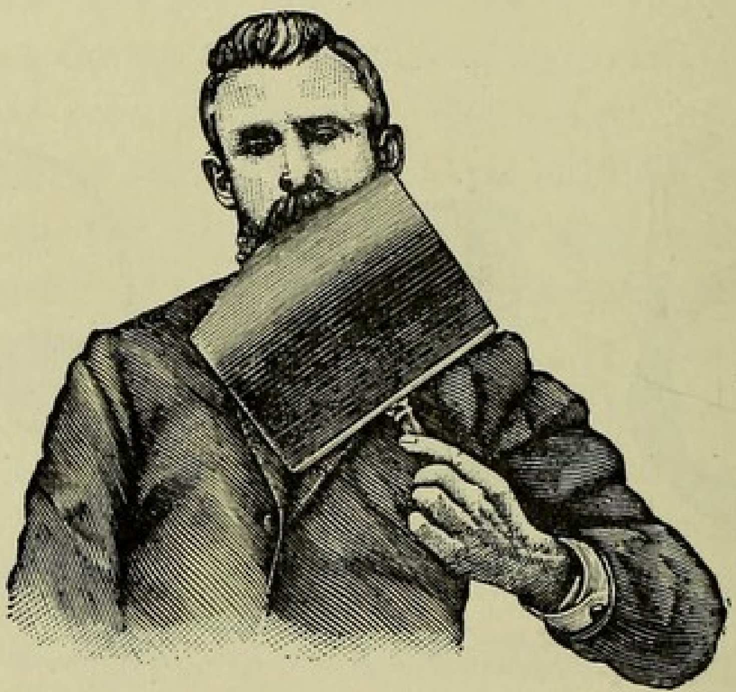


Fig. 107.—The Audiphone.

general conversation one or both ears may have been defective. The condition in which this occurs is always disease of the middle ear. When the affection is one of the acoustic nerve, there is no more ability to hear by means of the telephone than in ordinary conversation. The cause for the ability of those suffering from an affection of the middle ear to hear through the telephone, is probably to be found in an increased vibration of the membrana tympani caused by the instrument.

It is analogous to the state of things when a patient hears better in a noise, which was shown to be always dependent upon disease of the middle ear (Roosa). The acouphone is actually a kind of telephone, and the principle of its action is somewhat the same. The acouphone consists of an ear piece to be applied over the external meatus, and a tube a few feet long connected to an electric battery and terminating in sound receivers. The acouphone is by no means as generally useful as the

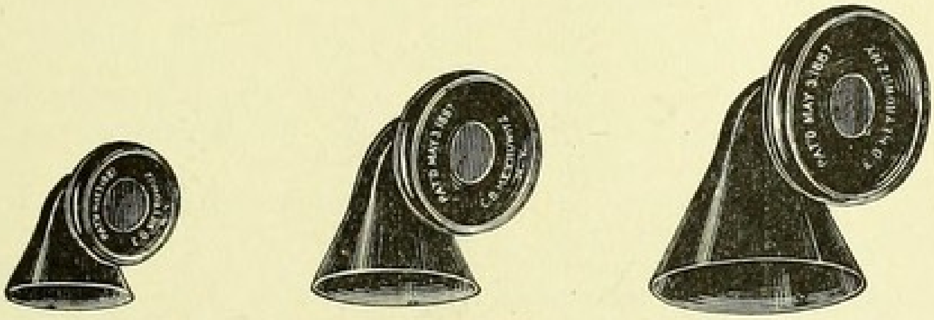


Fig. 108—Murphy's Hearing Trumpets.

telephone, for of a very limited number of patients with advanced disease of the middle ear, only a few are able to use the acouphone with any benefit to their hearing.

The acouphone for general conversation is placed upon a table, the patient seated at one end so that the sound receiver is turned toward the person or persons with whom he wishes to converse. No one should purchase an acouphone without making a careful trial of its assistance to them before doing so, for, as was said above, we are not able as yet to say in advance just to whom it will be of benefit. It is now being used in churches and lecture halls, with a view to assist persons in the audience who may suffer from impaired hearing. There is a future for such instruments constructed on the principle of the telephone.

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