Buck (A. H.)

DISEASES

OF THE

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Mastoid Process;

THEIR

DIAGNOSIS, PATHOLOGY, AND TREATMENT.

Presented by
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Box 1

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DISEASES OF THE MASTOID PROCESS; THEIR DIAGNOSIS, PATHOLOGY, AND TREATMENT.

By ALBERT H. BUCK, M.D.,

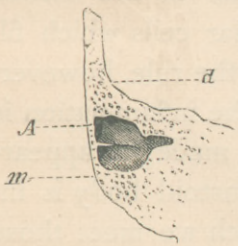
OF NEW YORK.

The bony prominence, lying behind the ear and known as the mastoid process of the temporal bone, may be the seat of various morbid processes. It is true that these are usually secondary to affections of the meatus or tympanic cavity, where the disease originates and from which it is propagated either to the fibrous covering of the bone or to the peculiar cells which fill its interior. This propagation is not the rule, however. In the far larger proportion of cases the inflammation is confined to the locality where it first made its appearance, and only in rarer cases the mastoid body is invaded. These are the cases in which we meet those groups of clinical phenomena which are usually known as mastoid diseases. As a rule we are not justified in giving a new name to morbid processes which are simply extensions of the same vital changes to different portions of the same tissue. In this instance, however, the ultimate pathological results give rise to special trains of symptoms which call for peculiar treatment, and therefore warrant us in regarding the diseases themselves as essentially separate.

Two important facts will attract our attention in re-

viewing the literature of this subject. It will be seen that in a large majority of instances *the disease was not appreciated* and that the *mortality has been very large.* Let us inquire into the causes of these two facts. The rarity of the affection cannot be urged by practitioners as a reason for their ignorance. I have good grounds for believing that such cases occur with tolerable frequency in ordinary practice: they certainly form a fair percentage of the cases which come under treatment at our infirmaries. Much of the fault must be laid to our ordinary text-books on surgery, even the most recent, for they either omit the subject entirely or dismiss it by a brief allusion to caries of the mastoid body as a disease of rare occurrence. We find some attention given to the subject in our text-books on otology and in monographs, but much still remains buried in obscurity.

FIG. 1.



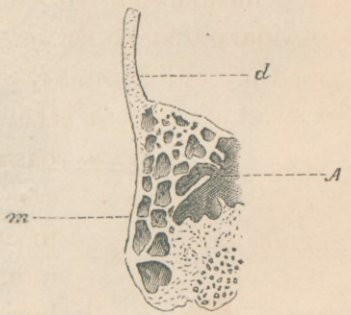
A vertical transverse section through mastoid portion of an infantile temporal bone.
d = dura mater.
A = antrum.
m = rudimentary mastoid process. (Natural size.)

The following article will aim to show the course of the diseases through their various stages. A sufficient number of cases will illustrate the points brought forward, and certain features will be noticed that will enable the ordinary practitioner to recognize the gravity of the affection at an early stage.

At birth the mastoid process consists of a small, flattened tuberosity, containing but one cell of considerable size—the antrum. (See Fig. 1.) At puberty there is a distinct prominence, conical in shape, whose apex

points downwards, and whose length, in some instances, may measure an inch and a quarter. (Figs. 3 and 5.) The substance of this bony prominence is formed of a number of small cavities, or cells, varying very greatly in size and shape. These cells communicate with one another, and are lined with an extension of the mucous membrane of the tympanum. Their mode of distribution and size vary so much in different individuals, that it is scarcely possible to give a description which will be true in even a majority of instances. The accompanying figures illustrate some of the most striking forms. In thickness the outer lamella of bone varies very materially in different individuals; at times being almost as thin as ordinary writing paper. At the posterior end of the tympanic cavity is the entrance to the mastoid vestibule, if I may so call it. This entrance, which is sometimes double, is rather narrow, and lies at a much higher level than the floor of the tympanum.

FIG. 2.



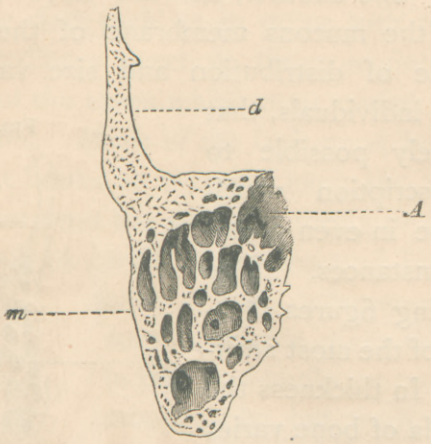
Mastoid process of a child (æt. circa 5). Same section and lettering as in Fig. 1. (Natural size.)

In the adult the vestibule, or antrum (horizontal portion of the mastoid cells, Toynbee) is placed much nearer the dura mater and the lateral sinus than the outer surface of the bone.

It is an irregularly-shaped cavity, oblong in its antero-posterior diameter, and having honey-combed walls.

with numerous ridges and intervening depressions, which lead to the surrounding cells. In adults the vestibule is just large enough to admit a small-sized pea, or sometimes a still larger body.

FIG. 3.



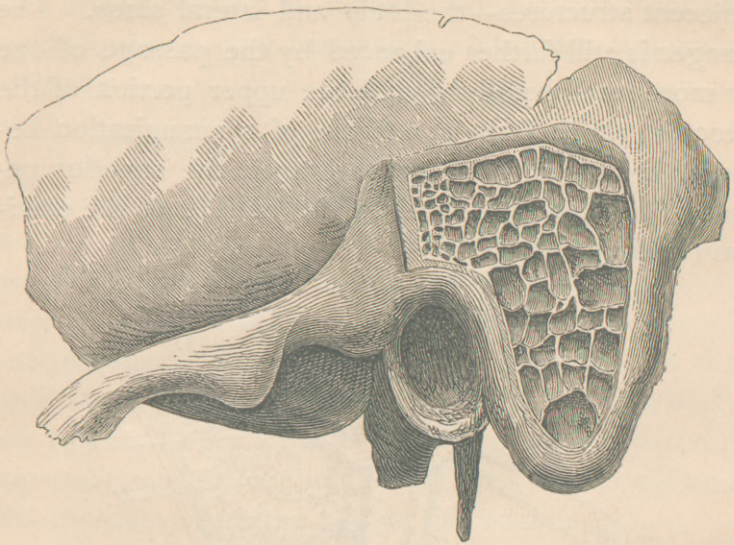
Mastoid process at puberty.
Same section and lettering as in Fig. 1. (Natural size.)

As a rule the cells are not confined merely to the mastoid process, but extend forwards over the external auditory canal, and upwards towards the parietal bone, to a still higher level than the canal. (Fig. 4.) In fact we may regard the entire mastoid system as a collection of bony cells, each one of which is lined with mucous membrane, and communicates with its neighbor by a narrow passage. They all have their final outlet into the middle ear through the antrum.

In no other part of the body do we find a mucous cavity so ill adapted to withstand the action of morbid processes.

In this respect the ethmoid, sphenoid, maxillary and frontal cells, which are the only similar structures, are much more favored. The reasons of this are apparent. The nasal cavity, into which they all open, has very

FIG. 4.



Mastoid process. External portion chiseled away to show how far the cells extend.

broad outlets and is rarely the seat of grave inflammation. The ethmoid and frontal cells have a further advantage: their outlets are at the most dependent portions of the cavities, so that gravity facilitates very materially the discharge of any accumulation. This is not true, however, of the antrum maxillare and sphenoid cavity, though in their case the danger of the extension of an inflammation to the brain is materially lessened by the circumstance that the point of least resistance is on the side toward the nostril, and not toward the brain. In the mastoid cells the reverse is true: their natural

outlets are so small that under inflammatory action they may very readily become closed, and before the imprisoned pus can force its way through the outer table of the bone, the periosteum and thick integuments, there will be great danger of its involving one or both of the adjacent structures—the brain and lateral sinus. The danger is still further enhanced by the passage of one or more small veins through the upper portion of the process, which form a medium of communication between the lateral sinus or its branch, the superior petrosal sinus, and the veins on the outside of the cranium (Henle).

FIG. 5.

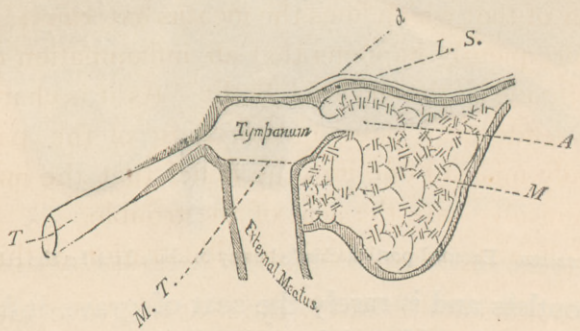


Diagram showing the relations of the dura mater, lateral sinus, external meatus and tympanum to the mastoid cells.

T = Eustachian tube. M = mastoid process.
M. T = membrana tympani. L. S. = location of the lateral sinus.
d = dura mater. A. = antrum.

Disease of the mastoid process may usually be *recognized* under the following forms:—

1. Inflammation of the external periosteum.
2. Simple congestion of the mucous membrane.
3. Congestion and filling up of the cells with a reddish, pulpy material.

4. Chronic subacute inflammation of the mucous membrane with sclerosis or hyperostosis.
5. Caries, with accumulation of pus, within the mastoid process.

The second, third, and fifth forms are simply the three different stages of an acute inflammation; yet for practical purposes it is better to regard them as separate varieties.

I. Inflammation of the External Periosteum.

This occurs as a concomitant symptom or phase of an acute inflammation of the external auditory canal. The periosteum of the mastoid process is a direct continuation of that which lines the meatus externus; hence it not infrequently happens that an inflammation of the latter extends to the mastoid body. As it is characterized by tenderness, pain, and swelling of the parts, it may easily mislead one into the belief that the mastoid cells themselves are the seat of the trouble.

The following case is a good illustration of this first form:—

Case I. (New York Eye and Ear Infirmary).—Sarah Golden, æt. 18, October 16, 1872. No ear trouble until about a week ago, when she began to suffer from a roaring in the left ear, followed shortly by pain, which gradually increased in severity, and extended to the mastoid region. No discharge. Watch heard at a distance of two inches. Outer orifice of the meatus almost closed by the congested and swollen condition of the parts. Beyond the constriction a hard mass of impacted cerumen was seen. The integuments covering the mastoid process were red, swollen, and tender to the touch. Patient evidently in great suffering. The impacted mass was broken down piecemeal, by a probe, and removed with a delicate pair of bent forceps. The

deeper portion of the mass was found to rest against the membrana tympani.

All the unpleasant symptoms rapidly disappeared after the removal of the mass.

In these cases the treatment consists in allaying the inflammation of the meatus, after which the tenderness and pain behind the ear soon disappear of themselves. Sometimes the inflammation of the periosteum results in the formation of an abscess in the subcutaneous cellular tissue of the mastoid region without involving the subjacent bone to any appreciable extent. In such cases the indication is to afford a free outlet to the pus by a suitable incision. The following case illustrates this point:—

Case II. (New York Eye and Ear Infirmary).—March 27, 1872. Benjamin Curtin, æt. 24, a robust, powerfully-built man, was taken with a severe earache and tinnitus nine days ago. No discharge until two days ago. Removal of pus from the meatus brought into view a small mass of granulations, springing from the lower wall, about at the junction of the cartilaginous with the osseous portion. By the aid of a curved probe it was ascertained that these granulations concealed the entrance to a sinus, which led downwards and backwards a distance of three-quarters of an inch. No exposed bone could be felt. The integuments over the mastoid process were red, swollen, and tender to the touch. Membrana tympani red and swollen, but not perforated.

Valsalva's experiment caused pus to escape from the opening in the lower wall of the meatus. Membrana tympani punctured, and pus driven out through the incision by means of Politzer's inflation. Leeches also applied to mastoid region. April 3. Swelling behind the ear is more prominent, and extends much lower downwards. A free incision gave escape to about two ounces of healthy pus. A careful exploration revealed the fact that the bone was still covered at all points by periosteum. From this time the recovery was rapid.

As a point of interest in differential diagnosis it will be well to mention here that a small gland is sometimes found lying directly upon the mastoid process. In certain affections of the middle ear and external auditory canal, this gland becomes painful, swollen, and tender to the touch, and may lead the surgeon to suspect mastoid disease. A few applications of the tincture of iodine usually suffice to dispel the pain and swelling.

II. Simple Congestion of the Mucous Membrane.

The second form may be observed, in a very slight degree, in many cases of acute inflammation of the middle ear. In these cases the patients direct the surgeon's attention to the deeper parts of the ear, and rarely to the mastoid region. In a few cases, however, the trouble is referred chiefly to the mastoid process. These are the cases which may be classified under the head of simple congestion of the mastoid mucous membrane. The following examples will illustrate the prominent clinical features of this form of disease :—

Case III.—Mrs. ....., æt. circa 30, of excellent health, after exposure during house-cleaning on the 1st of May, 1872, began to suffer from sore throat, slight deafness, and pain in the right ear. The pain soon extended to the parts behind the ear, and gradually increased in severity, robbing her of her sleep. On the 6th of May I saw her for the first time, and found the ear in the following condition :—The external auditory canal normal; the membrana tympani red and swollen, though entire; the Eustachian tube closed to Politzer; very marked tenderness on pressure, and some redness of the skin over the mastoid process. Upper portion of pharynx moderately congested. Watch heard when pressed against the ear. Four leeches applied over the mastoid process gave great relief. May 9th. Pain and tenderness

entirely gone. A solution of nitrate of silver (℥j—℥j aquæ) applied to the still swollen membrana tympani. May 13. No return of the pain. Swelling of the membrana tympani diminishing. Watch heard at a distance of half an inch. She subsequently had no return of the pain in that ear, and the improvement in hearing was steady and marked.

On the 8th of the following November I was consulted again for a very similar attack in the left ear. The history given was that about the 1st of November she was attacked with a severe pain behind the ear, accompanied by tenderness on pressure, and a little swelling. The application of six leeches to the affected part relieved these symptoms entirely, but on the previous night the pain returned with considerable severity. On examination I found the left membrana tympani sunken, but not congested. Watch heard at a distance of three feet. There was tenderness over the mastoid process, and some œdematous swelling of the integuments. Six leeches applied behind the left ear afforded entire relief. Since this time there has been no recurrence of the trouble.

Case IV.—(N. Y. Eye and Ear Infirmary.)—Mary A. Hanley, æt. 32, in robust health, was attacked with an influenza on the 9th of November, 1872. She had more or less fever, and a constant catarrh of the eyes and nose. On the 12th, the right ear became involved, the symptoms being moderate deafness, roaring and some pain. Watch heard at a distance of 6 inches. External auditory canal healthy. Membrana tympani dull, opaque and rather flatter than normal. The air during inflation entered the middle ear with a dry sound. Four leeches applied in front of the ear. Nov. 14. The leeches afforded only partial relief. Membrana tympani œdematous in appearance and somewhat convex outwardly. Nov. 15. Passed a bad night. The pain is again severe, and is referred by the patient to the entire side of the head. Tenderness on pressure over the mastoid process. The posterior wall of the external auditory canal has also become tender upon pressure. A free vertical incision through the posterior half of the membrane was followed by an oozing of bloody serum from the wound. By inflation of the middle ear through the Eustachian catheter the serum was made to escape in such quantity that it ran down over her

cheek. Nov. 16. Comparatively free from pain last night. The watery discharge continued through the night, as shown by the stains on the pillow. The tenderness has disappeared, and patient feels quite well again. No subsequent return of the pain.

If the pain should not yield to moderately active local blood-letting (leeching), an incision may be made over the mastoid process, down to and through the periosteum. If both of these means fail to relieve the patient's suffering, and especially if after the temporary relief, which leeches or an incision are pretty sure to afford, the pain returns with even renewed severity and extends backwards toward the occiput and upwards toward the vertex, we may then draw the inference that the disease has already passed into the third, or even the fifth form. As a rule, however, the measures here recommended prove sufficient to check the further progress of the inflammation.

IV. *Chronic subacute inflammation of the mucous membrane with sclerosis, or hyperostosis.*

While this form constitutes a distinct pathological condition, we are not yet in possession of sufficient clinical facts to guide us to a positive diagnosis.

Sclerosis or hyperostosis of the mastoid process, is associated with either chronic catarrhal, or chronic purulent inflammation of the middle ear. Its progress is so insidious and so rarely accompanied by any marked symptoms that it is only at the post-mortem examination, or when called upon to trephine the bone, that we discover the existence of this condition. As the very delicate membrane, which lines the mastoid cells,

serves the double function of mucous membrane, and periosteum to the intercellular bony septa, it will be readily understood how a chronic congestion of the membrane may result on the one hand in thickening of its substance, and on the other in hypertrophy of the bone which it nourishes. In place then of air-containing cavities, separated by thin septa of bone, we find a tolerably dense bony mass, whose substance is studded throughout with small collections of slightly vascular connective tissue. (Fig 6.) Where this condition of things is the result of a chronic purulent inflammation of the middle ear we shall often find that the antrum is the receptacle for a mass of cheesy material, produced by a retrograde metamorphosis of pus, epithelial cells and mucus. Such masses have sometimes been found in the cavity of the tympanum, where the perforation in the membrane was small, or in one of the upper segments. This material probably owes its existence to the fact that the fluid elements of the discharge find an escape through the small outlet, while the solid portions remain behind and gradually accumulate until they form a solid mass, which entirely fills the antrum. From the frequency with which such masses are found in fatal cases of caries of the mastoid process, I think we are justified in believing that their presence in the antrum is not unattended with danger to life. The carious process in these cases appears to originate in the antrum, and its further progress to be confined chiefly to the region lying between that cavity and the fossa sigmoidea. This may be explained by supposing that the pus, prevented by the cheesy mass from escaping through its

natural outlet, sought an escape through the bone in the direction of least resistance, viz., toward the lateral sinus, or the dura mater.

I know of no series of symptoms which will enable us to recognise this form of disease with certainty, though sometimes certain symptoms, like those narrated in case No. 5, should lead us to suspect its existence.

Dr. Hermann Knapp of this city gave me an instance of a case of this kind which came under his observation. Suspecting cheesy matter in the antrum, he introduced a curved probe (as first proposed by Toynbee, Med. Times and Gazette, March 16, 1861) and succeeded in dislodging and removing quite a large accumulation from that cavity. I proposed to make a similar attempt in the following case, in which sclerosis of the mastoid cells with cheesy accumulation in the antrum was suspected. The patient however did not consent.

Case V.—Mr. C., æt. 24, somewhat anæmic, but otherwise in good health, consulted me in March, 1872, for an otorrhœa of fifteen years standing. It had established itself as a sequela of scarlet fever and was accompanied by tinnitus and a dull steady pain, referred to the deeper parts of the ear. Various methods of treatment had been pursued, but the discharge had never materially diminished. An inspection of the ear showed the membrana tympani to have been entirely destroyed, the handle of the hammer resting against the promontory, the mucous membrane pale and very fibrous in appearance, and the posterior upper portion of the tympanic cavity filled with a small mass of granulations which seemed to grow from the entrance to the antrum. There was no tenderness over the mastoid process. The watch could be heard at a distance of 7 inches. A few applications of chromic acid were made, and the granulations shrank entirely out of sight behind the projecting angle of bone.

The subsequent treatment consisted in introducing a probe armed

with cotton, thoroughly cleansing and drying all the parts within reach, and then applying nitrate of silver in solution (the strength being gradually increased from twenty grains to a drachm to the ounce of water). At the expiration of two weeks the discharge was just as abundant as at the first. On the 29th of March, I substituted powdered alum for the silver solution, blowing it in with a suitable tube. The quantity used was just sufficient to form a thin layer over the exposed mucous membrane. On the 30th the patient reported that there had been almost no discharge since the last application. The alum was accordingly applied a second time, after all the remains of the first charge had been removed. This second application was followed in the course of an hour by dizziness, nausea and vomiting, and a throbbing sensation in the ear, without tinnitus. Objects appeared blurred before his eyes. Two hours afterwards he had a second similar attack, which compelled him to take to his bed. The dizziness and nausea continued then for nearly 48 hours, when the discharge reappeared, and he was again able to walk about.

In view of the long continuance of the discharge, of the constant, dull, deep-seated pain, of the presence of granulations which seemed to spring from the entrance to the antrum, and from the throbbing sensation which ensued, when that entrance became closed—as it doubtless did when the alum was applied—it appeared to me probable that the case was one of chronic purulent inflammation of the antrum, associated perhaps with a cheesy accumulation and sclerosis of the mastoid cells; and in this opinion I was confirmed by Dr. Hermann Knapp, who afterward saw the patient with me in consultation. Case No. 16 shows us that we may meet this form of disease in persons as young as Mr. C. ——.*

* Dr. J. L. Vandervoort of this city has given me the following details of a case which perhaps belongs more properly to this than to the first form:—A lady, æt.

III. *Congestion and filling up the of cells with a reddish, pulpy material.*

V. *Caries with accumulation of pus within the mastoid process.*

In very many cases the clinical features of these two forms coincide so closely that it is exceedingly difficult, if not impossible, to distinguish between them. It is only in certain well-marked cases, that we can say: in this case the disease has gone on to the formation of pus in the mastoid cells. The important point, however, is to diagnosticate whether the disease has reached either of these two stages, for if left to itself the third form will soon pass into the fifth and endanger the patient's life.

The following cases will illustrate these two forms of disease.

Case VI. (reported by Dr. Flaiz, in the Archiv für Ohrenheilkunde, vol. 2). The patient, a man 46 years of age, and previously in good health, was exposed to severe weather during the summer of 1864. Pain in both ears with deafness ensued. His physician sent him to the warm baths at Aargau, but at the end of three weeks he returned, having grown worse rather than better. On the 17th of September, 1864, Dr. Flaiz was called to see him. On examination he found the mastoid process of the left side very tender on pressure. The calibre of the external auditory canal was diminished, and filled with pus. The membrana tympani was invisible. Inflation of the middle ear revealed the existence of a perforation in the membrane. Ordered a cathartic and leeches to the left ear.

54, has an exostosis projecting from the central portion of the mastoid process. It is about the size of a nutmeg, hemispherical in shape, smooth and painless, and has existed for over 30 years. When 14 years old she had scarlet fever which left her with an otorrhœa that ceased only twelve months ago. The growth of the tumor was quite slow. It has remained at its present size for many years.

September 20th. No relief yet. Leeches to be repeated. 21st. A free incision over the mastoid process. This relieved the pain, and the wound was allowed to heal.

October 15th. Pain has returned. Fluctuating swelling over mastoid process. Incision and evacuation of half an ounce of pus. No roughness of bone detected. Pain relieved. Wound again allowed to heal. By degrees the pain returned with its former severity, and was referred chiefly to the left occipital and parietal region. October 26th. Patient delirious. Mastoid process perforated with a drill, no pus found. October 27th. Free discharge from the wound. From this time there was a steady amelioration in all the symptoms, and at the end of four weeks the patient was able to resume his work.

In this case we are not informed what the condition of the mastoid cells actually was. It should be remembered, however, that when an operation of this kind is performed, the facilities for making a minute examination into the condition of the bone are not usually at hand; the most we can do is to distinguish the red of the congested mucous membrane, the yellow of the pus, or the whitish hue of the sclerosed bone.

CASE VII. (N. Y. Eye and Ear Infirmary.)—Richard Murphy, æt. 11, phthisical in appearance, contracted about the 4th of September, 1872, a pain in the left ear, in consequence of exposure to cold. Two days later a discharge appeared, and from that time to this (September 11th) he has suffered from severe pain in the affected ear. To-day the discharge ceased. Patient appears to be in great suffering. Pulse 108 and feeble. Tenderness and œdema over the left mastoid process. The external meatus closed by the swelling of its walls. Valsalva's experiment caused dizziness, and retching. The patient being under the influence of ether, an incision was made through the integuments of the mastoid process. The surface of the bone was found to be normal in appearance and consistency. The outer shell of bone was then perforated with a conical drill, which exposed to view the mastoid

cells at a depth of less than two lines. These were found to be highly congested, and the thin bony septa readily broke down under the pressure of the steel director. No pus was found. A small tent was introduced into the wound, and a poultice applied to the parts. Milk and beef-tea diet. Decubitus. September 12th. Pain is gone, but he is unable to keep anything on his stomach. The discharge from the meatus has returned. Some erysipelatous swelling about the wound. Ordered lime water p. r. n.

Sept. 13.—Food retained. General condition decidedly better. Free discharge from the meatus. Wound granulating. No return of pain. Ord. simple dressing to wound, tent to be left out and poultices omitted; also to take quin. sulph. gr. i. t. i. d. and solid food. Sept. 14. Erysipelatous blush is fading away. Sept. 16. Continued improvement. Is now able to leave the house. Sept. 18. A free discharge both from the meatus and from the wound. Ord. iron and cinchona to be substituted for the quinine. Sept. 21. Entire freedom from pain since the operation. His general condition, however, is not so good as when he last visited me three days since. Night-sweats have set in.

Since the last note I have not heard from the boy, and am inclined to think, judging from his low condition, that he did not survive many weeks. The operation certainly gave great relief, but the subsequent copious discharge of purulent matter was too great a strain for a system burdened with phthisis, and he probably succumbed under both.

Case VIII.—Dr. A. P. W., of Chester, S. C., æt. 56, of a strong constitution, consulted me, Oct. 12, 1872, for a painful affection of the mastoid process. He gave the following history:—In 1835 he contracted an acute inflammation of the left middle ear from the bursting of a gun barrel. The severe symptoms soon passed off, but the purulent discharge continued for some time after. Since that time, however, the ear has not troubled him in any way, except that there has

been a moderate degree of deafness and some tinnitus. The perforation in the membrane has always persisted. About the middle of last July he noticed a slight serous discharge from the left ear, and felt a little pain in it. The pain became gradually more severe and was associated with headache and fever. The doctor bled himself to the extent of about sixteen ounces; six hours later he took from the arm an additional quantity of about eight ounces. A profuse suppuration from the ear soon took place and the pain then became tolerable. For a month no marked change occurred in the condition of the ear. The discharge continued, but at times it would almost stop. On the 23d of August he had a rigor, which was followed by a return of all the acute symptoms. The pain was referred to the base of the brain, the mastoid process and the articulation of the jaw. That night the pain, according to his own words, was frightful. Bleeding to the amount of twelve or fifteen ounces afforded some relief, and the discharge again became abundant. For a week the pain remained bearable. On the 31st of August he had another rigor, followed by intense pain, referred to the mastoid process, and thence backward toward the occiput and occipito-vertebral articulation; in fact the whole side of the head was painful. There was tenderness over the mastoid process and the auricle was pushed somewhat out from the head. On the 2d of September, Dr. Darby, Professor of Surgery in the University of Columbia, S. C., and Dr. Robinson, of Winsboro', were telegraphed for, but by the time they arrived the discharge was re-established, and the pain had moderated. The mastoid region, however, was still swollen and quite tender on pressure. On the 18th of September, no improvement having taken place in his condition, the doctor started for New York in the hope of obtaining relief there. The sea voyage from Charleston benefited him very decidedly. The severe symptoms abated, and for some time after reaching this city he enjoyed, at least during the day, comparative comfort; toward night, however, the old trouble returned with greater or less severity. During the few days preceding his visit to me he suffered acutely from pain in the ear.

On examination the meatus was found to be normal, the membrana tympani perforated anteriorly, the Eustachian tube freely open, and only a trace of pus in the middle ear. Mastoid region œdematous and tender on pressure. The tenderness also extends back toward

the occiput. General condition fair. Pulse a little over 90. No heat of skin. At a consultation with Professor James R. Wood and Dr. Hermann Knapp, it was deemed best to perforate the mastoid process. At the patient's own request the operation was performed without ether. The appearance of the bone, after the periosteum had been lifted aside, was entirely normal. The drill was applied on a level with the upper wall of the meatus, and made to penetrate to a depth of three-fifths of an inch without encountering mastoid cells. At this depth, however, a tolerably firm pad of connective tissue was felt. The supposition at the time was, that this mass filled the antrum, but on subsequent inspection I became persuaded that, owing to the thickness of the swollen integuments, and the recumbent position of the patient, I had erred somewhat in the direction which I gave to the drill, pointing it too far backwards. The pad of connective tissue was undoubtedly the outer wall of the lateral sinus.

October 13th.—Passed a pretty comfortable night. Pain much easier than before the operation. Ord. quinine gr. ij. t. i. d.

October 14th.—Pain again severe. Consultation with Drs. Robert F. Weir (Professor Wood out of town) and Hermann Knapp. A second perforation was made, this time nearer to the meatus and on a lower level than the first. Mastoid cells congested, but no pus present. Tent inserted; poultices. Oct. 15. Slight improvement. Appetite rather poor. Ord. tinct. ferri chlor. gtt. X with each dose of quinine. Oct. 16. Appetite better. Temperature 97°. Pain diminishing. Ord. carbolic acid dressings to wound, from which there is a free discharge.

October 17th.—Marked improvement in every respect. Poultices to be stopped.

October 23d.—Tenderness over mastoid process almost gone.

November 14th.—Feels quite well again. There is no discharge from the meatus, and the wound behind the ear has healed except at two points, corresponding to the two sinuses which lead to the perforations in the bone. To return to South Carolina.

A few weeks later I heard from the doctor that there had been no return of the pain, and that his general health was quite good again.

Case IX. (New York Eye and Ear Infirmary.)—Wm. B. Hillison, aet. 45, janitor, previously in good health. In August, 1872, he over-

heated himself, and then sat in a draught of cool air. A few hours later, he experienced severe shooting pains in the right ear, and a throbbing sensation in the mastoid region. The pain continued, with varying severity, for ten days. At the end of this time a discharge appeared, and was soon followed by relief from pain. Early in November the discharge ceased, and the pain again became severe. This time it was referred chiefly to the region behind the ear, and was accompanied by some tenderness and swelling of the parts. The swelling gradually increased, and on December 14th he reluctantly decided to seek medical advice. His physician, Dr. Chas. E. Laight, found the meatus swollen, and the mastoid region the seat of a pretty large swelling. A free incision liberated about an ounce of healthy pus. No denuded bone detected. Dec. 15. Pain relieved. A profuse sweat to-day. Dec. 16. Mastoid region again moderately painful. Wound healing by adhesion. Occasional pain in the right chest. Dec. 18. To-day I saw the patient for the first time, in consultation with Dr. Laight. The pain again severe. The countenance pale. Pulse 108, and feeble. Holds his head as if suffering from a stiff neck. The skin and subjacent tissues over lower portion of mastoid process, and extending at least two inches below it, are soldered by inflammation into a single, flattened, hard mass, red on the surface. Tenderness on pressure, extending up toward squamous portion of temporal bone. Meatus very much swollen, and filled with fetid pus. A small mass of granulations on posterior superior wall of meatus, just beyond the junction of the cartilaginous with the osseous portion. From this point a sinus leads to bare bone, as ascertained by probe. Deeper parts not recognizable. Perforation of the bone advised, and patient recommended to enter the New York Eye and Ear Infirmary. The operation was performed the same afternoon by Dr. Laight. The perforation was made with a drill, which was applied at a point half an inch behind the meatus, a little below the level of the upper wall, and was directed inwards, decidedly forwards, and a little upwards. The instrument first encountered cell-structure at a depth of three-fifths of an inch. No pus. Ordered decubitus, poultices, generous diet, iron and quinine, and sherry wine, ℥ vj. daily.

Dec. 19. Almost entire relief from pain. Pulse 90, and stronger than yesterday. Meatus still swollen. Takes food well. C. T.

Dec. 20. Free discharge from the wound and from the meatus. Steady improvement. The wound and the meatus both to be syringed frequently with a weak solution of carbolic acid.

Jan. 18. The wound has entirely healed except at one point, where a small sinus leads to the perforation in the bone. The sinus in the meatus has also closed. Since the 8th of January there has been no discharge from the meatus. A small perforation still present in the membrana tympani. General condition greatly improved. No return of pain since the operation. Jan. 29. Patient is to-day discharged cured.

Case X. (N. Y. Eye and Ear Infirmary.)—Mrs. Kate Ryan, æt. 36, with syphilitic destruction of the bones of the nose, but otherwise in good health, consulted me January 15th, 1873, for a painful affection of the right ear. She stated that a week previously she was attacked during the night with a severe pain and roaring in the ear. She had always been hard of hearing in that ear, but could not recollect ever to have had a discharge from it. In the course of twenty-four hours she obtained some relief by the sudden giving way of something in the ear and the appearance of a discharge at the outer orifice. Soon, however, the pain returned and gradually became almost intolerable. It extended over the entire side of the head and was accompanied by soreness in front of and behind the ear. No head symptoms.

On examination I found the external auditory canal closed by an œdematous swelling of its walls. Membrana tympani perforated but invisible. Tenderness on pressure over mastoid region; moderate œdema. Tongue coated. Appetite poor. Pulse 90 and of fair strength. No appreciable heat of skin. Incision of the mastoid integuments.

January 16. No relief from the incision. Pulse 104 and feeble. She is evidently in much suffering. Consultation with Dr. Robert F. Weir. Perforation of the mastoid process advised. As the patient preferred to bear the pain, the operation was performed without anæsthesia. The bone was perforated with the larger of the two drills (Fig. 7) to a depth of half an inch, without encountering pus. The cells were few in number, and separated by strong septa. The outer surface of the bone appeared to be perfectly normal. Treatment:—introduction of a tent into the opening in the bone, poultices every four hours, iron and

quinine, and moderate stimulation. January 17. Decidedly better in every respect. Pain moderate. Pulse 88. Takes nourishment well. The meatus and the wound to be syringed every four hours with a warm, weak solution of carbolic acid.

January 22. Continued improvement. Wound granulating. Occasional shooting pains. C. T.

January 29. Entire freedom from pain in the right ear. Wound rapidly filling up with healthy granulations. Almost no discharge from the meatus. Three days ago, without any apparent cause, the left ear became acutely inflamed. Incision of membrana tympani afforded an outlet to the pus. Relief from the pain. February 8. Steady improvement. Left ear free from pain.

February 13. No discharge from the right ear since the 10th. A thin cicatricial depression indicates the location of the former perforation in the membrana tympani. Outer wound entirely healed except at one small spot which is still covered by a scab.

CASE XI. (Reported by Von Troeltsch in Virchow's Archives. Vol. XXI., p. 296.)—A girl, æt. 16, while in good health, was attacked with scarlet fever. On the second day after the appearance of the eruption she began to suffer pain in both ears. The pain increased until the fifth day, when a discharge appeared. Subsequent decrease of pain, but at no time entire freedom from it. Constant discharge. When first seen (March 24, 1858) the patient complained of pain in and behind both ears. There was no fever. Tenderness on pressure over both mastoid processes. On the right side, redness and a diffuse swelling behind the ear. Meatus swollen. Membrana tympani perforated. Watch heard only when pressed against the ear. Ordered injections of warm water into both ears four times daily.

March 30. Swelling behind the right ear increased in size. Pain severe. A free incision over mastoid process gave temporary relief.

April 1. Pain again severe.

April 3. A small opening found in the bone. This was enlarged by using moderate force with a buttoned probe. No appearance of pus until a few hours later.

April 4. Pain entirely gone. General condition much improved. By syringing a communication was found to exist between the external fistulous opening and the cavity of the meatus. About the middle of

June the discharge ceased on the right side. External wound nearly closed.

A year and a half later she died of phthisis pulmonalis. At the post-mortem examination the cells of the right mastoid process were found to be very small and in part filled with a semi-gelatinous material.

Case XII.—April 8, 1871, I was called to see Mrs. Peter Green (colored), æt. 47, and of strong constitution. The story was that on the preceding Christmas she had been attacked with severe pain in the right ear, followed soon after by a purulent discharge. Eight days previously, the discharge having almost ceased, she had again suffered from a severe earache, sleeplessness, occasional vomiting and at times incoherence of speech. At the time of my visit she appeared to be in great suffering. Pulse 104 and rather feeble. No heat of skin. Pus escapes through the Eustachian tube into the pharynx. Marked tenderness over the mastoid process. The external auditory canal closed by the swelling of its walls. A free incision over the mastoid process and warm fomentations. April 9.—Last night, soon after the operation, the discharge re-appeared.

April 18. Comparative freedom from pain since the last note. To-day I discovered a mass of granulations springing from the upper and posterior wall of the meatus, a little beyond the junction of the cartilaginous with the osseous portion. May 25. Occasional attacks of pain. June 5th. Another severe attack of pain last night. Motion of the jaws painful. Mastoid process tender on pressure. Ordered two leeches to the part. June 6. Some relief from the leeches. June 15. Since the last note the pain has been steadily growing worse. Leeches have been applied from time to time, but with only temporary relief. To-day there has been some nausea after meals. June 16. A sinus discovered leading from the mass of granulations mentioned above to the mastoid cells. Consultation with Dr. Robert F. Weir. Perforation of the mastoid process advised. The patient being under the influence of ether, an incision was made exposing to view the surface of the right mastoid process. The lower part of the process appeared to be softer than natural. The bone was perforated with a small drill, and the opening afterwards enlarged by means of a small gouge. No pus found. Mastoid cells congested. Two probes intro-

duced into the mastoid process, the one through the sinus, the other through the newly made opening, were found to meet.

From this time there was a rapid improvement in all the symptoms. Her general health, which had suffered materially by the prolonged sickness, soon regained its usual standard. On the 27th of July I was unable to find any trace of the fistulous opening in the meatus, and the discharge had entirely ceased. No return of the pain at any time.

Nos. 6, 7, 8, 9 and 10 afford good illustrations of the third form of mastoid disease. Nos. 11 and 12, however, represent intermediate forms between the third and fifth. Von Troeltsch's (No. 11) appears to be the only case on record in which an opportunity was offered of making a post-mortem examination of the mastoid cells after recovery had taken place. Case No. 12 confirms strongly the view that the third form, when left to itself, passes directly into the fifth. The limited caries in that portion of the mastoid cells, which lies nearest to the external auditory canal, afforded too small and too remote an outlet for the gorged cells of the remaining portion; hence the relief was unappreciable. In the following case, however, death seems to have occurred directly from an extension of the inflammation to the lateral sinus, before any appreciable amount of pus had formed in the mastoid cells. As a rule the mastoid cells will be found to be filled with pus in the cases that terminate fatally.

Case XIII.—(Reported by Dr. Stokes in the British Medical Journal, Feb. 12, 1870.)—A fisherman, æt. 49, of powerful build and temperate habits, was admitted to the Meath Hospital, Jan. 12th, 1870. His history was that on the first day of the year he caught cold and began to suffer from headache. This finally became so severe that

he was obliged to stop work, and seek for relief at the hospital. By questioning him it was ascertained that whenever he caught cold he was subject to a fetid discharge from the right ear.

At the end of 24 hours the head symptoms became more pronounced. Low delirium. Fetid discharge from the ear. Profuse perspirations on this and the following days. On the 17th a sudden and extreme œdema of both eyelids. 20th. Constant delirium. Involuntary evacuation of urine. 22nd. Slight puffiness over the right mastoid process. Integuments incised, but no pus found. Death occurred on the 25th. Up to the last, but very little febrile disturbance.

At the post-mortem examination purulent basilar meningitis found; also superficial softening of antero-inferior portion of the right side of the cerebellum. Lungs free from purulent deposits. Membrana tympani destroyed. Mucous membrane of middle ear pulpy, vascular and bathed in pus. Mucous membrane of mastoid cells in the same condition. Lateral sinus completely obstructed by softening coagula. Purulent matter lay between the outer wall of the sinus and the bone. Same condition in superior and inferior petrosal sinuses.

"From the absence of any fetor, discoloration or softening of the bone, it appeared that the lesion which caused death was essentially not a caries, but a suppurative phlebitis of the sinuses of the skull, propagated through the cells of the mastoid bone, from the inflamed mucous membrane of the middle ear."

The change from the third to the fifth form probably takes place in the following manner:—The inter-cellular passages being closed, and the cells themselves filled with the swollen and congested mucous membrane, stasis follows in the local circulation, the bone becomes deprived of its nourishment, and the soft parts filling the cells break down into pus. The bony septa then either become dissolved, forming granular detritus, or separate as a connected whole from the surrounding healthy bone. The following cases afford good illustrations of the clinical features of this fifth form.

Case XIV.—(N. Y. Eye and Ear Infirmary.)—William McClusky, a resident of Orange, N. J., æt. 21, of a healthy constitution, consulted me Sept. 4th, 1872, for a painful affection of the mastoid process. He stated that in June he was seized with a severe pain in the ear after bathing. The pain continued for three or four days, and then stopped, leaving him quite deaf in the affected ear. At the expiration of two weeks a discharge appeared, and this had continued since until the 4th or 5th day previous to his visit to me. Shortly before the discharge stopped, he noticed some tenderness behind the affected ear. The pain, which for four days had been growing steadily worse, was referred to the mastoid region, whence it extended upwards and backwards to the parietal and occipital regions. Tinnitus. Appetite poor. Countenance pale. Watch heard at a distance of 4 inches on the affected side. The skin covering the mastoid process red and swollen. External auditory canal diminished in calibre by the falling forward of the posterior cutaneous wall. Membrana tympani invisible. Incision of the integuments covering mastoid process. Free escape of pus and blood. The periosteum was dissected up a short distance on either side and the underlying bone seemed healthy. The following day, Sept. 5th, while pressing pretty firmly against the bone with a steel director, it seemed to me that the point of the instrument met with less than the usual resistance. I then attempted to perforate the outer shell with a small steel drill, and in doing so suddenly exposed a large abscess which nearly filled the entire mastoid cavity. The opening was further enlarged with a conical drill until the little finger could be admitted, and the contents were then entirely evacuated. Tent inserted and patient allowed to return to his home where he said he could get further medical treatment. The incision of the integuments on the previous day had already greatly alleviated his sufferings.

On the 14th of November following he wrote:—"The pain never returned since you performed the operation, and the wound healed inside of ten days. I went to a doctor to have it dressed, but he refused to have anything to do with it, and said that it was a very dangerous operation, and might have killed me; so I went to a friend of mine and had it dressed. In ten days the outside was all healed, and I could hear a great deal better. Now I can hear my watch tick about twenty-four inches from my ear."

Case XV. (New York Eye and Ear Infirmary).—Mrs. Sarah Curry, æt. 62, of a rather feeble constitution, consulted me July 10, 1872, for a painful affection of the left ear. Her story was that for many years she had been somewhat hard of hearing, especially in the left ear, but had never had any discharge from either ear. Two years previously she had an attack of facial paralysis, affecting the left side. After a certain length of time this passed off entirely. About nine weeks previously she began to suffer from pain in and behind the left ear and extending over the entire left side of the head. There was also tenderness behind the ear. For two days and nights the pain was severe. After that there remained a steady, dull aching, together with a moderate degree of tenderness behind the ear. Two weeks previously the acute pain again returned, and since then she had suffered pretty constantly up to the time of her visit to the Infirmary.

On examination the meatus was found nearly closed by a falling forward of the posterior cutaneous wall. Membrana tympani invisible. No appreciable tenderness in the meatus. No discharge. Tenderness over the mastoid process, and also over the lower part of the parietal bone. Watch heard when pressed against the ear. The patient's countenance was indicative of great suffering. Incision of the integuments and periosteum covering the mastoid process. No pus found.

July 13.—Little or no relief afforded by the incision. To-day the auricle is pushed forward by a swelling behind the ear. Incision entirely healed. A second incision gave exit to about half an ounce of pus. No roughened bone or sinus discovered.

July 18.—Comparative relief from pain until last night, when the pain again became severe. She refers it to the mastoid process, the top and back of the head. The meatus is less swollen and the membrana tympani can now be seen. It is entire, but of a very tough, opaque, tendinous appearance. Eustachian tube open. The entrance of air is accompanied by râles. No brain symptoms. Consultation with Dr. Robert F. Weir. Mastoid process perforated with a conical drill. The outer surface of the bone found to be in every respect perfectly sound. At a depth of about one-fifth of an inch pus was found filling a cavity about the size of a filbert. Pus removed with pledgets of cotton, and outer orifice of the cavity enlarged sufficiently to admit the end of my little finger.

July 19. Patient much relieved by the operation, but she still complains of soreness over the back and side of the head. Pressure over the left occipital and parietal regions produces pain.

July 20.—Severe pain in the head, behind the mastoid process. Appetite only moderately good. Is losing strength. Stimulus ordered. Wound discharging freely.

July 22.—Still severe pain behind the mastoid process. Consultation with my father, Dr. Gurdon Buck. Skull trephined about three-quarters of an inch behind the mastoid process, at the point of greatest tenderness. The outer surface of the bone appeared to be perfectly healthy; but on withdrawing the trephine, after sawing through the outer table, the circular track was found to be filled with healthy pus, which had welled up from the intervening cancellous diploë. No appreciable softening of the bone. The removal of the inner button of bone exposed to view a tense, deep-red dura mater, but no pus. The subsequent oozing of venous blood from the ruptured branchlets was readily checked by laying a pledget of cotton-batting in the circular opening.

July 23, 11 A.M.—Patient slept a part of the night. This morning she has considerable heat of skin. Pulse 100 and feeble. Less pain in the head. Eight P.M. pulse 106 and feeble. Intellect perfectly clear. The discharge from the mastoid process appears to have nearly ceased. Vomited once this evening.

July 24, Noon.—Patient is evidently sinking. Pulse 110 and very feeble. Respirations 44. No râles over anterior and lateral portions of the chest. Intellect still clear, but she has not sufficient strength to speak in an audible tone when answering my questions. She died on the 26th, apparently from exhaustion.

Post-mortem examination refused by the friends.

The disease, if unchecked by operative procedure, may terminate in various ways:—

(*a*) In death, through basilar meningitis (Nos. 16 and 17); abscess of the brain (No. 18); embolus and pyæmia (No. 21); or exhaustion (No. 20).

(*b*) In recovery, after the extrusion of the carious

bone *en masse* or in fragments through an opening in the outer table of the bone, either behind the ear (No. 23), or in the external auditory canal (No. 22). If the caries has resulted in the formation of an abscess, the pus may find an escape through a similar opening. The carious process may also be followed by the growth of polypoid masses in the mastoid process (No. 24).

CASE XVI. (New York Eye and Ear Infirmary.)—Michael Casey, æt. 23, a sufferer from pulmonary phthisis, applied to me March 20th, 1872, for relief from a painful affection of his left ear. He stated that two months previously he first noticed a discharge from the left ear; that at first there was no pain connected with it, but that when the discharge became copious, as it did about two weeks before, he began to suffer from earache. On examination, the left meatus was found to to be completely closed by a collapse of the upper cutaneous wall. After the speculum had been forced in for a certain distance, it encountered a mass of granulations, which obstructed a view of the deeper parts. Three leeches applied near the orifice of the meatus.

March 23. Better. The motion of the lower jaw produces pain in the left ear. Granulations removed with Blake's snare. Probe encountered denuded and roughened bone surface in the meatus.

March 30. Paralysis of the left side of face noticed to-day for the first time.

April 6. Œdema of the skin above and behind the ear. Incision over mastoid process gave escape to a large quantity of pus, a part of it lying between the periosteum and the bone, the surface of which was somewhat roughened. Occasional nausea to-day.

April 8. Is steadily losing strength. Pulse 112, and feeble. Suffers great pain throughout left side of head, but does not refer it to the mastoid region. On my advice the patient entered St. Luke's Hospital, where he could obtain proper food and nursing.

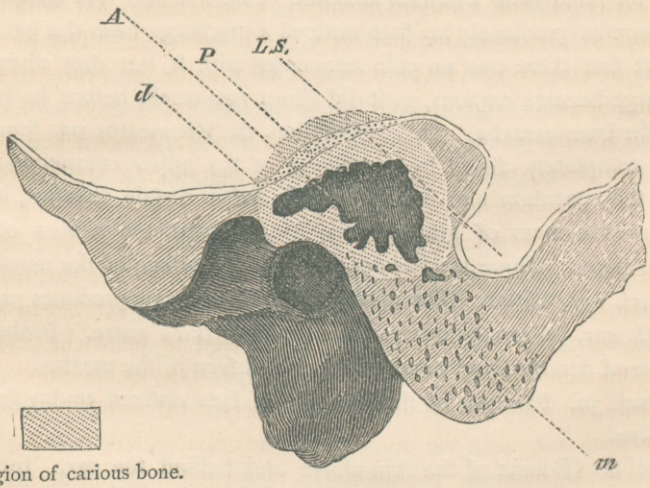
On the 9th of April, Dr. George A. Peters made a free incision through the upper wall of the meatus, exposing to view the denuded and roughened bone, and giving a free outlet to the pus that had accumulated above the auricle, and to that which was constantly forming

in the deeper parts of the ear, but had hitherto found an escape chiefly through the Eustachian tube.

The operation afforded the patient great relief; but in the course of a few days the temperature rose to 106°, the head symptoms became alarming, and the patient died comatose.

At the post-mortem examination, the dura mater covering the convexity of the left hemisphere was found to be intensely red; on the right side it was nearly normal. Pus at the base of the brain on the left side. Dura mater covering the left tegmen tympani thickened,

FIG. 6.



Region of carious bone.
d—dura mater; very much thickened over antrum.
A—antrum.
L.S.—lateral sinus.
P—pus collected between dura mater and bone.
m—mastoid process.
(Antero-posterior vertical section. Natural size.)

(Case No. 16.)

and of a maroon color. The thickened portion, whose limits were very abrupt, could easily have been mistaken for a swollen Peyer's patch, as seen in typhoid fever, so close was the resemblance between the two. Between the swollen dura mater and the greenish, softened

tegmen tympani lay quite a collection of cheesy, disorganized pus. The lateral sinus was not involved. The antrum mastoideum was nearly filled with a cheesy mass enveloped in a coating of foul greenish pus. The mastoid cells were sclerosed. A small sinus led from the outer surface of the upper portion of the process directly inwards to the antrum. (It was not detected during life.) The tympanum was filled with the same greenish, foul pus, which had also accumulated in the vestibule and scala tympani, owing to the destruction of the stirrup and membrane of the round window. The lining mucous membrane of the tympanum was not recognizable; the pus seemed to be lying in direct contact with the bone. Membrana tympani totally destroyed. The cavity of the temporo-maxillary articulation filled with pus. Eustachian tube ulcerated and very much enlarged. The pus had also burrowed down in the direction of the basilar process of the occipital bone.

Case XVII.—On the 21st of September, 1872, I was asked by Dr. Hermann Knapp to see with him, in consultation, a Mr. F., æt. 57, and of a strong constitution. The history of the case was briefly this: During the previous ten or twelve years Mr. F. had had five distinct attacks of acute purulent inflammation of the left middle ear, from all of which he made a good recovery. The present attack began about seven weeks previously, and was characterized by headache and dulness of hearing, unaccompanied by discharge. On examination of the ear Dr. Knapp found the external auditory canal swollen, especially on the posterior side; the membrana tympani injected, and the mastoid process tender on pressure. In the progress of the disease, the membrana tympani becoming more congested and convex outwardly, the doctor incised it. No pus escaped, but the patient experienced relief from his suffering for about a week. The pain then returned, and the integuments covering the mastoid process became swollen. The patient also noticed a gurgling sensation in the ear, whenever he shook his head. An incision down to and through the mastoid periosteum afforded only temporary relief. The pain again became severe. At the consultation (Sept. 21) it was decided that perforation of the mastoid process was the only course that offered any hope of recovery. The patient however refused.

Sept. 22. Up to this time there had been no brain symptoms, but

to-day, being called in haste to see the patient during the absence of Dr. Knapp from the city, I found him unconscious, pupils non-responsive, face flushed, and head very hot; pulse about 120, and full; breathing stertorous. The friends were then willing enough to have the operation performed, but it was clearly too late. The patient died the same night.

At the post-mortem examination, purulent basilar meningitis was found, together with a free communication between the mastoid antrum and the cavity of the lateral sinus. The two formed together an irregularly-shaped cavity filled with pus. The pus did not extend down into the jugular vein, nor back toward the torcular Herophili. Both these portions of the vein contained venous blood. Sclerosis of the mastoid cells. Membrana tympani entire.

Case XVIII. (Reported by Von Troeltsch in the "Archiv für Ohrenheilkunde," Vol. IV.)—A girl, æt. 20, of habitual good health, but affected for more than ten years with a discharge from the left ear, began to complain in November, 1866, of frequent headaches. Her family also noticed that she was depressed in spirits. On the 6th of January, 1867, the headache returned with great severity. On the 8th of January the family physician was sent for. He found her somewhat feverish, pulse 96, occasional vomiting; she complained of great pain, of a boring, lancinating character, in and around the left ear. Fetid otorrhœa. Ordered six leeches to the ear, cold applications to the head, and calomel internally.

January 9. Pain still severe. Vomiting. Pulse 110. Ordered six leeches to ear.

January 10. Pain less severe.

January 11. Delirious during the night. Pulse 120. Ordered leeches for the fourth time.

January 13. Some stupor. Pulse 140. She died on the 14th.

At the post-mortem examination an abscess was found in the left cerebellum, and one also in the left lower lobe of the cerebrum. Discoloration and thickening of the dura mater over the tegmen tympani. Discoloration of the bone near the mastoid antrum, which was filled partly with a greenish pus, and partly with cheesy material. Mucous membrane of the tympanum green, swollen and ulcerated. The membrana tympani very much thickened and defective in the upper and

posterior portion. (This, however, may have been artificially produced by the saw). The vestibule of the labyrinth filled with a brownish semi-fluid substance.

Case XIX. (Reported by Ludwig Mayer in the "Archiv für Ohrenheilkunde" Vol. I.)—A boy, æt. 15, of good health, was attacked July 10th, 1864, with a severe pain in the region of the left ear, chiefly behind it. For fifteen months previously he had been troubled with a discharge from that ear. An examination of the parts revealed swelling and tenderness over the left mastoid process.

July 13. Patient had a chill to-day. Steady increase in the severity of the pain. Dizziness, fever and loss of appetite. Pulse 130. Discharge fetid. Motion of jaws painful. Meatus filled with pus, but not tender on pressure. Membrana tympani entire and of a milky hue. Polypoid granulations on the upper wall of the meatus near the membrana tympani (Dr. Mayer states that probably a sinus led from this portion of the meatus into the cells which often lie above it.) Incision over mastoid process. Surface of bone rough. Perforation performed with a trocar. Very little pus found. Ordered poultices.

July 14. Much better. Pulse 72.

July 16. Chill followed by sweating. Pain in head. Ordered fifteen leeches to the left mastoid region. Discharge from the meatus has ceased.

July 17. Double vision. Several passages from the bowels. Chill.

July 18. Delirium.

July 20. Comatose. Patient died on the 22d July.

Post-mortem examination not allowed.

Case XX—Mr. I. H. N., æt. 40, a sufferer from pulmonary tuberculosis, was sent to me in consultation by Dr. William Hyde, of Stonington, Conn. He stated that he became somewhat deaf in the left ear eight years previously. In the autumn of 1871 he was attacked with pain, roaring and throbbing in the left ear, followed in the course of a week by a discharge. Since then the discharge had never ceased, and there had always been more or less pain. On one occasion he found a small fragment of bone in the discharge. Pain pretty severe recently, but not referred specially to the mastoid process.

The condition of the patient at the time I saw him was that of a person advanced in phthisis. An examination of the ear revealed a

marked degree of deafness, tenderness over the mastoid process, and pus escaping from the meatus, which was quite blocked up by the presence of a mass of granulations, springing from the upper and posterior cutaneous wall. During the exploration I extracted four loose fragments of bone, which were evidently bony septa from the mastoid cells. By aid of a curved probe I ascertained that a sinus led from the meatus (quite near the outer end of the osseous portion) backwards into the very centre of the mastoid process. In its course the probe encountered two or three sharp projecting spiculæ of bone. The patient was so feeble that I was obliged to desist from further exploration.

On the 28th of September following the patient died, with no other symptoms than those of exhaustion. Two days before death, there was a considerable hæmorrhage from the ear.

No post-mortem examination made.

Case XXI. (Reported by Von Troeltsch, in the "Archiv für Ohrenheilkunde," vol. iv.)—Patient entered the hospital March 30th, 1866. She was 21 years of age, and in the sixth month of pregnancy. She complained of daily chills followed by fever and sweating. During these attacks she suffered from severe frontal headache. The diagnosis of febris intermittens was made, and quinine prescribed in moderate doses. On the 5th day a purulent discharge from the right ear was discovered. The patient said it had existed for three years. On examination œdema and redness of the skin were found in the neighborhood of the ear, and extending back toward the occiput. Meatus swollen and filled with thick pus. Treatment: frequent syringing of the ear with warm solutions of acetate of lead; blister to the mastoid process; poultices. On the seventh day some delirium. Right pupil more dilated than the left. The chills continued in spite of large doses of quinine. On the 13th of April the child was born. It lived but a few hours. On the 15th diarrhœa; patient comatose; increase of swelling around the ear. April 17. Profound coma and death.

At the post-mortem examination the following pathological conditions were found: phlebitis of the right lateral sinus. Metastases in the lungs. Tissues around the right ear infiltrated with pus. Pia mater of the right hemisphere much congested. Dura mater along the right lateral sinus very vascular, and of a greenish hue. Within the sinus

transversus a purulent, yellowish-red material. Along the upper surface of the petrous bone, beneath the dura mater, two distinct collections of a creamy, yellowish-green pus. Beneath one of these collections, the bone was found to be rough and discolored. Pus between periosteum and right mastoid bone, whose outer surface was discolored. Upper and posterior wall of the meatus decidedly swollen. Membrana tympani intact but very much thickened, and of a bluish red color. Bony roof of antrum perforated by caries. Antrum itself entirely filled with cheesy pus. The cells of the mastoid process converted into a large cavity containing discolored pus and fragments of bone. The adjacent bone green. The cells immediately above the meatus filled with thickened, discolored pus; lining membrane everywhere much thickened and congested. Tympanum filled with dried pus.

Case XXII.—(Reported by Dr. Chas. Laight in the Transactions of the American Otological Society, July, 1871.)—William Quinn, æt. 13, of good health, was admitted to the N. Y. Eye and Ear Infirmary July 5th, 1871. He stated that six years previously he had been sick with a painful affection of the left ear followed by a discharge which had continued ever since. Present condition:—Pain in the ear. General condition good. An examination of the ear revealed the presence of a loose mass of bone in the meatus; it was attached only by a small fleshy peduncle to the upper cutaneous wall. Discharge very fetid. Bony mass removed. On examination it proved to be a portion of the mastoid process, about the size and shape of a small bean, which had come away as a single sequestrum. Further examination revealed the existence of a correspondingly large sinus, leading from the external meatus back into the adjacent mastoid cells.

The pain passed off at once, after the removal of this large sequestrum, and the otorrhœa soon after ceased entirely under appropriate treatment.

Case XXIII.—A. B., æt. 15, of robust health, consulted me on the 28th of September, 1871, for a deafness of the left ear. The history of the case, so far as I could ascertain it, was as follows:—When a small child he had measles, followed by inflammation of the left ear. For several years subsequently there was a discharge from the outer orifice

and some difficulty behind the ear, but exactly what was the nature of that trouble he could not recollect. For the past three or four years, however, he had been entirely free from otorrhœa.

On examination I found evidences of a former purulent inflammation of the left middle ear. Behind the ear there was a deep depression in the skin, corresponding to a similar depression in the mastoid process, a large portion of which had come away, either *en masse* or in fragments, through an opening on the outer side of the bone. This depression was large enough to admit the end of my little finger.

CASE XXIV.—(N. Y. Eye and Ear Infirmary).—Catherine Bergeman, æt. 42, of healthy appearance, consulted me February 7th, 1872, with reference to a polypus in the right ear. Her history was simply this:—From childhood she had always been troubled with a discharge from the affected ear, and had first noticed the existence of the polypoid growth about six years previously. On inspection I found a rather tough, fleshy mass, presenting at the outer orifice, and extending out a little distance from it. With Blake's snare I succeeded in extracting the mass entire. The subsequent hemorrhage was moderate and soon ceased of itself. An examination of the parts then showed that this large polypus (length $1\frac{3}{4}$ in., greatest diameter $\frac{3}{8}$ in.) sprang from the farther end of a broad sinus, which led from the external osseous meatus far back into the mastoid process. No exposed bone could be felt with the probe. No trace of membrana tympani or ossicles.

Four days later I again saw the patient and ascertained that there had been no discharge since the removal of the polypus. Subsequently she did not make her appearance.

These cases will serve to illustrate the chief characteristics of mastoid diseases, with the course they pursue either towards a favorable or a fatal issue. In concluding this portion of the subject, I shall briefly recapitulate the symptoms that will lead us to diagnosticate between these different varieties, and then take up the question of treatment.

In simple periostitis we have tenderness on pressure,

pain and swelling of different degrees. If we find the external auditory canal inflamed, without any appreciable trouble in the middle ear, we may feel pretty sure that the inflammation is limited to the outer fibrous textures. The pain too is not so deeply seated, nor has it the same intensity as when the cells themselves are affected. Pus occasionally results from this inflammation.

In simple congestion of the mucous membrane we may expect to find tenderness on pressure, pain and swelling of the integuments. If we remember that this is simply an extension of the diseased process from the middle ear, the difficulties in diagnosis will be materially lessened. As a rule, we shall find the pain more intense and deeper seated than in simple periostitis, and the external auditory canal will be unaffected. The relief which follows local depletion or an incision will distinguish it from other mastoid diseases.

Chronic subacute inflammation is not characterized by any definite train of symptoms. Its existence can only be shown by direct physical examination.

In the two remaining forms, it is scarcely possible to make a differential diagnosis, except perhaps in certain well-marked examples. This, however, is unnecessary, for the treatment in both cases is the same. The symptoms of pain and tenderness on pressure are almost invariably present. Dr. Roosa's case (No. 25 of the statistical note) is the only exception I know of. These two symptoms will not be permanently relieved by local depletion, or incision of the integuments or membrane. In some cases there is an entire absence of swelling. There are certain other phenomena observed in these

two forms which vary more or less in constancy. They are so valuable as aids to diagnosis that I shall mention them somewhat in detail.

(*a.*) Prolapse of the posterior or superior wall of the external auditory canal has been noticed in a few cases. In all of them it seemed to be associated with caries of the meatus. Swelling and tenderness of the posterior wall are frequently present in both forms.

(*b.*) Brain symptoms do not always indicate uniform pathological conditions. They may occur in inflammation with or without pus. They may also be absent when there is extensive caries of the part with local meningitis.

(*c.*) Facial paralysis is an occasional intercurrent symptom, and usually indicates that the bony walls of the tympanum, in which the nerve is embedded, have become involved.

(*d.*) Cessation or marked diminution of the purulent discharge is the usual precursor of acute mastoid inflammation.

(*e.*) In rare cases the membrana tympani remains entire.

(*f.*) The discharge of pus through the Eustachian tube indicates that some obstruction exists preventing its escape by way of the meatus.

(*g.*) The presence of granulations, springing from either the upper or posterior wall, should lead us to suspect that there is an opening leading to the mastoid cells. This fact can easily be ascertained by exploration with a bent probe.

Treatment.—The preceding cases illustrate so fully the methods of treatment to be adopted, that we have nothing new to add. We shall, therefore, simply give a brief recapitulation.

In the earlier stages of disease, when there is merely pain, tenderness on pressure, and perhaps swelling in the mastoid region, the most prompt relief can be afforded by local depletion. Apply from four to ten leeches, and follow them with warm fomentations. The external auditory canal and middle ear should then be carefully examined and treated according to indications. No reliable exploration can be made without the speculum and reflector.

If these measures do not give relief, and the unfavorable symptoms persist, a free incision through the integuments and periosteum of the mastoid process should be made.

The knife should enter at the level of the upper wall of the meatus, about ¼ inch posteriorly to the insertion of the auricle, and should extend downwards nearly to the tip of the process.

Should this latter procedure also fail, the bone should be trephined or perforated in such a way as to expose the mastoid cells.

This latter operation has now been repeated so many times that its great value and comparative freedom from danger have been securely established. It may be easily performed and will enable us to save life in a large majority of cases where a fatal termination is im minent.

Out of thirty-one cases (see statistical note), in which

the operation has been performed, the progress of the disease was arrested in twenty-three; in the remaining eight fatal cases, death could not be attributed to the operation, directly or indirectly, in more than one case (No. VII). In the remaining seven cases the operation was performed too late: pyæmia had already developed itself, or there was already inflammation of the brain or its membranes; or pus in the lateral sinus.

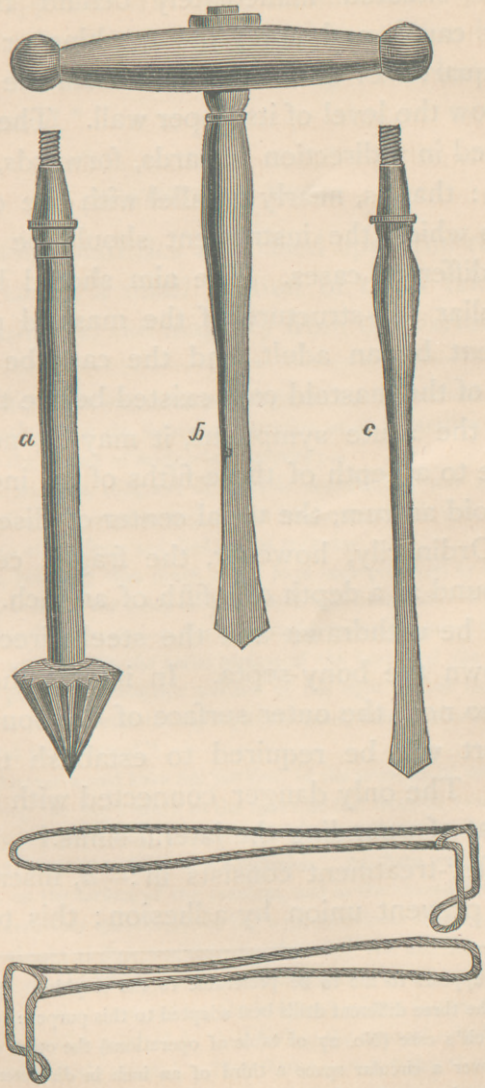
Some surgeons discountenance the operation in young persons, and claim that the disease in such cases will almost always terminate in recovery by a spontaneous perforation of the outer bony wall.

The incorrectness of this view will be shown further on in the statistical note. We are unable to judge of the comparative fatality of such cases from the insufficiency of our data. It will be seen, however, that a sufficient number of fatal cases are on record to make it unsafe for us to trust to natural processes only.

The steps of the operation are briefly as follows:—

A free vertical incision should be first made through the integuments and periosteum of the mastoid bone. The condition of the bone should then be noted. If it be soft or roughened, an attempt should be made to break through the outer lamella by firmly pressing upon it with the end of a steel director. If pus be found between the periosteum and the bone, search should be made with a bent probe for a sinus through which the pus may have found an escape from the mastoid cells. If such a one can be found, apply the drill or trephine at this point, and simply enlarge the existing opening. If no opening be found, dissect up

FIG. 7.



Drills for perforating the mastoid process.
Retractors.

the periosteum from that portion of the mastoid process which is situated immediately behind the external auditory canal, and apply the trephine or drill * at a point a quarter of an inch distant from the canal and a little below the level of its upper wall. The drill should be rotated in a direction inwards, forwards, and a little upwards: that is, nearly parallel with the canal. The depth to which the instrument should be carried will vary in different cases. The aim should be to reach the peculiar cell-structure of the mastoid process. If the patient be an adult, and the case be one where sclerosis of the mastoid cells existed before the development of the acute symptoms, it may be necessary to penetrate to a depth of three-fifths of an inch to reach the mastoid antrum, the usual center of disease in such cases. Ordinarily, however, the fragile cell-structure will be found at a depth of a fifth of an inch. The drill can then be withdrawn and the steel director used to break down the bony septa. In infants the antrum is situated so near the outer surface of the bone that very little effort will be required to establish the desired opening. The only danger connected with this operation is that of wounding the lateral sinus.†

The after-treatment consists in :—*a*, inserting a tent of lint to prevent union by adhesion: this tent should

* The drill appears to me to be preferable to the trephine. Fig. 7 gives the actual size of the three different drills best adapted to this purpose.

† In Dr. Weir's case (No. 27 of table of operations) the outer wall of the sinus was exposed over a circular space a third of an inch in diameter. At the post-mortem examination, twelve days later, this part was examined very carefully, and yet no trace could be detected of any inflammatory action, either in the fibrous wall or in the neighboring bone.

be replaced by fresh ones at least once in twenty-four hours, until suppuration is freely established; *b*, poultices, until the pain moderates and free suppuration becomes established; *c*, carbolic acid dressings and lotions frequently repeated.*

STATISTICAL NOTE.

The following statistics are based upon the record of sixty-seven cases, a small portion of them taken from my own case-book, the majority from the various medi-

* Lallemand (Recherches anatomico-pathologiques sur l'encéphale. Vol. II., p. 87. Paris, 1825), relates the following narrative as an illustration of how these cases may become the subject of medico-legal inquiry:—

J. Conrard, æt. 20, pale, thin, and of a feeble constitution, was struck several times while quarreling with another boy, and in consequence fell sick. He had all the symptoms of an ataxic fever and died on the 20th day.

The magistrate, believing that death might have been produced by the blows the boy had received, ordered the body to be opened and examined. The physicians reported "that they had found:—1, the brain rather more congested than natural; 2, a thin layer of pus between the under surface of the brain and the dura mater; 3, a collection of pus in the anterior portion of the right lobe of the cerebellum; 4, the arachnoid in contact with the right petrous bone, adherent to the dura mater and of a deeper red than normal."

A superficial observer would have felt justified, in the presence of such ample evidence, in attributing the boy's death to the blows he had received twenty days previously. Happily, the physicians, whose duty it was to enlighten the consciences of the jury, were not hasty in arriving at a conclusion. As there was no trace of any serious contusion on the surface of the cranium, and as the abscess was contained in a well organized cyst, they questioned the boy's parents about his antecedent history, and ascertained—thanks to their truthfulness—that their son had been troubled with his head for a long time previously, and had been subject to attacks of pain in the right ear. The physicians then returned to the body and made a further examination of the temporal bone, which resulted in their finding the mastoid cells filled with pus, and the middle ear similarly affected. They then reported "that the disorganization which they had found must have existed already before the occurrence of the fight and had no connection with it: that it was simply possible that the blows may have hastened the course of the disease."

cal periodicals and works on otology which were within my reach. Only those cases were taken in which the post-mortem examination or the clinical history afforded unmistakable evidence that the mastoid cells were diseased (third or fifth form).

Out of sixty-seven cases I found that thirteen occurred in children 10 years of age and under,

26 in persons between the ages of 10 and 25,
9 " " " 25 " 40,
12 " " " 40 " 55, and
7 " " " 55 " 62.

The youngest patient was 8 months old, the oldest 62 years. More than half of the patients were under 25 years of age. Six of the cases belonged properly to the third form, two were doubtful (third or fifth), and the remainder belonged to the fifth. Of the entire number three terminated in a spontaneous recovery, twenty-two were operated upon and recovered, eight were operated upon and died, and the remainder, thirty-six in all, terminated fatally. All the cases of spontaneous recovery occurred in persons under 16 years of age.

TABLE OF OPERATIONS ON THE MASTOID PROCESS.

No.	Where reported and name of operator.	Age.	Form of disease.	Otorrhœa.	External appearances of the bone.	Instrument used.	Result.
1	Jasser, 1776.... (Arneman's Bemerkungen über die Durchbohrung des Processus mastoideus. Göttingen, 1792.)	Adult.	Simple deafness.	None.	Normal.	Trocar.	Recovery from operation.
2	Fielitz..... (Ibid.)	Young Adult.	Not cle'rly stated.	Present.	Not stated.	Some kind of borer.	Recovery
3	Fielitz..... (Ibid.)	An old woman	Simple deafness.	None.	Normal.	Same.	Recovery from operation.
4	Löffler..... (Ibid.)	Adult.	Simple deafness.	None.	Normal.	Same.	Recovery from operation.
5	Hagstroem.... (Ibid.)	Adult.	Simple deafness.	Not stated.	Normal.	Gouge.	Recovery from operation.
6	J. L. Petit..... (Von Troeltsch's work on Otology.)	Not stated.	Not stated.	None.	Not stated.	Gouge.	Recovery
7	Weber..... (Mentioned by Von Troeltsch in Virchow's Archives, vol. xxi.)	44	5th.	Present.	Not stated.	Not stated.	Recovery
8	Forget..... (L'Union Médicale, 1860, No. 52.)	14	5th.	Present.	Not stated.	Not stated.	Recovery
9	Follin..... (Gazette des Hôpitaux, 1864.)	44	5th.	Present.	Not stated.	Trephine.	Recovery
10	Ludwig Mayer.. (Archiv für Ohrenheilkunde, vol. i.)	15	5th.	Present.	Roughened	Trocar.	Death from pyæmia.
11	Flaiz..... (Arch. für Ohrenh., vol. ii.	46	3d.	Present.	Normal.	Drill.	Recovery
12	Jacoby..... (Archiv. für Ohr., vol. iv.)	48	5th.	Present.	Pus on the outer side of bone, but no roughn'ss or softening.	Drill.	Recovery

TABLE—CONTINUED.

No.	Where reported and name of operator.	Age.	Form of disease.	Otorrhœa.	External appearance of the bone.	Instrument used.	Result.
13	Jacoby ..... (Archiv für Ohr., vol. vi.)	10	5th.	Present.	Not stated.	Drill.	Recovery
14	Jacoby ..... (Ibid.)	37	5th.	Present.	Not stated.	First with drill, later with trephine.	Death.
15	Jacoby..... (Archiv, vol. v.)	20	3d.	Present.	Normal.	Drill.	Recovery
16	Kessel ..... (Archiv. für Ohrenh., vol. iv., p 58.)	24	5th.	Present.	Not stated.	Trocar.	Recovery
17	Pagenstecher ... (Mentioned by Jacoby, in the Archiv. für Ohrenheil., vol. iv., p. 222.)	60	5th.	Present.	Not stated.	Cartilage knife.	Recovery
18	Pagenstecher ... (Ibid.)	Not stated.	Not stated.	Present.	Not stated.	Drill.	Recovery
19	Hinton ..... (Med. Times & Gazette, Sept., 1868.)	58	5th.	Present.	Not stated.	Trocar.	Recovery
20	Colles ..... (Dublin Quarterly, Aug., 1870)	Middle Age.	5th.	Present.	Not stated.	Drill.	Recovery
21	Buszard..... (British Med. Jour., Jan., 1871.)	40	5th.	Present.	Small sinus in upper portion of mastoid process.	Trephine and chisel.	Recovery
22	Barwell..... (Lancet, April, 1871.)	6	5th.	Present.	Softened at one point.	Pointed gouge.	Recovery
23	Barwell..... (Ibid.)	47	5th.	Present.	Not stated.	Same.	Recovery
24	Stokes..... (Dublin Med Jour., Aug., 1870.)	49	3d.	Present.	Normal.	Semi-circular saw.	Death.
25	Agnew..... (Trans. Amer. Otol. Society, 1870.)	Middle life.	5th.	Present.	Small sinus.	Trephine.	Recovery
26	Roosa ..... (Ibid.)	38	5th.	None.	Small sinus.	Not stated.	Death.
27	Weir, N.Y. City (Reported verbally. I was also present at the operation.)	12	3d.	Present.	Normal.	Drill.	Death.

TABLE—CONTINUED.

No.	Where reported and name of operator.	Age.	Form of disease.	Otorrhœa.	External appearance of the bone.	Instrument used.	Result.
28	Laight, N.Y.City (Reported verbally. I was also present at the operation.)	45	5th.	Present.	Normal.	Drill.	Recovery
29	North ..... Waterbury, Ct. (Reported verbally.)	19	3d.	Present.	Normal.	Trephine.	Death.
30	Buck	62	5th.	None.	Normal.	Drill.	Death.
31	Do.....	11	3d.	Present.	Normal.	Drill.	Death.
32	Do.....	21	5th.	Present.	Softened.	Drill.	Recovery
33	Do.....	56	3d.	Present.	Normal.	Drill.	Recovery
34	Do.....	47	5th.	Present.	Normal.	Drill.	Recovery
35	Do.....	36	3d.	Present.	Normal.	Drill.	Recovery

The cases of Jasser, Von Troeltsch, and Turnbull are omitted from the list simply because I can find no evidence in the printed reports of these cases that any operation was performed upon the bone, beyond the mere introduction of a buttoned probe into a small fistulous opening. Other cases have been omitted through inability on my part to gain access to the printed reports. The names of these surgeons are Pagenstecher, Schwartze, and Von Bruns.