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Roosa, D. B. St. John 1838-1908.
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New York : W. Wood & Company, 1873.

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A

PRACTICAL TREATISE

ON THE

DISEASES OF THE EAR,

INCLUDING

THE ANATOMY OF THE ORGAN.

BY

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WOOD ENGRAVINGS AND CHROMO-LITHOGRAPHS.

NEW YORK:

WILLIAM WOOD & COMPANY,

27 GREAT JONES STREET.

1873.

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PREFACE.

THIS work is intended to be a guide to those who wish to treat the diseases of the ear. The portion that is devoted to a description of these diseases, and the means for their relief and cure, is founded upon my own experience in the observation and treatment of more than thirty-eight hundred cases, in public and private practice. I have, however, taken pains to give the experience of other practitioners, both at home and abroad. I have endeavored not only to give a comprehensive digest of the most recent European researches, but also to present with entire impartiality, the views and experiences of American practitioners and writers, so far as the plan of a practical treatise like this would allow. To give a complete account of all that has been written on Otology has not, however, been my aim.

Considerable space has been given to illustrative cases, with a view of showing the actual symptoms of aural diseases and the results of treatment. I have also added historical sketches upon all points of practice that are new or still under discussion, in order that the successive steps by which our present position has been reached might be distinctly traced, believing that thereby the practitioner will often be saved needless labor in re-investigating and re-experimenting. The nomenclature contained in this treatise is that which I have found, after some years of experience in lecturing upon diseases of the ear, most readily grasped by the student, and is, I believe, founded upon the real nature of the diseases.

The anatomical portion of the volume has been compiled from the most recent authorities. The text-book of Professor J. Henle, of Göttingen, a work which has not been translated into English, has been made the general basis of the descriptions of the various parts of the ear, and of the arrangement of the subject.

In the preface to a translation of Von Tröltsch on the Ear,

published a little more than nine years since, the translator had so little faith in a general professional interest in the diagnosis and treatment of diseases of the ear, that he quoted a proverb to indicate that an ordinary human life would not suffice to see the fruit of the tree then being planted, in presenting to the English-speaking profession a work which has done much for the progress of Otology.*

In view, however, of the active and permanent interest in this subject, which has shown itself in the formation of societies, the establishment of journals, improvements in methods of practice, and a general appreciation of diseases of the ear, the author can but felicitate himself that even in a short life he has seen some fruit of a tree, which, although he did not plant, he at least assisted in cultivating.

The practice of Otology in this country was, a few years since, almost exclusively confined to charlatans; but it is now cultivated by a class of men who are the equals of any in the profession. Ten years ago, in most parts of the country, those who wished advice upon a disease of the ear were forced to seek aid outside of the profession. At the present time, there can be found those in the large cities who are constantly and successfully treating aural diseases; and all over the land the old and familiar advice, "Not to meddle with the ear," is growing far less frequent. The day will soon arrive—if indeed it be not already upon us—when Otology will take equal rank with Ophthalmology, to which department it has so long been a mere appendage, and when some knowledge of the diseases and treatment of the ear, will be required of every practitioner.

I have been assisted in various ways, in the preparation of this work, by many who may rest assured that I have not been unmindful of their labors because their names are not here mentioned; but to Dr. Charles E. Rider, of Rochester, for assistance in compiling the anatomy of the middle ear, and to Dr. George M. Beard, for critical suggestions in the literary execution of the work, of a very valuable character, I am much indebted, and to both of these gentlemen, I desire to present my cordial acknowledgments.

It is believed that in the foot-notes, the various authorities whom I have consulted have been given proper credit, and they

* "Arbores seret diligens agricola quarum adspiciet baccam ipse nunquam."

are given in full at the close of the sketch of the progress of Otology, and at the end of each anatomical section, in order that an aural bibliography of works actually consulted by the author, and accessible in this country, may be furnished to any who may desire to pursue any special subjects further than would be fitting the limits of a text-book.

Most of the engravings were made by Messrs. J. A. Coughlan & Co. Those of instruments were furnished by Messrs. Shepard & Dudley, Otto & Reynders, and George Tiemann & Co., of this city.

The chromo-lithographs were drawn by Dr. H. P. Quincy, of Boston, from cases loaned me by Drs. Clarence J. Blake and Henry L. Shaw, Surgeons to the Massachusetts Charitable Eye and Ear Infirmary. Without the assistance of these gentlemen, I should have found it very difficult to procure satisfactory representations of the morbid membrana tympani. Dr. John L. Vandervoort, Librarian of the New York Hospital, has extended me many courtesies in giving me free access to the valuable library of that institution.

New York, *May 29, 1873.*

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PART I.

INTRODUCTORY SKETCH OF THE PROGRESS OF OTOLOGY.

THE EXTERNAL EAR.

INTRODUCTION.

CHAPTER I.

A SKETCH OF THE PROGRESS OF OTOLOGY.

THERE is perhaps no department of the art and science of medicine in which there has been so much literature, with so little exact, or as we say, scientific knowledge, as that which was formerly known as aural medicine and surgery, but which is better designated by the term Otology.

460–370 B.C.] Hundreds and perhaps thousands of volumes have been written on the anatomy, physiology, and diseases of the ear, from the time of Hippocrates until our own day, and yet until the age of Valsalva, the seventeenth century, the treatment of the affections of the organ of hearing was purely empirical, while the knowledge of its anatomy and physiology was often incorrect and fragmentary. Even after the investigations of the famous Italian, investigations which consumed sixteen years of his life, and the subsequent anatomical discoveries of the eighteenth century, it was reserved for our own day and generation to place the science of otology, or the knowledge of the anatomy, physiology, and diseases of the ear, on a level with that of other fields of labor in medicine.

A singular apathy in regard to the maladies of one of the most important organs of the body, an inexplicable ignorance as to their results, a most irrational and empirical manner of treatment, have been our heritage from the fathers. Probably to-day, in the closing years of the nineteenth century, there are more practitioners of medicine who view aural medicine and surgery from the stand-point of the errorists of the

dark ages, than there are in any other field. It is to be feared that even now many wise and skillful men do not know, that to drop stimulating or even anodyne applications upon a membrane which they have never examined, to probe an ear for wax that they cannot see, are purely empirical practices which every conscientious physician should hold in abhorrence.

The great reformer of this science, *Wilde*,* wrote, as late as 1853, that "the affections of the ear, whether functional or organic, are spoken of, lectured on, written of, and described (even in great part to the present day), not according to the laws of pathology which regulate other diseases, but by a single symptom, that of *deafness*."

It is with no desire to recount the details of the long and painful story of the gropings in the dark, which have characterized the teachings on otology from the days of the philosopher of Cos, until the seventeenth century, that the author attempts an historical sketch of our progress up to our present position. He has neither the time nor the facilities for such a task; but he has simply aimed to sketch the outline history of otology, from the sources to which he has been able to gain access, in such a manner as to show the obstacles which, until twenty years ago, have prevented the satisfactory progress of the science.

The authorities which I have consulted in this introduction will be found at the close of the chapter; but I must first of all make especial acknowledgment of my indebtedness for the greater part of my material to that valuable compendium, *Lincke's Handbuch der Ohrenheilkunde.* I have, however, consulted the original authorities as far as the best medical library of New York, that of the New York Hospital, and my own, would permit. Where no other authority is given in a foot-note, Lincke is the one from which I quote, and often by an exact translation.

The discoveries and teachings in the anatomy of the ear will be first reviewed, after which the progress in the examination and treatment of its diseases will be noted.

* Aural Surgery, English edition, p. 7.

PROGRESS IN THE ANATOMY OF THE EAR.

Hippocrates probably knew very little of the anatomy of the ear, although it is supposed on doubtful grounds

570 B.C.] that *Alcmæon*, a disciple of Pythagoras, was aware of the passage that led from the cavity of the tympanum to the throat, inasmuch as Aristotle quotes him as saying that goats breathed through their ears.

384–322 B.C.] The knowledge of Aristotle as to the anatomy of the ear did not go beyond the membrana tympani.

A.D. 98–117] *Rufus of Ephesus*, who was the first medical lexicographer, and who lived in the age of Pliny,* used the names helix, lobe, tragus, and anti-tragus, which are still employed to describe the different parts of the auricle.

Marinus, the preceptor of Galen, and whom Galen named the restorer of anatomy, called the acoustic and facial nerve one, under the name of the fifth pair.

A.D. 130] *Galen* does not seem to have made any great advance in anatomical studies, and they were greatly neglected down to the fifteenth century. The darkness of the blind leading the blind is scarcely broken for thirteen hundred years. What Galen wrote was authority, and naught else. One valiant skeptic in medicine would have effected more good during these centuries, than all the ponderous tomes that were written by philosophers who reasoned upon premises that had never been thoroughly established. So late as 1559 one Doctor *Geynes* was called before the College of Physicians in London, for impugning the fallibility of Galen. On his acknowledgment of his error, however, he was again received into the college.†

The strong arm of the church, in the dark ages, prevented anatomical investigations on the human cadaver, and for hundreds of years anatomical knowledge remained at a stand-still.

Galen, however, corrected the error of his preceptor in thinking that the facial and acoustic nerves were one, and showed that the latter entered the *meatus auditorius internus*,

* History of Medicine. Dunglison, p. 166.

† Chambers' Encyclopedia. American edition. Article, Galenus or Galen.

a passage which his predecessors had regarded as impermeable. He gives no account of the anatomy of the internal ear, although he compares it to a labyrinth, a name which Fallopius, fourteen hundred years later, fastened on it forever.

There is no record of the ossicula auditus until the fifteenth century. Two Italian anatomists, *Achilini* and *Beren-*

1480] *gario*, were the first to describe these bones, although they were not the discoverers of them.

Berengario also first described the membrana tympani "with exactness." The exactness of his knowledge may be shown by the fact, that he was doubtful whether the origin of the membrane was from the acoustic nerve, or the meninges of the brain.

1542] *Andreas Vesalius*, who is said to have been the most accurate anatomist of his day,* described the long process of the malleus, the Eustachian tube, the vestibule, and the semicircular canals.

1604] The honor of the discovery of the stapes bone is claimed by no less than three anatomists, viz., *Ingrassia*, *Columbo*, and the renowned *Bartolommeo Eustachius*. The former wrote commentaries upon Galen's works, that were published long after his death. He claims to have shown it to his scholars in 1546, at Naples.

1523–1562] *Gabriel Fallopius*, of Modena, died in the bloom of youth, at the age of 39,† but he lived long enough to accomplish much for anatomical science. He showed, among other valuable points in the anatomy of the ear, that the mastoid cells communicated with the cavity of the tympanum. He described the fenestræ rotunda and ovalis, and gave his name to the canal in which runs the facial nerve in its passage through the cavity of the tympanum, *acquæductus Fallopii*.

The great *Cuvier* regarded *Vesalius*, *Eustachius*, and *Fallopius* as the three anatomists of the sixteenth century to whom belongs the honor of having restored the science of anatomy.

1500–1574] *Bartolommeo Eustachius* described the tensor tympani as well as the stapedius muscle. He

* Dunglison. History of Medicine, p. 233.

† Chambers' Encyclopedia. Article, Fallopius.

also gave a more exact account of the tube leading from the pharynx to the middle ear, which is called the Eustachian tube, although it was discovered by *Vesalius*. Eustachius also gave a superficial description of the cochlea.

It is said that if poverty had not prevented Eustachius from publishing his anatomical plates, anatomy would have attained the perfection of the eighteenth century some two hundred years earlier.*

1587] The first monograph on the anatomy of the ear was from the pen of *Volcher Koiter*, a student of Fallopius. It contained no original observations, however.

1543–1573] *Constant Varolius*,† so well known from his descriptions of the brain, made the singular mistake of supposing that the muscles of the cavity of the tympanum were nerves which were torn by the sawing through of the bone. Subsequently he admitted this error; but he went so far to the other side as to say that the tensor and laxator tympani muscles could be moved at will.

1537–1619] Lincke‡ does not think that the famous *Fabricius* of Acquapendente, contributed very much to our knowledge of the anatomy of the ear, while he led many away into error as to some points. For example, he thought that the chorda tympani nerve was a peculiar body, and not a nerve. At any rate, Fabricius did good service by his labors as a comparative anatomist, and it should be remembered that he was the instructor of the discoverer of the circulation of the blood.

1593–1609] *Julius Casserius*, who was a professor in Venice in 1609, a pupil and subsequently a rival of Fabricius, described the fissures that make the cartilaginous portion of the canal so flexible. He and Fabricius described the laxator tympani minor in the same year, and both claim to have discovered it first. Casserius also gave a better description than had hitherto been done of the membrana tympani, the ossicula auditus, and the labyrinth. He was the first to

* Chambers' Encyclopedia. Article, Eustachius.

† Biographie Médicale. Paris, Pankoucki.

‡ Handbuch, Bd. I., s. 14.

describe the three and a half turns of the cochlea and the membranous zone.

1665] The ceruminous glands, whose function and physiological action were first described by *Nicolaus Stenon*. Lincke speaks of him as *Stenson;* but this must be a mistake in transcribing the name of the great Danish anatomist.

Passing on to the eighteenth century we find *Antonine Marie Valsalva* rising up a head-and-shoulders above the anatomists of his age, and far exceeding his predecessors in the amount and exactness of his knowledge.

He devoted more than sixteen years of his life to the study of the anatomy of the ear, and for the purpose of its study dissected more than a thousand heads. His master-work was a treatise on the ear.* This work passed through five editions in a short time. He described the attachment of the tensor tympani to the Eustachian tube. He made the mistake, however, of supposing that the ossicula auditus had no periosteum, and that the cavity of the tympanum was connected by many openings to the cavity of the cranium. He discovered the muscle that dilates the Eustachian tube and moves the uvula. He also showed that the fenestra ovalis was covered by membrane. His anatomical plates show a good knowledge of the cochlea and semicircular canals.

Morgagni, himself an original investigator, a student and friend of Valsalva, edited his master's work and made some additions.

Of Valsalva's contributions to the treatment of the ear, which were quite as important as his anatomical investigations, we shall have occasion to speak in the second part of this sketch.

1714] Valsalva had a rival, whose name the lapse of time has well nigh effaced, *Raymond Vieussens*, who also wrote a work on the ear. He gave new names to various parts of the organ; but his descriptions are said by Lincke to be so mysterious that his contemporaries could not understand them.

1717] *Rivinus*, professor in Leipsic, observed an opening

* Tractatus de Aure Humana. Lugdunum Batavorum, 1742.

in the membrana tympani, which he believed to be a constant anatomical condition. This supposed discovery excited the warmest discussion among such anatomists as *Walther*, *Ruysch*, *Morgagni*, *Cassebohm*, and *Valsalva*. *Hyrtl*, the present distinguished anatomical teacher of Vienna, showed that it was a rent in a macerated membrane; but his predecessor, *Berres*, believed in its existence and described it minutely.*

Quite recently Professor Bochdalek, of Prague, has revived the question,† and has described the foramen of Rivinus as a constant opening in the membrana tympani; this author says that there are sometimes two. It is, however, according to Bochdalek, so small as not to be seen without the aid of a magnifying glass.

In a discussion in one of the medical societies of Vienna,‡ Professors von Patruban, Gruber, and Politzer, unite in affirming its existence, thus confirming Bochdalek's statement.

1718] The famous *Ruysch* (Frederick), professor in Amsterdam, contributed to our knowledge of the distribution of the vessels of the cavity of the tympanum, and corrected Valsalva's statement that the ossicula were not covered by periosteum.

1730] *Cassebohm* (Joan. Frid.), published a monograph upon the ear, in six parts, which Lincke calls "a monument to the German industry and spirit of inquiry of the time." "Ein Denkmal deutschen Fleisses und deutschen Beobachtungsgeistes."

He disproved Valsalva's idea of the close connection between the cavity of the tympanum and the cerebrum; he described the cochlea, and the development of the auditory apparatus in the fœtus.

1747–1753] *Brendel* and *Zinn*, two Göttingen anatomists, the latter of whom is well known as the describer of the suspensory ligament of the lens, known as the zonula of Zinn, made further investigations as to the structure of the cochlea.

1761] *Dominic Cotugno*, or *Cotunni*, the discoverer of the fluid

* Prager Viertel. Yahrschrift, 1866, I.

† Tröltsch on the Ear, 2d American edition, p. 26.

‡ Monatsschrift für Ohrenheilkunde, Jahrgang III., No. I.

of the labyrinth, won such a reputation by his work upon the internal ear, that he was called to the anatomical chair at Naples. He was the first clearly to show that the labyrinth was filled with fluid, and that this was one of the necessities for the perception of the undulations that we call sound.

1747–1832] *Antonio Scarpa* issued a work on the structure of the ear, which brought the knowledge of its inner arrangement to such a height that it seemed to his contemporaries that there was little more to be done. The investigations of our own day have shown how premature was this expression. Scarpa wrote upon the fenestra rotunda, which connects the tympanic cavity with the lamina spiralis of the cochlea. He described the osseous labyrinth with exactness, the membranous labyrinth, and the expansion of the acoustic nerve.

Scarpa was secretary to the octogenarian Morgagni, when the latter had lost his sight, and he wrote letters of advice in Latin at the dictation of his blind preceptor.

1797] *Alexander Monro*,* "Professor of Anatomy, Medicine and Surgery," in the University of Edinburgh, was the author of a monograph on the organ of hearing in man and other animals. It is a fine specimen of typography. In his preface he states that Dr. Camper called in question his description of the semicircular canal in whales, and that *Scarpa* said that some of his teachings in regard to the human ear were erroneous. Professor Monro claims to have been the first anatomist to trace the auditory nerve within the cochlea, vestibule, and semicircular canals. He quotes from Valsalva, Winslow, Cassebohm, Haller, Cotunnius, Meckel, and others, to show that none of these anatomists had traced nerves into the cochlea. Dr. Monro seems to make out a good case for himself as against Scarpa, as far as I have been able to determine, and to be entitled to the credit of having traced the nerves into the cochlea before with greater minuteness than Scarpa, and appears to have been correct in his comparative anatomy.

* Three treatises on the Brain, the Eye and the Ear. Edinburgh and London, 1797.

1800] *Mr. Everard Home* wrote an excellent, and, for its time, exact account of the membrana tympani in a paper for the Royal Society.* The measurements are accurately given, but Mr. Home supposed that the fibrous layer was muscular. He seems to have been a comparative anatomist of great ability.

1806] *Samuel Thomas Soemmering*, a great name in anatomical science, contributed to otology by a series of plates of the anatomy of the ear, which are almost as well worth study to-day as they were seventy years ago.

1832] *Henry Jones Shrapnell* contributed a series of papers to the London Medical Gazette.† He described the membrana flaccida of the drum-head, its nerves, with clearness and accuracy. His description of the former is available for the student of the present time, and Shrapnell's membrane is probably firmly fixed in the nomenclature of the anatomy of the ear.

1832] *Thomas Buchanan*, of Hull, brought out a monograph illustrative of the anatomy and diseases of the ear. His ideas as to the importance of the cerumen produced many errors in treatment, from which the profession has not yet fully recovered. He published four works; the title of the last one illustrates what has just been said: "Physiological Illustrations of the Organ of Hearing, more particularly of the Secretion of Cerumen, and its effects in rendering Auditory Perception acute and accurate."‡

1836–39] The distinguished English surgeon, *T. Wharton Jones, Esq.*, contributed to a great cyclopædia an article on the organ of hearing, which comprised all that was known up to that time, and which is a very valuable monograph for reference.§

1821–51] We are now, in our review of the investigations of the anatomy of the ear, down nearly to our own time; and we come to the familiar names of *Huschke, Ar-*

* Philosophical Transactions, 1800. The Croonian Lecture.

† Vol. x., 1832.

‡ Mr. Wilde on the early history of Aural Surgery. Dublin Medical Journal, 1844, p. 441.

§ Cyclopædia of Anatomy and Physiology. Edited by Robert B. Todd.

nold, *Schlemn*, *Johannes Müller*, *Breschet*, *Bonnafont*, and *Toynbee*.

1851] *Toynbee** investigated anew the membrana tympani. He especially added to our knowledge in regard to the fibrous layer, and described, for the first time, the dermoid layer. This paper was published in the Philosophical Transactions. It was preceded by papers in the Medico-Chirurgical Transactions, on the pathological anatomy of the ear, papers which have given *Toynbee* lasting fame, because they did very much to place otology upon as sound a basis in pathology as they had been placed in anatomy by the labors we have enumerated.

Toynbee's statement, that the Eustachian tube was usually a closed canal, and that muscular action was required to open it, led to Politzer's method of inflating the ear, of the value of which procedure more will be said in our review of the progress in therapeutics.

1856] *Von Tröltsch* began a series of anatomical investigations, which, we may hope, have not yet ended. His contributions relate to the structure of the membrana tympani, the muscles of the Eustachian tube, and the pathological anatomy of the middle ear. He also, in the course of some investigations of the cavity of the tympanum of the fœtus, found that it was filled with a proliferation of the mucous membrane of the labyrinth wall, which forms a mucous cushion, that rapidly lessens in size after birth. This anatomical fact explained the frequency of inflammations of the middle ear in young children.

1858] *Gerlach*† followed Toynbee in the investigation of the fibrous layer of the membrana tympani, and showed that in the extreme periphery the circular fibers were wanting.

1860] *Magnus* investigated anew the articulations of the ossicula, and showed that there was no real joint between the malleus and incus. He also denied the voluntary or involuntary contraction of the tensor tympani muscle.

1862] *Politzer* and *Lucæ* published the results of experi-

* Diseases of the Ear. American edition.

† Schwartze, Archiv für Ohrenheilkunde. Bd. I.

ments, which were supplementary to those of Müller, in showing that the origin of a certain crackling sound in the ear was not in the tendon of the tensor tympani, but in the Eustachian tube.

1851] *Corti*,* an Italian anatomist, reviewed the work of his countrymen of the former centuries who studied the cochlea, and divided the lamina spiralis membranacea into two different broad zones—an inner one, *Zona denticulata;* and an outer, *Zona pectinata.* He described some peculiar bodies as teeth, which soon got the names of *Corti's organ,* and which were subsequently found to be the termination of nerves.

Claudius, *Böttcher*, and *Deiter* followed Corti in investigations of this part, which will be fully noticed in discussing the anatomy of the internal ear.†

1858] *Hyrtl*, an anatomist of great industry and reputation, made an important discovery of the frequency of a thin and porous bony covering to the roof of the cavity of the tympanum, thus elucidating some cases of cerebral disease arising from affections of the middle ear.

Our review now extends to the time of the publication of the Archiv and the Monatsschrift für Ohrenheilkunde, as well as to that of the American Journal; the Archives of Ophthalmology and Otology; to familiar ground, in the knowledge of which the subsequent pages are written.

PROGRESS IN AURAL THERAPEUTICS.

In the earlier ages the progress in the treatment of the ear by no means kept pace with the advance in the knowledge of its anatomy. While the structure of the organ was sufficiently well understood to cause the investigation of its diseases to be both interesting and profitable, the treatment was crude and illogical, unworthy of the knowledge which should have been its basis.

Herodotus‡ says that there were specialists in Egypt, a par-

* A Manual of Histology by Stricker, p. 1054 (Translation).

† For the material for the sketch of the preceding page, I am indebted to *Schwartze*, Archiv für Ohrenheilkunde. Bd. I.

‡ Herodotus, translated by Cary. Euterpe, p. 125.

ticular physician for each disease, but no mention is made of aurists. "The art of medicine is thus divided amongst them: each physician applies himself to one disease only, and not more. All places abound in physicians; some physicians are for the eyes, others for the head, others for the teeth, others for the parts about the belly, and others for internal diseases."

Although Hippocrates knew very little about the anatomy of the ear, he speaks at some length of the causes of aural disease. For many of these he must have drawn upon his imagination. They were very comprehensive, and may properly be said to explain almost anything. They are such as heat, cold, dryness, moisture, the blood, mucus, and the yellow and black bile.

Hippocrates considered internal inflammation of the ear as essentially an inflammation of the head. He described as a very dangerous disease, pains in the ear, connected with high fever, and if neither pus escaped from the ear nor blood from the nose, the death of the patient usually occurred from the ninth to the eleventh day.

This was probably the disease that we now name acute catarrh of the middle ear, and the great medical philosopher was certainly right in calling it a serious one.

Among all the improper remedies which Hippocrates recommends to be dropped into the ear, there is one good one, although it is very simple, which is often thought to be a suggestion of our own day; that is, the instillation of warm water, which the great physician advises to be done by means of a sponge. If this simple, but often efficacious, treatment were universally practised in cases of acute inflammations of the outer and middle ear, it would alleviate a great deal of suffering.

Hippocrates seems to have had an eye to the effect upon the patient's mind, to use no harsher term, if we may believe that the following passage was not, as Lincke insinuates, interpolated*: "If any person has a pain in his ear, the physician should roll a bit of wool about his finger, and then pour some warm oil into the ear, and then taking the wool in the hollow of his hand, and hold it before the ear, in order to

* Lincke's Handbuch, Bd. II. p. 5.

make the patient believe it has come out of it. In order that the deception may be complete, the wool should be at once thrown into the fire."

Asclepiades, a friend of Cicero, recommended instillations for the ear, of oil, in which three or four cockroaches, or an African snail were cooked, while a piece of henbane in oil of roses, or woman's milk, is to be afterwards added.

B.C. 44, A.D. 19] *Celsus* (Aulus Cornelius) also used a composite remedy which was said to be of service in all kinds of diseases of the ear. It was made of cinnamon, cassia, blossoms of bulrushes, castoreum, white pepper, ammonia, myrrh, and saffron, as well as of various other agents. These substances were all rubbed up with vinegar, and diluted with the same agent when used.

Celsus, in his treatise *De Medicina*, spoke in some detail of aural disease. He was perhaps the first to recommend vigorous injections of water in order to remove foreign bodies from the ear, although this proper recommendation carries less weight than it would have done had it not been mingled with a great deal of bad advice, which shows that a disposition to use the simplest means for a desired end, is not always connected with great learning. Celsus recommends in obstinate cases of a foreign body in the ear, that the patient should be laid upon a table, and upon the side of the affected ear, when the surgeon strikes with a hammer upon the table, in order to dislodge the foreign body by the concussion.

Among the mass of writers mentioned by Lincke as being before Galen's time, *Archigenes* seems to have had some correct notions. He practised venesection for severe pain in the ear, and employed purgative enemas, warm baths to the ear, especially by means of a sponge dipped in hot water. He warns against the use of cold water. He also has his method of removing a foreign body from the ear, and recommends a vigorous shaking of the affected head. A child is to be seized by the feet and well shaken, while adults are to be held very much as Celsus proposed; that is, they are to be laid on a table, while the leaf of it nearest the head is to be repeatedly opened and shut with a slam.

Archigenes, like other ancient authorities, however, thinks

very much of instillations of various kinds for the relief of the different forms of deafness. He recommends speaking-tubes to the deaf.

A.D. 130–201] *Galen* recognized the importance of the ear, inasmuch as it lies so closely to the head. Although his classifications of disease are very minute, we do not seem to learn much from his writings, except the value of agents that will excite the secretions of the nose and mouth, which he recommends in aural disease. He complains of the empirical practices of his predecessors in ordering now cold and now warm agents, now sweet and now sour ones.

He also tells of a poor patient of some less learned, or less practical man than himself, who, in accordance with advice, used black pepper as a local means of treatment for an inflamed ear, and whose sufferings were so much augmented, that he came near hanging himself.

Galen objects to the common use of opium, which seems to have been employed very much in relieving the pain of aural disease.

Tinnitus aurium, according to Galen, was due in some cases to exhalations from the stomach, and in others to increased sensitiveness of the ears. Both of these causes certainly leave much to be wished for, in the way of exact knowledge, as to the nature of this distressing symptom.

It would be tedious in the extreme to follow Galen through his classification of diseases of the ear, and remedies for them. Like his predecessors and contemporaries, he was not willing to admit that there were some diseases for which remedies were useless, so far as their knowledge went. The aural prescriptions of the ancients may well be compared to the mitrailleuse, dangerous far and wide.

Cœlius Aurelianus, a successor of Galen, stands out prominently from the absurd theorizers of his time, in his clear delineations of pain in the ear, and his sensible remedies for it—leeches, cups, poultices, mustard-plasters, and so on.

Apollonius, quoted by Galen, took out foreign bodies with ear-spoons, forceps, hooks, etc., which were enveloped in wool and dipped in turpentine. He softened ear-wax with saltpetre in vinegar, and then removed it with lukewarm water or oil.

About this time we read of the materia medica of *Marcellus*, who gives us a glimpse of the popular remedies of the day. Frogs' fat is recommended for pain in the ear; the urine of pigs, of children and men, and the blood of young chickens, for an ulcer in the ear; for worms in the organ, the saliva of a hungry man, and so on.

We see a great deal in the ancient literature, of worms in the ear; so that we must conclude that they were much more commonly found in the olden time than with us. This was probably due to the fact that cases of neglected suppuration were very frequent, and that living larvæ were thus often developed.

600 A.D.] The famous surgeon and obstetrician, *Paulus Æginita*, who flourished in the seventh century, should be remembered as a contributor to the surgery of otology. He expended much energy on the subject of foreign bodies in the ear, a field which has unfortunately always suffered from surgeons over-anxious for operations. He suggests a method for their removal, which, when all other means fail, is still to be thought of in our day. It is an incision behind the ear, to detach the auricle from the canal. We are thus enabled to get at the foreign body very readily. Hippocrates is said to have also recommended this procedure.

According to Lincke, the Arabians got their knowledge of otology, whatever it was, from the Greeks, of whom Galen was the chief authority; so that we can only add a few more absurd remedies as their contribution to knowledge: for deafness, the brain of a lion mixed with oil (the brain, not the lion,) is advised by *Rhazes*. *Serapion* advises instillation of woman's milk for the cure of ear-ache in children; and he gives the important caution that if it be a boy who is affected, the milk must be that of a woman who is nursing a female infant.

As we have seen, in noticing the progress in our knowledge of the anatomy of the ear, the centuries from Galen to Valsalva were dark ages for our science. Lincke says: "Otology remained at the same point at which the Grecian, Roman, and Arabian physicians had left it." In Lincke's own list of the progress of these centuries we find traces of ignor-

ance and empiricism only. One author named *Gadesden* recommends that, in cases of inflammation of the ear, one of the lower classes be hired to suck out, by means of a tube placed in the meatus externus, all the morbid material of the ear; and this is said to be a cure for all kinds of deafness, not even excepting that from a purulent affection of the organ. Lincke believes that *Peter de la Cerlata* was the first to use a speculum for widening the auditory canal for purposes of inspection.*

1560] *Johannes Arcularius* gave some sensible rules for the management of aural disease. He declaimed, for instance, against the indiscriminate practice of stuffing the ear with cotton; but he advised an extremely peculiar means of extracting a foreign body from the ear. The head of a lizard was to be cut off, placed in the affected ear, and allowed to remain there for three hours. The animal is then to be removed, when the foreign body will be found in its mouth.

1560] *Alexander Benedetti* recommends, as a remedy for pain in the ear, the semen of a boar, which is to be carefully taken from the vagina of a sow, before she has dropped it upon the ground. This, however, is the suggestion of a writer on general medicine, and not on otology.

1523–1562] *Gabriel Fallopius*, in this century, seems to be entitled to the honor of having first taught that a discharge of pus from the ear of a child should not be meddled with; for as Fallopius gravely taught, and as has been gravely repeated by his legitimate successors for two hundred and seventy-three years, this discharge of pus is an effort of nature to throw morbid material out of the head through the ear. The otorrhœa of adults, according to Fallopius, is also a discharge from the brain, and should not be treated by astringents, but with mild, cleansing remedies. He used an aural speculum, and employed sulphuric acid to remove polypi.

1600] In the seventeenth century we hear of *De Vigo*, body surgeon to Pope Julius II., curing his Holiness of a very

* The passage quoted to sustain this view is "*per inspectionem ad solem trahendo aurem et ampliando cum speculo aut alio instrumento.*"

obstinate abscess of the right ear, by means of a mixture, or liniment, of ʒ ij of oil of eggs with ʒ iij of oil of roses. What kind of an abscess this was, or where it was situated, *Lincke* does not tell us.

In the latter half of the sixteenth century a certain *Capivacci* seems to have deviated a little from the errors of his predecessors. He speaks with more precision of aural disease. He describes thickening, ulcers, and cicatrices of the membrana tympani, and says that deafness which arises from an affection of the nerve or labyrinth is incurable—a declaration in which his successors, three hundred years after him, are forced to unite. Capivacci also describes a method of making a differential diagnosis between the diseases of the peripheric and of the central parts of the organ of hearing. One end of an iron rod, an ell in length, is put between the teeth of the patient, while the other is placed upon a keyed musical instrument. If he could distinguish the tones produced by the vibrations of the keys of the instrument, his deafness depended upon some lesion of the membrana tympani ; if not, it was an affection of the nerve. Here we see glimpses of deduction from the anatomical knowledge of the time.

Peter Forest, who must have been an Englishman, judging from his name, but who practised in Rome in this century, to whose works Lincke gives no definite reference, collected fifteen cases of aural disease that seem to have been carefully observed. One is a case of disease of the ear, ending in an affection of the brain and death. He speaks of pain in the ear caused by the rays of the sun, and he tells a wonderful story of a female deaf for seven years—so deaf that she could not hear a clock strike—who, being advised by that character so common in medical scenes, an old woman, to put some musk in her ear, did so, and was cured. He also tells how his teacher, *Gisbert Horst*, the director of a hospital in Rome, used to heal deafness with water that was distilled over a young mouse having no hair.

We trace one of the delusions that still lingers among us—namely, that the hearing is completely destroyed when the membrana tympani is broken—to a writer named *Hercules Sassonia*, who lived in this century. He also had the peculiar

notion that patients always spoke in a low tone when the disease of the ear was seated in the auditory nerve, because the nerve supplying the tongue, a branch of the fifth, was at the same time affected. In deafness arising from venereal disease, blisters behind the ear, and a mixture of oil of guaiacum and hydrochloric acid, as a local application, of which the patient drank a little, were highly spoken of.

1510–1590] The great Frenchman, the father of modern surgery, *Ambrosius Paré*, figures in otological history as the first one to employ a syringe for cleansing the ear.

1597] *Caspar Tagliacottzi*, of Bologna, who did so much for plastic surgery, did not neglect the ear, but attempted to restore the auricle by taking integument from the adjacent skin. He relates one case of a Benedictine Monk, where he had done this with success.*

1690] Although the aural speculum had been used a hundred years before, we find a certain *Johann Hartman* very unwilling to use it; for he seems to advise the detection of inspissated cerumen by the following simple method. He placed a curved silver tube into the ear, and blew through it. If the patient felt the breath to be cold, the deafness did not proceed from impaction of wax. In our day the detail of this method is sometimes simplified without altering the principle; that is to say, a probe is used to *see* if wax is in the ear. Through all this century, the seventeenth, there are numerous volumes on the treatment of the ear, but they all tread through the barren waste of drops and decoctions, theories, nomenclatures, and rank empiricism.

Lusitanus gives an amusing explanation of the practice of cutting off the ears of thieves. He said that such treatment rendered them incapable of propagating their kind, and hence no more thieves could be born of them. He founded this opinion on the statement of Hippocrates that the division of the veins behind the ear rendered a man sterile, because the

* The efforts made to instruct and to cure the deaf and dumb, which were first thoroughly incited in this half of the sixteenth century, we leave for a fuller discussion in the chapter on deaf-muteism.

semen, which was generated in the brain, could no longer pass down to the genitals.

Johann Baptista van Helmont, evidently a Belgian, casts away the theory that had so long prevailed, of deafness being caused by ascending exhalations, and clears up the whole matter by ascribing it to the work of the devil, or other evil spirits.

1640] *Marcus Banze* gives us the first idea of an artificial membrana tympani, by proposing to place a tube of ivory in the auditory canal, the end of which is covered by a bit of pig's bladder, as a protection to the exposed ear, when the membrana tympani was lost by ulceration.

1646] The renowned surgeon, *Fabricius* of *Hilden*, or *Fabricius Hildanus*, so called to distinguish him from *Fabricius* of *Acquapendente*, contributed somewhat to the surgery of the ear. He invented an instrument for extracting foreign bodies from the ear, as, indeed, every surgeon of eminence seems to have thought it his duty to do. He also wrote of the removal of aural polypi.

In the latter half of the seventeenth century, *Thomas Willis* attempted to prove, by experiments on animals, that total deafness does not ensue when the membrana tympani is destroyed. He also made some interesting observations on deaf persons who only heard in the midst of a noise. Von Tröltsch quotes one of these cases in his text-book,* that of a woman who could only hear her husband when a servant was beating a drum. The conversations in that family were probably not very protracted. This kind of impairment of hearing, which was called *paracusis Willisiana*, was referred by its describer to a relaxation of the membrana tympani, the normal tension being restored by the noise, or vibrations of the atmosphere.

1683] *Du Verney*, known by his labors in the anatomy of the organ, and his work on the diseases of the ear, contributed very little to sound knowledge, although he made an attempt to arrange the diseases in accordance with the anatomy. He, however, disputed the generally accepted opinion that a dis-

* Diseases of the Ear, American translation, 2d edition, p. 256.

charge of pus from the ear came from the brain, and showed that the meatus auditorius internus was closed by the auditory nerve, and that the pus must pass through the cochlea and the fenestra ovalis rotunda, before it could get into the external auditory canal.

Du Verney modified Hippocrates' suggestion to get at a foreign body not otherwise easily removed, by making an opening behind the ear, and recommended that the incision be made upon the upper side, because the vessels are smaller in this position. He thus anticipates Von Tröltsch, who made the same modification of the original suggestion nearly two hundred years later.*

We still continue, in the works upon the ear that appear in this century, to hear much of worms, or living larvæ, in the ear —a state of things, however common among the ancients, that is now very rare, because suppurating ears are usually cleansed. The disgusting and magical ear-drops of the early and dark ages are still used in this latter part of the seventeenth century. Thus one writer records that a Capuchin monk mixed the urine of a female donkey, that had brought forth but once, with that of a male hare, of a wolf, or in case of the absence of the latter, of an entirely white goat, warmed it, and adding a little oil of caraway, used it as drops for the ear. Urine of the various animals figures largely among the ear-drops of the period. *Paullini*, one of the writers of the day, is in doubt, however, whether it is proper that women should use the renal secretion of dogs as a remedy for deafness.

We begin to hear more in the latter part of the seventeenth century of the education of the deaf and dumb, but it is mingled with much that is absurd in attempts at treatment. The great error was then made, as it often is now, of supposing that the diseases of the ear which produced deaf-muteism were of a different nature from those which in the adult caused deafness only.

John Wallis, an Englishman, was perhaps the first to instruct a deaf-mute to speak—which he did, and that very well. The case was one of acquired deaf-muteism, the patient having

* Diseases of the Ear. American translation, p. 488.

lost his hearing at eight years of age; but he became able to read the Bible aloud, and to converse with some fluency.

Lincke begins his account of the progress of otology in the eighteenth century with the lament that it did not keep pace with the anatomical investigations of the organ, which had been brought to such a high point by the labors of *Valsalva*, *Cassebohm*, *Cotugno*, and *Scarpa*, and he says that Otology would have advanced very much faster had Antoine Marie Valsalva devoted himself more to its prosecution. But Valsalva did much to give us correct notions in regard to the diseases of the ear. He adduced cases where the membrana tympani had been restored. He showed that the hearing power is merely impaired, not lost, by a perforation of the membrana tympani. He recognized auchylosis of the base of the stapes as a cause of deafness. He gave us the Valsalvian experiment, the mode of forcing air through the Eustachian tube by a forced expiration with the mouth and nostrils closed, and he advises it as the best means of cleansing the middle ear from pus. He proved that the cavity of the tympanum is connected to the cells of the mastoid process, by a case in which he injected the former through a fistulous opening in the latter.* He also showed that stoppage of the Eustachian tube is often a cause of deafness. This is certainly a refreshing catalogue after we have been wading through the disgusting empiricism of the centuries before.

Valsalva's century is, however, also cursed with theoretic treatises on aural disease, such as that of one *Frederich Hoffmann*, who goes on, in the good old way, with instillations of wonderfully compounded ear-drops. Lincke mentions numerous inaugural dissertations of this time, but they relate chiefly to cases that were not properly understood by the reporters of them; and these authors, as well as their theses, are deservedly forgotten.

1774] *J. L. Petit* in a work upon surgical diseases, reports many interesting cases of caries of the temporal bone. In one case of suppuration in the ear, with caries of the mastoid, he advised that this part should be cut down upon and

* As I have elsewhere shown, this case was for a long time supposed to be one of perforation of the mastoid. Vide chapter on the disease of the mastoid.

trepanned. His advice was not followed and the patient died. He also relates cases where this operation was successfully performed, and he must therefore be considered as the originator of this valuable procedure.*

1735] We then come to the famous postmaster of Versailles, *Guyot*, who first injected the Eustachian tube. His own hearing was impaired, and in order to relieve it he introduced an angular tube of tin through the mouth, opposite *(gegen)*, not into, the Eustachian tube. The distal extremity of this instrument was attached to a leathern tube. This was connected to the reservoir of two small pumps, which were moved by two cranks and a wheel fastened in machinery, by means of which he forced fluid through a curved pewter tube, placed behind the uvula, into, or about, the mouth of his Eustachian tube, and removed the impairment of hearing.

1735] *Beck*,† who quotes from the *Hist. de l'Acad. des Sciences*, thinks that Guyot washed out the mouth of the Eustachian tube. We now know that the procedure alone is a very valuable one. I regret very much that I cannot get access to Guyot's original report to the French Academy.

About fifteen years later *Archibald Cleland*, an English physician, revised the operation of catheterization of the Eustachian tube, and introduced a tube through the nose, which was a much more practicable method than that of Guyot. His contemporaries seem to have paid little attention to his suggestions, for *Van Swieten* recommends catheterization of the tube through the mouth as a possible operation. Wilde attempts to claim the use of the catheter as a British discovery. He makes Guyot a mere suggester of the operation of catheterization, but I think the evidence is in favor of the French postmaster.

1755] *Jonathan Wathan*, an English author, reported cases of restoration of hearing by means of catheterization of the tube through the nose. His paper is in the Philosophical Transactions of the Royal Society. He seems not to have known of Cleland's labors in the same direction.

* For a full account of the operations on the mastoid, see the appropriate chapter in this work.

† Die Krankheiten des Gehoerorganes, 1827, p. 21.

Archibald Cleland still farther advanced the science of otology by introducing a three-inch convex lens, with a handle, as a means of examining the ear. The ear was illuminated by a waxlight attached to the lens.

1748] *Julian Busson* proposed, in rather an undecided way, to perforate the membrana tympani, in order to remove collections of pus from behind it; but, as this was a very dangerous operation, he advised the inhalation of vapors through the mouth and nose, and then that they be forced into the Eustachian tube by means of Valsalva's method, as he thought that the pus might thus be driven out of the middle ear.

The surgeons, after the seemingly complete failure of physicians to successfully treat diseases of the ear, animated by the invention of the Eustachian catheter and Petit's operation for perforation of the mastoid, seem to have been exceedingly active in otology during the latter half of the eighteenth century. *Antoine Petit*, as well as *Cleland*, recommended the use of an instrument through the nose instead of through the mouth, as proposed by Guyot, and injections through the tube are everywhere recommended in their writings.

The successful cases which were reported about this time were usually among young persons. The reason that the Eustachian catheter fell into such disrepute can be found in the fact, that it was used in chronic cases, in which the prognosis should have been pronounced bad or hopeless from the beginning, and a natural disappointment occurred from the want of success.

One very careful soul who seems to have been in great horror of the operation, proposed that patients upon whom the catheter was to be used should have the hairs of the nostrils removed, and a day before the operation that lukewarm milk, or a linseed-meal mixture, or the like, should be drawn into the nostrils, so as to make the parts more pliable.

1792] The operation of perforation or trephining the mastoid process fell into great disrepute because a Danish surgeon, *Berger*, caused it to be performed upon himself, and very improperly, for "deafness which had been years in occurring, and which was accompanied by vertigo, headache, and noise in both ears." Meningitis resulted, and the pa-

tient died in a few days. This put a stop to the performance of this very useful and necessary operation, until it was lately revived, chiefly by German and American surgeons.

1800] *Everard Home*,* by his writings, suggested to Sir Astley Cooper the operation of perforation of the membrana tympani, which the great English surgeon performed successfully in four cases. The history of the rise and fall, and revival of this operation will be found in the chapter on chronic non-suppuration of the middle ear.

John Cunningham Saunders† wrote a work on the ear, its anatomy and diseases, which went through several editions in England, and one in America.

It is a brief, but scientific treatise, and far beyond its predecessors. It is characterized by simplicity, and is without the absurdities of the older text-books. It is deficient in descriptions of the methods of examining the drum-head, and teaches the erroneous doctrine that it is proper to probe a membrana tympani to see if it be intact.

It should be remembered that Saunders advised paracentisis of the membrana tympani in cases of acute suppuration of the tympanum‡—an operation that was revived by Schwartze a few years ago.

He says: "But let it be admitted that the tympanum has suppurated, ought the membrana tympani to be abandoned to a casual ulceration, or is it better to open it by art? I am inclined to prefer the latter, and if I can be assured, by any symptom, that suppuration has taken place, I should not hesitate to make a small perforation of the membrana tympani, and to repeat it, if necessary, taking, at the same time, every precaution to suppress the fresh collection of matter."

Saunders speaks wisely against the objections made to checking a purulent discharge from the ears, and shows that disease of the brain is very apt to follow a neglected chronic suppuration, and he gives some interesting illustrative cases.

* Philosophical Transactions, 1800.

† The Anatomy of the Human Ear, &c. Edited by Wm. Price, M.D., Philadelphia, 1827.

‡ Ibid., p. 59.

The book is very deficient in its treatment of the Eustachian tube. Thus early do we find, in spite of Cleland's and Wathan's teachings, the English prejudice against the use of the catheter, which has only lately been overcome.

1817] *J. H. Curtis* also published a book on the ear,* but it added nothing to our knowledge, being a feeble imitation of the work of Saunders.

1819] *J. A. Saissy*, of Lyons, devoted the last twelve years of his life to the study of aural disease. He published a work on the ear, which attained the honor of a place in the "Dictionnaire des Sciences Médicales." This work was translated into English by Nathan R. Smith, the celebrated American surgeon.†

1821] *I. M. G. Itard*, Physician to the Royal Deaf and Dumb Institution in Paris, also publishes a treatise, which was translated into German,‡ and which did much in the pioneer work of clearing up the undergrowth of centuries of neglect.

Then followed *Deleau*, on the diseases of the middle ear and on perforation of the membrana tympani, an operation for which he claimed more than it deserved.

1827] *Karl Joseph Beck*, of Freiburg, published a Handbook of the Diseases of the Ear.§ It is a succinct and carefully written compendium of what was then known in this department of science, and has a very good bibliography, with the exception of the fact that the names of English authors are very often misspelled.

1833] *Wilhelm Kramer*, of Berlin, an author who still lives in a vigorous old age, brought out a work which was animated by the true scientific spirit, and which greatly simplified the practice of otology. He has since then published a number of volumes.

He introduced a valvular handled speculum, that was an improvement upon the very clumsy ones hitherto in use. He

* A Treatise on the Physiology and Diseases of the Ear, by John Harrison Curtis, Esq. 3d Edition. London, 1823.

† An Essay on the Diseases of the Internal Ear. Baltimore, 1829.

‡ Die Krankheiten des Ohres und des Gehörs.

§ Die Krankheiten des Gehoerorganes. Heidelberg und Leipzig.

also gave us the air-press, by which air or vapors could be introduced through the Eustachian tube into the middle ear.

In speaking of the practices of his predecessors, the intolerance of Kramer's spirit is seen—an intolerance which is painfully manifest in his later works.* In 1860 he speaks of the writings of Hinton of London—a writer whom, I am sure, all my readers will learn to respect, "as in every respect unimportant," while Toynbee's pathological investigations, to which science is so much indebted, are actually treated with sneers. In 1865, Kramer published a monograph,† which is essentially a review in a very unfriendly spirit of the labors of Toynbee, Wilde, Von Tröltsch, Erhard, Voltolini, and others, of whose writings I shall soon speak. What good work Dr. Kramer actually did for otology in his younger days has been overshadowed by his subsequent writings. In spite, of what I am almost inclined to call common sense, he still persists in rejecting the modern method of investigation, as well as the results of examinations of ears removed from persons who have been deaf. He still continues to use the handled bi-valved speculum, with sunlight as the only source of illumination, and on cloudy days sends away patients without examination; and because Toynbee made post-mortem examinations of many ears of persons whom he had not seen during life, Kramer rejects all pathological investigations, except experiments conducted upon a dead body or a glass model. He speaks of Politzer's method of inflating the middle ear, "as a miserable resort in cases of necessity, the employment of which, all pompous commendations to the contrary notwithstanding, stamps him who uses it with want of skill in the introduction of the catheter." Again he calls Toynbee, in his work published in 1867,‡ and this after Toynbee had lost his life in experiments as to the effect of chloroform and hydrocyanic acid, "a very poor aural surgeon." "Ein miserabler Ohren-arzt."

These are fair specimens of Dr. Kramer's style in dealing with an opponent, with any one who claims to have accom-

* Ohrenheilkunde der Gegenwart, 1860. Berlin, 1861.

† Ohrenkrankheiten und Ohrenartze in England and Deutschland.

‡ Handbuch der Ohrenheilkunde, p. 44. Berlin, 1867.

plished anything for aural pathology and therapeutics in any other way than by the employment of *his* catheters, *his* bougies, and his valvular-handled speculum.

In this review of what has been done to bring otology up to its present position, I have been compelled to notice the difficulties with which the advance of the science has been obliged to contend in the way of improper and unjust criticism, from one who, in this country and England, has acquired the reputation of a safe guide and leader in this part of the field of medicine.

1841] *George Pilcher* wrote an essay on the ear, which received the Fothergillian gold medal from the Medical Society of London. It is a valuable compilation. The section on foreign bodies in the meatus is full of warning interest. There is, however, very little of the author's own experience in the volume.*

In 1841, a gentleman from New York, consulted Dr. James Yearsley, of London, in regard to his deafness, who informed Dr. Y. that he was enabled to improve his hearing power, so that he could produce in his left ear a degree of hearing quite sufficient for all ordinary purposes. This was done by the introduction "of a spill of paper previously moistened with cotton to the bottom of the passage."†

This was the real discovery of the artificial membrana tympani, although Dr. Martel Frank, in his cyclopædic text-book, refers to a means of *preventing injury to the ear*, but not of improving the hearing when the membrana tympani is lost, which is the use of a silver, gold, or lead tube, the inner end of which is covered by a membrane. The fact that such a means of protecting the ear was used in 1640 has been already alluded to. It cannot be said, however, to be an artificial membrana tympani in the sense of Yearsley's cotton wool, which he soon substituted for the paper of the New York patient, or of Toynbee's disk of rubber attached to a wire. The artificial membrana tympani has proved itself a very valuable

* Treatise on the Structure, Economy, and Diseases of the Ear. American edition, 1843.

† On Deafness. Yearsley, p. 221.

means of treatment, and is in constant use by many of those who treat suppurations of the middle ear.*

Yearsley's book, as its title indicates, "Deafness Practically Illustrated," is not to be rated with the text-books of Wilde, Toynbee, Kramer, or Frank.

The work of *Dr. Frank*,† already alluded to, will be found a valuable work of reference, although it lacks individuality. Hoffman's (Tröltsch's) mode of examining the auditory canal and membrana tympani is fully described by Frank on page 49 of his book; but he attached no importance to it, not foreseeing that it was to supersede all other methods, as it has done, as improved and brought into general use by Von Tröltsch.

1843] The work of *William R. Wilde*,‡ surgeon to St. Mark's Hospital, which was republished in this country, where it has had a large circulation, and which was translated into German, probably did more to place our science upon a sound basis than anything that has been done in otology since the days of Valsalva. This work was founded on the observations of a careful observer, who had acquired fine habits of study as a skillful ophthalmologist. It was not, as the works of Lincke and Frank, a cyclopædia of what had been written on otology, nor was it full of absurd theories like that of Kramer, but it consisted in the application of thorough anatomical, physiological, and therapeutical knowledge to the study of an organ that had been hitherto treated as if it were *sui generis*, and not subject to the same accidents and diseases, and consequences of those diseases, as other parts made up, in like manner, of integument, of cartilage, mucous membrane, periosteum, and bone. In fact, Wilde—now Sir William Wilde, in consequence of the well-earned recognition of his Queen—brought otology, or aural surgery as he called this department, down from the terra incognita of the ancients to a point where it could be investigated by the average practitioner, and where it was respected by all. He gave us

* Frank, p. 293.

† Practische Anleitung zur Erkenntniss und Behandlung der Ohrenkrankheiten. Erlanger, 1845.

‡ Practical Observations on Aural Surgery. London.

the conical specula, reviving a suggestion of Dr. Newburg of Brussels and Ignaz Gruber of Vienna, and drove the unhandy ones of Fabricius and Kramer out of use. More than all, he taught us that the most of aural disease was dependent upon inflammation, and not upon that which was one of Kramer's pet ideas at that time, "nervous disease," whatever that may mean.

1860] Then came Toynbee's book,* which is mainly valuable for its anatomical and pathological investigations. It can never take rank with Wilde's book as a useful treatise for the practitioner, indispensable as were Toynbee's labors as an anatomist and pathologist. Mr. James Hinton's supplement has, however, materially improved Toynbee's treatise.

1861] Dr. Anton von Tröltsch, of Würzburg, published a monograph † upon the anatomy of the ear, in 1861, which he entitled a contribution to the scientific establishment of otology. It was certainly all that, and something more. While it gave a very simple and complete account of the anatomy, except that of the internal ear, there were many wise suggestions in the text with regard to the treatment of aural disease. Von Tröltsch showed himself to be what in the eyes of Kramer is a reproach, but what is, in those of the profession at large, an honorable position, a disciple of Wilde and Toynbee. He built upon the foundations which the clinical skill of the Irish, and the industrious labors of the English observer had made, and brought otology in Germany into a position which made it an inviting department of labor. His work upon the anatomy contains the results of many original investigations, which will be found in the anatomical descriptions of this volume.

1862] This work on the anatomy of the ear was soon followed by a text-book upon its diseases,‡ which had the same scientific characteristics with the monograph upon the anatomy. It has been translated into the English, French, and Italian languages. In this country it met with great

* The Diseases of the Ear: their Nature, Diagnosis, and Treatment. Reprint, Philadelphia.

† Die Anatomie des Ohres. Würzburg, 1861.

‡ Die Krankheiten des Ohres.

favor, having passed through two editions, and it has given tone to all the otological literature and investigations of its day.

Von Tröltsch improved and brought into general use the method of illumination first proposed by Dr. Hoffman, of Westphalia, and thus at one step advanced the science very materially.

In 1862, the same year that Von Tröltsch issued his text-book, Dr. Adam Politzer, of Vienna, promulgated his method of injecting the middle ear with air, or of inflating the middle ear. It is hard to overestimate the value of this simple procedure, and the benefit to our science and art that its invention caused.

The writer can but quote the opinion of an eminent practitioner of this city, who in speaking of Politzer's method once said to him: "If a man were to take this air-bag, and travel through the country, advertising himself as an aurist, and blow up all the ears indiscriminately that were brought to him, he would be a very successful quack." Indeed, the effects of this means of treatment, especially in the case of children, or adults who have suffered but a short time from impairment of the hearing, from disease of the middle ear, are often wonderful.

1863] Dr. *Julius Erhard* published a work upon the diseases of the ear, which is a peculiar mixture of truth with error. The book is rather curious and interesting.*

In 1864, Dr. *von Tröltsch*, Dr. *Politzer*, and Dr. *Herman Schwartze*, of Halle, issued the first number of the Archiv für Ohrenheilkunde, a work which has been regularly continued under their management, and which has formed a true guide to the otological student and practitioner.

In 1865 Dr., now Professor, Politzer published a monograph upon the membrana tympani, which was translated into English, and published in the United States, by my friends and colleagues Drs. Arthur Mathewson and Homer P. Newton, of Brooklyn. The frequent use which every recent writer on otology is obliged to make of this valuable monograph, is sufficient evidence of its merit.

In October, 1867, the first number of the Monatsschrift für

* Klinische Otiatrie. Berlin.

Ohrenheilkunde was issued, under the direction of Dr. *Voltolini*, of Breslau, Dr. *Josef Gruber*, of Vienna, Dr. *F. E. Weber*, of Berlin, and Dr. *N. Rüdinger*, of Munich. All of these editors have contributed very much to the scientific advance of otology; while Dr. Rüdinger has probably done more than any anatomist of his day to elucidate the anatomy of the Eustachian tube. His photographic atlas of the ear is a work of permanent value, and one of which the author has made frequent use in illustrating some of the chapters of this work.

1866] Dr. *S. Moos*,* of Heidelberg, issued a practical treatise on aural disease in 1866, and Dr. *Gruber*,† of Vienna, one in 1870. Both of these volumes show much original research and are worthy of an English translation, which would bring them before a much larger circle of readers.

The American Otological Society was established in 1868, and has held annual meetings since, and has published four volumes of Transactions. To these papers the author has had frequent occasion to refer in the preparation of the following chapters, and it is believed that they furnish evidence of the high character of the work that has been done by American otologists.

No outline of what has been done in the last twenty years for otology would be complete without a reference to the writings of Professor Edward H. Clarke, of Harvard University. Dr. Clarke published a paper on perforations of the membrana tympani,‡ its causes and treatment, which was probably the best that had been written on this subject. It received a full recognition among foreign authorities. In this article is contained a very important sentence, quoted by Von Tröltsch in his text-book, a passage full of meaning and warning: "*So necessary is a careful attention to the ear, during the course of an acute exanthema, that every physician who treats such a case without careful attention to the organ of hearing, must be denominated an unscrupulous practitioner.*"

Dr. Clarke has also published a monograph upon polypus

* Klinik der Ohrenkrankheiten.

† Lehrbuch der Ohrenheilkunde.

‡ American Journal of the Medical Sciences, January, 1858.

of the ear, which contains very much of value as to the nature and treatment of these products of inflammation.*

In 1869, Drs. *H. Knapp*, of New York, and *S. Moos*, of Heidelberg, began the publication of the Archives of Ophthalmology and Otology, which are issued simultaneously in English and German, and which have added much to the scientific interest in otology. The union of the two branches of science in so valuable a journal has certainly assisted to gain the respect of the profession for the department of otology.

Dr. *Lawrence Turnbull* issued a treatise on the ear in 1872, which more than any other book as yet published exhibits the work done in otology on this side of the Atlantic.

Lincke, writing in 1840, regrets that in Germany no clinique for the treatment of aural patients had as yet been organized. *Dr. Reiner*, he says, had attempted to do so in Munich, but had failed, as had Dr. Lincke in Leipsic; and we know that Saunders and Cooper had failed in establishing one in London; for in 1804, Saunders had an eye and ear infirmary in London, under the name of the "New London Dispensary for Curing Diseases of the Eye and Ear." But the aural part was so unsuccessful, that it became necessary to close it to the aural practice. John Harrison Curtis, in 1816, was more successful, and when Lincke wrote, his dispensary was still carried on. In 1828, the New York Eye and Ear Infirmary, which had been in existence eight years, treated 91 cases of diseases of the ear, to 925 of diseases of the eye. That institution, according to its last published report, treated more than 2,000 aural cases, while every large city of Europe and America now enjoys the benefits of institutions where aural diseases are properly and specially treated.

The striking want of success in the treatment of aural disease was due to the fact, that as yet no simple means had been found for examining the membrana tympani and auditory canal. Besides this, the pharynx was not recognized as the point of origin of the most of aural diseases, and there was not a simple means of opening and treating the Eustachian tube. All these difficulties have been removed in the

* Observations on the Nature and Treatment of Polypus of the Ear. Boston, 1867.

nineteenth century, and in many details of treatment great advances have been made, which render the care of aural disease quite as satisfactory as that of any other of human ills. This is not altogether due to the fact that so many new truths have been discovered, but much of the gratifying change has resulted from the sweeping away of the webs of error.

In concluding this introductory chapter, the author begs that the reader will bear in mind, that he has not attempted to make it more than an outline of what has been done in otology from the earliest times until our own day. I have attempted to sketch only that which has left its traces upon the science, and which has contributed materially to its progress. I have merely desired to give such a historical account of the work of the Fathers as would render any frequent references to them unnecessary in the body of this work, and one which may be a guide and encouragement for the workers of the present and the future. The results of the investigations of a more recent period will be found, as far as they pertain to the subjects treated in this volume, in the appropriate chapters.

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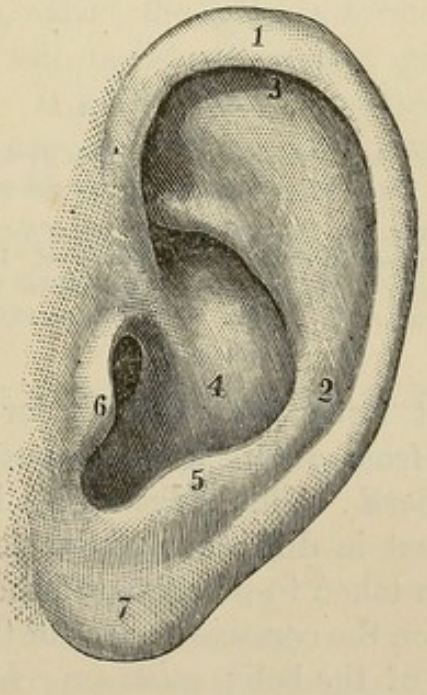
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CHAPTER II.

ANATOMY OF THE AURICLE AND THE EXTERNAL AUDITORY CANAL.

THE beautiful appendage to the organ of hearing, which is called the auricle, or *little ear*, has as its functions the reception, reflection, and condensation of the waves of sound. Its general shape is that of a funnel. Its framework, or basis, is made up of flexible fibro-cartilage, and it is from one to two millimetres in thickness. The cartilage is of the variety known as reticular, and it is covered by perichondrium which contains many elastic fibres. These fibres pass into the substance of the cartilage, and form a network in the meshes of

FIG. 1.

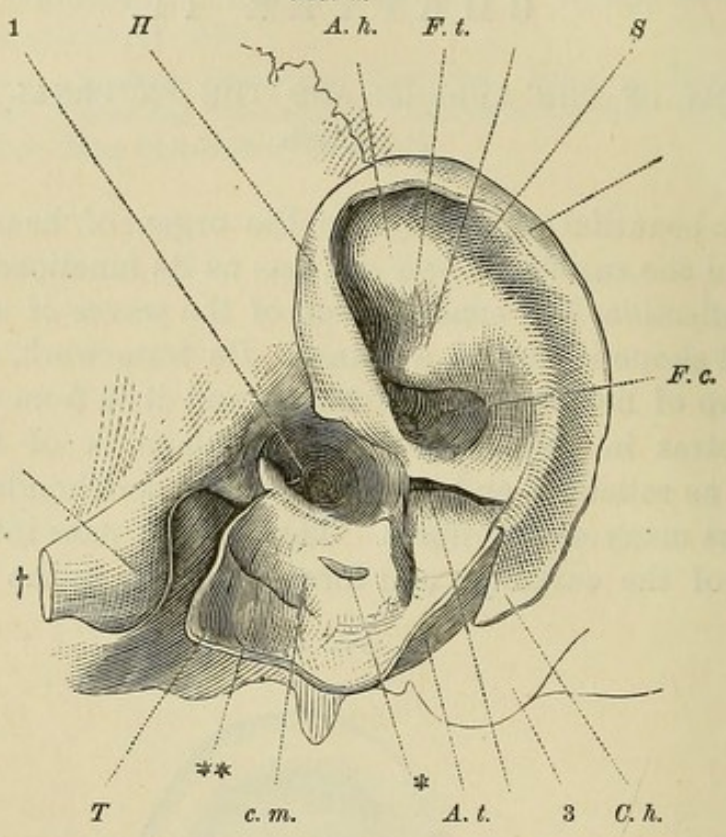


The Auricle.

1. *Helix.* 2. *Anti-helix.* 3. *Fossa helicis.* 4. *Concha.* 5. *Anti-tragus.* 6. *Tragus.* 7. *Lobe.*

which small cartilage cells are embedded. From the time of Rufus of Ephesus (see page 19), the different parts of the auricle, which give it its beautiful and useful shape, have been named as follows:

FIG. 2.



Profile View of the Skull, with the Skeleton or Cartilage of the Auricle, as well as that of the External Auditory Canal. The latter is exposed and drawn downwards, c.m. *After Henle.*

1. *Meatus auditorius externus.* 2. *Tuberculum articulare of the temporal bone.* 3. *Mastoid process.* † *Transverse section of the zygomatic process.* H. *Helix.* A. h. *Anti-helix.* F. t. *Fossa triangularis.* S. *Scapha, or Fossa navicularis.* F. c. *Concha.* C. h. *Cauda helicis.* A. t. *Anti-tragus.* T. *Tragus.* ** *. *Fissures in the cartilage of the external auditory canal.*

The edge that forms the outer border of the auricle is called the *helix*, from a Greek word, ελιξ, *anything twisted*, ελισσω, *to turn around*.. This ridge varies in breadth, and is more or less distinct in different individuals, according to the care that has been taken to preserve the shape of the ear. It begins at a point on the concave surface of the cartilage, called the spine or crest of the helix, *spina seu crista helicis.* By following down the posterior border with the finger, it will be seen that its tissue does not pass into the lobe of the ear, but that the latter is formed by the integument alone.

Just beneath the helix is a fossa—*fossa navicularis*, or 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*, or goat, because hairs usually grow upon this part, which were supposed by the ancients to give it a certain kind of resemblance to the beard of that animal. Just opposite to this, across the mouth, or meatus, of the auditory canal, is a similar projection called the *anti-tragus*. The greatest concavity of the auricle is called the *concha*, from a Greek word meaning concave 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 a depression of a triangular shape, *fossa triangularis*.

Elastic fibrous bands, springing from the malar bone and mastoid process, fasten the auricle in its position, and allow a certain mobility to it. 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 extremity of the ear, a projection of tip, called the lobe, is formed. This portion is poorly supplied with blood and nerves, and is consequently not very sensitive. It is also very distensible, and when overburdened by heavy ear-rings may become very much elongated, and thus its beauty be greatly marred.

In rare cases the cartilaginous structure extends to the lobe, when severe reaction will follow the usually harmless operation of boring the ears for the insertion of ear-rings.—*Gruber*.*

MUSCLES OF THE AURICLE.

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

I. *Levator* or *Attollens aurem*,
II. *Attrahens aurem*,
III. *Retrahens aurem*.

They are placed immediately beneath the skin. In man they are usually rudimentary ; but they are the analogues to

* Lehrbuch, p. 61.

certain 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. I have often observed their action when patients were listening for the ticking of a watch, which was being gradually approached to the ear, and it may be observed when such persons are attempting to hear distant sounds.

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 aurem* 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 aurem* consists of two or three bundles of fibres, which arise from the mastoid process. They are inserted into the lower part of the cranial surface of the concha.

The names of these muscles indicate their action: the levator slightly lifts the auricle, the attrahens draws it forwards and upwards, and the retrahens draws it backward.

Hyrtl states that no animal has a lobe as a part of the auricle, and that none of the mammals living in water have this appendage.*

INTRINSIC MUSCLES.

The auricle has also a set of muscles which are contained in its structure; *intrinsic* muscles, as they are called by several authors. With a single exception these muscles run between different parts of the cartilage of the auricle and of the auditory canal.

They are all muscles of animal life, but they are very slightly developed, and are therefore 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. It is possible, although not

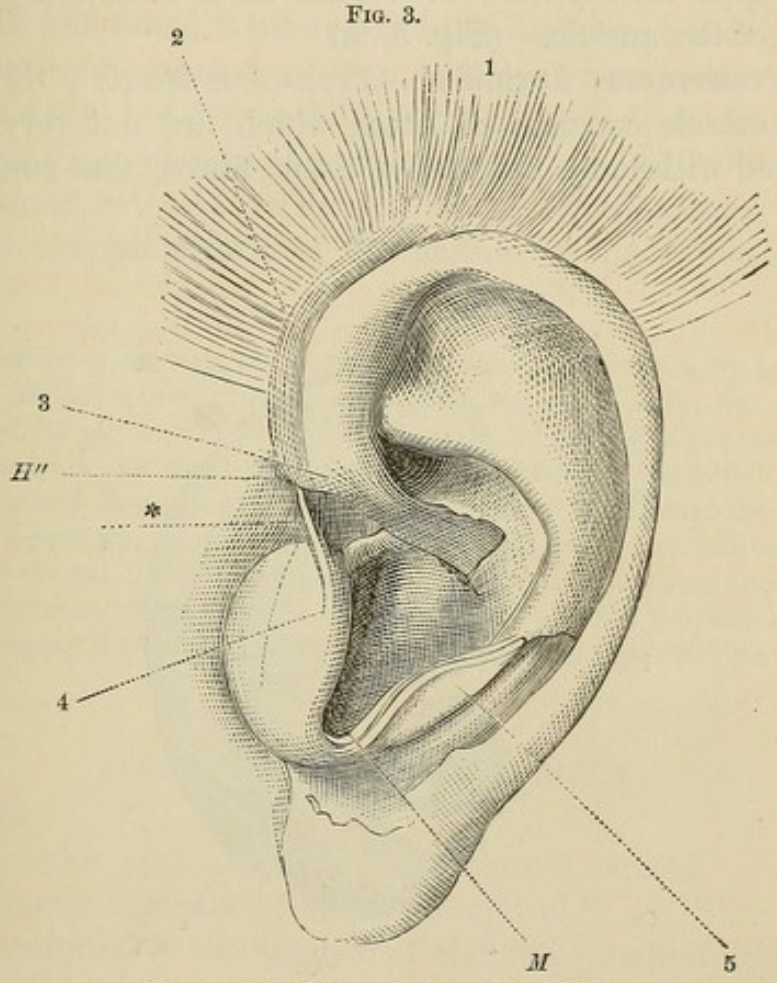
* Lehrbuch der Anatomie des Menschen, Bd. II, p. 517.

certain, that they always exist at birth, but that 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

FIG. 3.



Muscles of the External Ear. After Henle.

M. *Meatus auditorius externus.* H″. *Spine of the helix.* 1. *Attollens, or Levator aurem.* 2. *Helicis major.* 3. *Helicis minor.* 4. *Tragicus.* 5. *Anti-tragicus.*

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. (See Fig. 3, 4.)

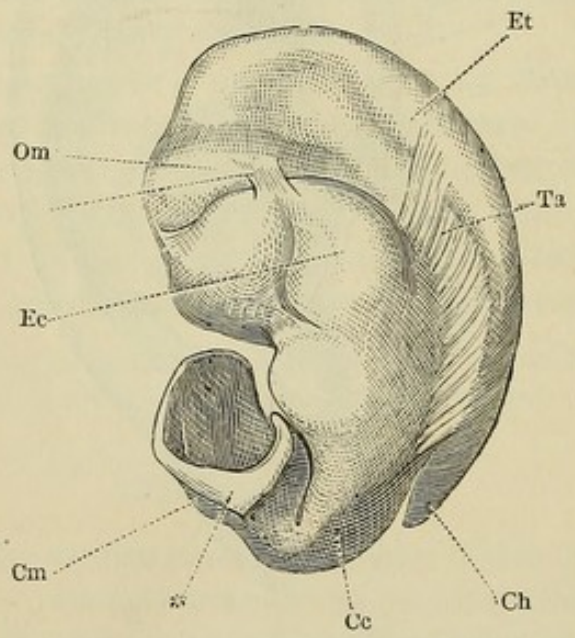
2. **Anti-tragicus.**—This muscle lies on the posterior surface of the posterior wall of the cartilage of the meatus. (See Fig. 3.)

3. **Helicis Minor.** Henle says that this is the most constant of the muscles of the auricle, and that it is often the strongest of the intrinsic muscles. It is a fan-shaped muscle, and is found on the lateral surface of the helix between its root and spine. (Fig. 3, 3.)

4. **Helicis Major.**—This muscle runs over the anterior margin of the helix, and is only loosely connected with it, and passes over into a kind of tendinous termination into the levator of the auricle. (Fig. 3, 2.)

5. **Transversus Auriculæ.**—*Transverse Muscle of the Auricle.* —This muscle consists of fibres which are not very thickly combined with loose connective tissue fibres, that run on the

Fig. 4.



View of the Cartilage and Muscles on the Posterior Surface of the Auricle. After Henle.

E. t. *Elevation made by fossa mangularis.* E. c. *Elevation formed by concha.* O. m. *Oblique muscle.* E. s. *Elevation of scaphoid fossa.* T. a. *Transversus auriculæ.* C. m. *Cartilage of the external auditory Canal.* *. *Attachment to the edge of the osseous canal.* C. c. *Cartilage of the auricle.* C. h. *Cauda helicis.*

posterior surface of the auricle from the scaphoid fossa to the concha over the deep furrow corresponding to the anti-helix. (Fig. 4.)

6. **Oblique Muscle of the Auricle.**—*Obliquus Auriculæ.*—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. (See Fig. 4.)

7. **Dilator of the Concha.** *(Masculus incisuræ majoris auriculæ Santorini.)* Sometimes the above-named muscle is found on the tragus.

*Hyrtl** has found it arising from the anterior circumference of the external meatus, whence it runs downwards and outwards to the lower border of the tragus, which it draws forward, and thus enlarges the space of the concha.

The same author says that he knows of no instance of the voluntary change in form of the auricle by the action of this muscle.

"The power of moving the auricle as a whole, is, however, by no means very rare. *Haller* speaks of many such cases, and *B. S. Albin*, the greatest anatomist of the eighteenth century, used to take off his wig at his lectures, to show his students how easily he could move the muscles of the auricle."

Duchenne and *Ziemssen*,† by means of faradization, found that the muscles of the cartilage of the meatus narrowed the *incisura auris*, and thus the canal leading into the ear, preventing a portion of the sound undulations from reaching the membrana tympani, while, according to *Duchenne*, the helicis major and minor lift up the helix, and thus favor the access of the sound waves.

BLOOD-VESSELS OF THE AURICLE.

Arteries:

1. Posterior auricular, from the external carotid.
2. Anterior auricular, from the temporal.

(The temporal is the smaller of the two terminal branches of the carotid.)

3. An auricular branch of the occipital.

It will thus be seen that 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.

* Hyrtl, l. c., p. 518.

† Henle, l. c., p. 729.

NERVES OF THE AURICLE.

The nerves are the—

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

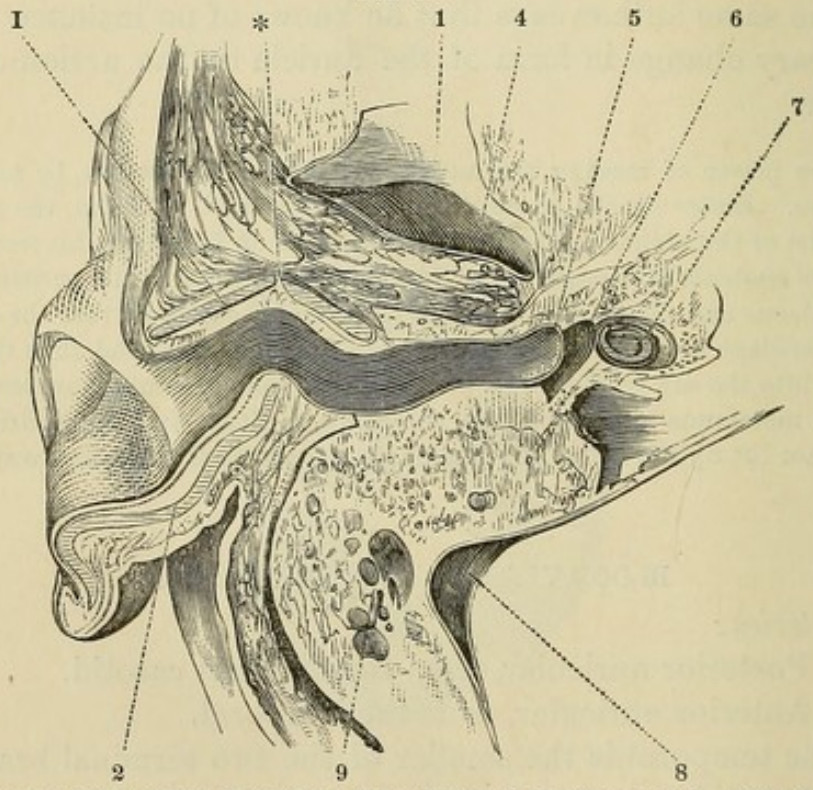
2. Posterior auricular, from the facial.

3. An auricular branch of the pneumogastric.

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

The branches of the cervical plexus are on the posterior side of the auricle.

FIG. 5.



Horizontal Section of the Head, through the External Auditory Canal. After Henle.

1. *Cartilage of the External Auditory Canal.* *. *Fissure in the cartilage.* 2. *Cartilage of the Auricle.* 3. *Tuberculum articulare of the lower jaw.* 4. *Fossa mandibularis.* 5. *Membrana tympani.* 6. *Cavity of the tympanum.* 7. *Vestibule.* 8. *Transverse sinus.* 9. *Mastoid cells.*

External Auditory Canal. (Meatus Auditorius Externus.)—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.

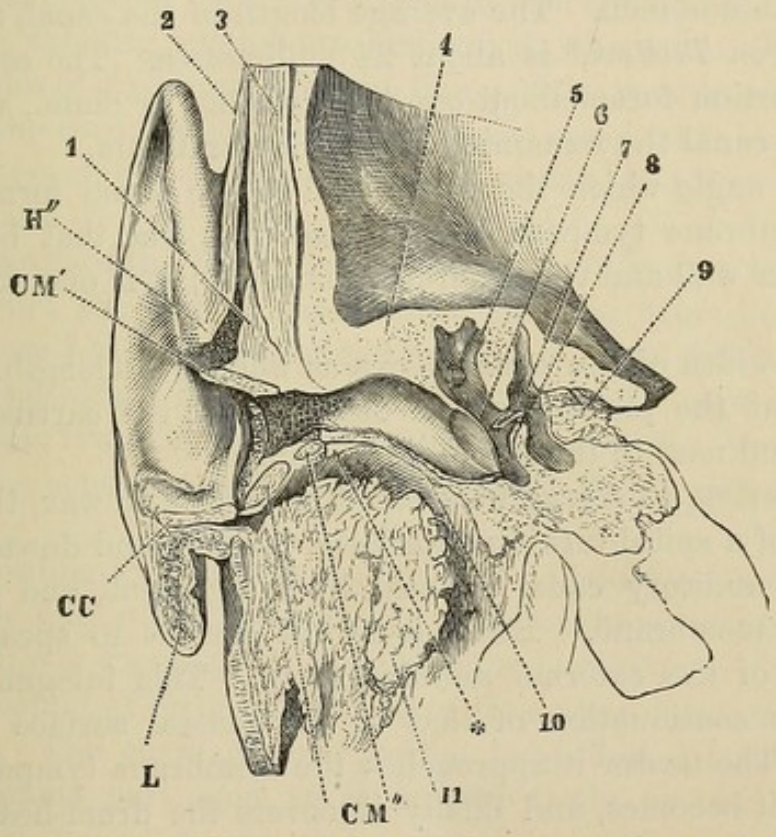
Its external opening, which is formed by the cartilaginous

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 horizontal plane, the walls of the canal 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.

FIG. 6



Section through the External Meatus and the Ear at the point of junction of the Cartilage of the Auricle, c c, *with that of the Auditory Canal. After Henle.*

A small portion of the upper wall of the latter remains as a narrow band, CM′. CM″. *Lower wall of the cartilage of the external meatus.* H″. *Spine of the helix.* L. *Lobe of the ear.* *. *Fibrous lip of the border of the osseous meatus.* 1. *Epicranius temporalis muscle.* 2. *Levator auricularis.* 3. *Temporal muscle.* 4. *Upper wall of the osseous canal.* 5. *Cavity of the tympanum.* 6. *Membrana tympani.* 7. *Stapes bone.* 8. *Vestibule.* 9. *Meatus auditorius internus and acoustic nerve.* 10. *Lower wall of the osseous meatus.* 11. *Parotid gland.*

The first curvature is described by Henle as zigzag in

shape, and is well shown in the two preceding cuts. This curvature is constant.

These curvatures may be overcome, and the outer portion of the canal rendered nearly if not quite straight, by drawing the auricle upwards and backwards.

The cartilaginous portion of the canal is interrupted, especially on its inferior wall, by gaps and fissures—the so-called *Incisuræ 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. (*Sulcus pro membrana tympani.—Hyrtl.*)

The length of the canal, according to *Hyrtl*, varies from 9 lines to one inch. The average length of the canal, according to *Von Tröltsch*,* is about 24 millimetres. The cartilaginous portion forms about one-third of this, or 8mm., and the osseous canal the remaining two-thirds, or 16mm.

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

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

According to *Hyrtl*, if the canal be filled with wax, the cast is that of a spiral turning anteriorly, inwards and downwards.

The auditory canal is lined by integument, and not by mucous membrane. Hence it is not correct to speak of a catarrh of the external auditory canal. This integument is merely a continuation of that of the general surface of the body. 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 1½mm. thick, and contains soft hairs, with their sebaceous glands, the ceruminous glands, and a little fat in its subcutaneous tissue. In the osseous part of the canal, the integument is only 0.1mm. in thickness, the soft hairs become very

* Treatise on the Ear, 2d American Edition, p. 18.

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 are found arranged in rows under the cuticle, and also a corium with abundant elastic fibres, of which the lower layers pass into the periosteum." *

The ceruminous glands are like the sebaceous or sweat glands in their development and secretion. The only difference between the secretion of the two kinds of glands, is that the ceruminous glands contain some coloring matter. (*Cerumen* is probably derived from *cera aurium.—Hyrtl.*)

The substance of the ceruminous glands is a yellowish white, rather fluid material, which consists essentially of fat globules, coloring matter and cells in which single globules of fat and coloring matter are embedded; there are also hairs and scales of epidermis from the lining of the meatus.—(*Kessel.*) 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.

Sometimes the hairs of the canal grow to such a length as to obscure the view of the meatus and the drum-head. In such cases I have been obliged to remove them with a pair of curved scissors. They may also drop off, and, lodging on the membrana tympani, become a source of annoyance, by causing a tickling sensation in the ear. Dr. R. F. Weir relates such a case.†

According to *Buchanan*, an author who laid too much stress upon the part which the cerumen plays in the economy, there are from one thousand to two thousand ceruminous glands.

The child at birth, and for some time after, has no osseous meatus. The cartilaginous portion is at first attached to a membranous part, just as it is afterwards to the osseous portion.

Gruber ‡ thinks that there is a very narrow rim of osseous canal in the last months of embryonal life.

In the newly-born this membranous portion constitutes

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

† Transactions American Otological Society, 3d year.

‡ Monatsschrift für Ohrenheilkunde, Bd. II., p. 67.

about one-half of the canal; but it gradually becomes shorter as the bone grows outwardly.*

This ossification proceeds irregularly, and often leaves a foramen, which, according to Von Tröltsch, has been mistaken for a pathological condition, the result of caries.

An inflammation of the meatus in a young child, as shown by the same author, might readily pass through this foramen to the maxillary articulation or parotid gland.

The auditory canal of the dog and cat are closed at birth, as are their eyelids. There is, perhaps, as Von Tröltsch suggests, an analogous condition in the closure of the meatus of young children with *vernix caseosa*, and the approximation of the walls of the meatus, near the membrana tympani.

Some birds have the power of stopping their ears by a kind of valve. The turkey has a kind of erectile tissue projecting into the meatus, so that it can close the ears more or less perfectly when angry.—(*Von Tröltsch.*)

RELATIONS OF THE AUDITORY CANAL.

The cartilaginous portion is bounded anteriorly and inferiorly by the parotid gland. Cases have been observed where 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 caliber of the canal by pressure.

The anterior wall is also in relation with the posterior wall of the articular fossa of the inferior maxillary bone. Hence a blow upon the chin may produce a fracture of this plate, and cause a hemorrhage from the ear. The thick articular cartilage protects the auditory canal and temporal bone from the full force of such a blow.

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.—(*Von Tröltsch.*)

The wall between the integument of the canal, as is shown

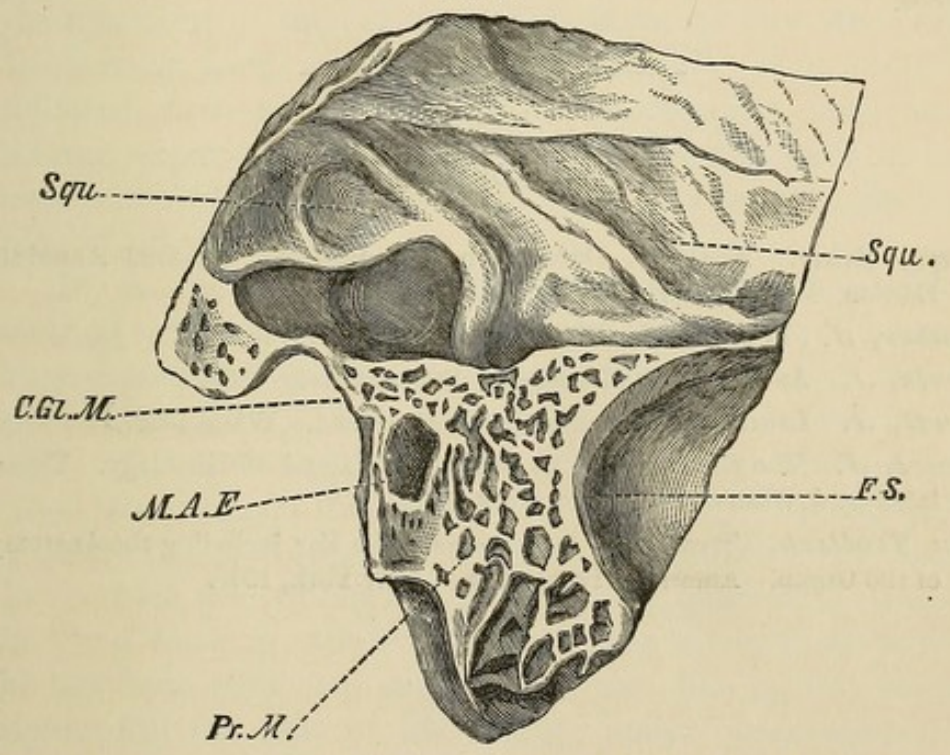
* Von Tröltsch, l. c., p. 6.

by the instructive section that is given below, may be exceedingly thin, and inflammations of the meatus may produce disease of the brain.

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 beyond 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.

The importance of these relations was first fully pointed out by Von Tröltsch.

FIG. 7.



Vertical Section of the Osseous Meatus, right side, close to the Membrana Tympani. After Von Tröltsch.

M. A. E. *External auditory canal.* C, gl, m. *Articular fossa of lower jaw.* Sq. *Inner part of the squamous portion of the temporal bone. The dura mater has been removed.* F. S. *Fossa sigmoidea for the sinus transversus.* Pr. M. *Mastoid process.*

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 third branch of the tri-facial or fifth nerve. These enter through the anterior wall, between the cartilaginous and osseous portions.

2. An auricular branch from the pneumogastric, which enters the anterior wall of the bony canal.

This auricular branch was first described by *Arnold* in 1828.

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.

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CHAPTER III.

THE EXAMINATION OF AURAL PATIENTS.

It is a self-evident proposition, that in order to intelligently treat any disease, we must carefully and thoroughly examine the parts involved. This is certainly as true of the affections of the ear as it is of those of any other organ. In making such an examination a definite plan should be followed, even in the seemingly simple cases, until at last a large experience enables the practitioner to omit or hurry over some of the details which were necessary in the beginning of his practice.

In the examination of an aural patient, the following method is the one that I have found very useful:—I usually keep a record of the cases; a plan which the young, and consequently not very busy, practitioner will find extremely valuable. The name, age, and occupation of the patient are noted. The history should then be given. This history should include a pretty full statement of the general condition, the diseases from which the patient has suffered, the number of times he has had what is called "ear-ache," the medication to which he has been subjected, and so on, from his earliest recollections until the date of his coming under observation as an aural patient.

By no other means than by eliciting such a history, can the practitioner get the essential knowledge for a thorough understanding of the subjective manifestations of the affection of the ear. It is very important to ascertain when the troublesome symptoms were *first* observed. Sometimes several minutes will be consumed in obtaining an answer to this question. The first reply will be, perhaps, "A few months ago," or, "A year or two." If this response be followed by

the inquiry, "Before that time were your ears perfectly well?" in many instances the patient will state, "Well, no. I have had a little dulness of hearing on one side, for ten or twelve years, or for a good while" (which proves to be a number of years); or perhaps he says, "There has been a little discharge from that ear, 'which didn't amount to much,' ever since I had the scarlet fever or the measles." As illustrative of this point, I may mention a case which lately came to my clinic; the patient, an old man, gave the following history: While sitting quietly by the fire, blood began to run from his ears, until he had lost quite an amount; he stated positively that this was the first time in all his long life that he had ever been affected with an affection of the ear, and that he could imagine no cause for it. On close examination in the manner of questioning above indicated, he admitted that he had suffered from a "slight running from the ears, which didn't signify, ever since he was a child." An inspection of the organs showed that both membranæ tympani were removed by ulceration, and that exuberant granulations existed, which accounted for this seemingly mysterious hemorrhage, to which the patient could assign no cause.

It is well in obtaining the history to allow the patient to tell his own story, occasionally interrupting him, as may be necessary, in order to keep him to the matter in hand. After having thus obtained as accurate an account as possible, the next step is to test the amount of hearing. We have three tests for the hearing power:

1. Ordinary conversation.
2. The tick of a watch.
3. The tuning-fork.

The first of these tests, the power of hearing conversation, perhaps tells the most about a person's practical hearing power, and yet it is the one that is carried out with most difficulty. There are many persons who can hear the tick of an ordinary watch but a short distance, say six inches, and yet are able to hear ordinary conversation with some ease; and on the other hand, there are others who can hear the same watch twice as far, but who are utterly unable to enjoy conversation carried on in an ordinary tone. About the best test

of the hearing power that we have, is the one which shows the patient's capability for hearing what is said in social intercourse, at the table, in the drawing-room, and so on. Inasmuch, however, as practitioners, especially those who live in large cities or towns, have not always, or even usually, the opportunity of making such a test of their patient's hearing capabilities, and since the amount of this power, although it may be appreciated by the observer himself, cannot be made clear to one who simply reads the case, we are obliged, in recording the histories of patients, to be content with a statement as to how far an ordinary ticking watch may be heard, or at what distance words can be understood when they are directed to the person observed, with his face so placed that he cannot see the mouth of the speaker. This latter precaution is an essential one, since all persons with impaired hearing soon learn to watch the lips of the speaker, in order to compensate for their loss of hearing power.

In testing the hearing by means of the watch, it should be first placed at a distance at which its ticking cannot be heard by the patient, and then gradually approached to a situation where the ticks can be accurately counted. The latter may fairly be considered as the farthest point of distinct hearing. The ear which is not being tested should be closed during the examination by the hand. It is hard to state the distance at which a watch should be heard by a healthy ear, for the simple reason that different watches may be heard at different distances, so varying is the distinctness of the tick. It may be approximately stated, however, that an ordinary ticking watch should be heard, by a person with average hearing power, at least four feet. To this rule there are, however, exceptions. For instance, I know a medical gentleman in this city, who, as tested by the ordinary transactions of professional and social life, is not at all hard of hearing, who cannot hear a watch of common tone more than six inches. Exact examination would undoubtedly show that this gentleman's hearing is defective with regard to all tones like those of a watch.

In testing the hearing power by means of a watch, it is well to remember, as Von Tröltsch suggests, that all watches are

heard better immediately after they are wound, and also that the intensity of their sound is increased by holding them so that the surgeon's hand covers the back, or when they are held by the patient's own hand. In the two latter instances the cause of the increased clearness of the tick is, in the one case, the retardation of the reflection of sonorous waves from the watch, and in the other, the conducting power of the patient's own arm as it is stretched out.

The use of a tape or other measurer, to note the number of inches at which the watch is heard, is indispensable for an accurate record of a case. The measure should not be used, however, until the distance has been ascertained without it.

When the patient cannot hear the watch at any distance from the ear, it should be laid or pressed upon the auricle, mastoid process, or forehead. Before using a watch for the purpose of testing the hearing power of diseased ears we should carefully ascertain how far it may be heard by persons whose hearing is unimpaired.

My friend *Dr. J. S. Prout*, Surgeon to the Brooklyn Eye and Ear Hospital, has greatly facilitated our means of recording the hearing power, by a simple method, which is somewhat analogous to that used in estimating the acuteness of vision; but, as Dr. Prout says,* "the accuracy with which we measure the visual power by Snellen's test types, and record the results obtained, cannot be arrived at by means of any of the usual sound-makers (sonofactors); nor will it be until an instrument can be made which shall always produce uniform tones." Dr. Prout recommends a formula for registering the hearing power, which he describes as follows: "For nearly three years I have recorded the hearing power as a fraction, the numerator of which is the distance at which the particular sound is heard, the denominator the distance at which it should be heard by an ear of good average hearing power. This denominator must vary according to the sonofactor used, and should generally be expressed in inches.

"For still further simplification, and that the method may be adapted to international use, I suggest the following abbreviations: A. D., auris dextra, instead of right ear, or R. E.;

* Boston Medical and Surgical Journal, Feb. 29, 1872.

A. S., auris sinistra; P. A., P. aud., potentia auditûs, hearing power; V., vox, the spoken voice; V. S., vox susurrata, whispered voice—or simply S., susurrus, a whisper; H., horologium, the watch.

"If this system should become general, then the formula P A, A D, H, $= \frac{12}{36}$, would to all otologists represent the fact that a watch that should be heard at 36 inches was heard by the right ear of the patient at a distance of 12 inches; the formula P A, A S, V S, $= \frac{6}{36}$, would mean that the whispered voice was heard by the left ear at 6 inches that should have been heard at 36 inches."

I have employed Dr. Prout's method (more or less) for some years. My own watch can be heard by a person with good hearing power, at least 48 inches. It will be seen that if I wish to express the hearing power of a person who hears that watch one inch, I would use the fraction $\frac{1}{48}$, and so on. If the patient only hears the watch when brought in contact with the ear, we may employ the formula $\frac{c}{48}$; if only on pressure, $\frac{p}{48}$; if not at all, $\frac{0}{48}$.

THE TUNING-FORK.

The tuning-fork is of value in determining if any disease of the auditory nerve exists, and if so, whether its lesion predominate over the affection of the outer parts of the ear.

As is well known, if we close our ears, and speak, the sound of the voice seems to be confined to the head, as it were; its reflection being to a certain extent prevented by the closure of the external auditory canal. If now the auditory nerve be sound, and there be impacted wax in one auditory canal, or a thickening of the mucous membrane lining the cavity of the tympanum, the state of things will be similar to that when the external meatus of a healthy ear is closed by the finger, or by some similar means, and the vibration of the tuning-fork will be heard more distinctly by an ear thus affected than by the sound one. If the ears are equally affected, it will be, of course, more difficult to come to a conclusion. If the nerve be seriously impaired, either primarily or secondarily, by disease which has extended from the mid-

dle ear, no such marked difference will be noticed when the external meatus is closed.

Again, when the tick of a watch cannot be heard at all, if the auditory nerve be not seriously impaired, the vibrations of the tuning-fork, when its handle is placed on the teeth, forehead, or mastoid process, will be distinctly heard; while if the nerve be the seat of serious lesion, so that absolute deafness exists, these vibrations will not be at all perceived in the head. Some deaf-mutes, who were born deaf, and probably with a disease of the central apparatus, have assured me that they always felt the sound of the tuning-fork passing to the region of the diaphragm or stomach, and they would involuntarily place their hand there when the vibration began. The large tuning-forks of the note C are to be preferred to the smaller ones.

There is one source of error in the use of the tuning-fork that cannot be fully avoided. Patients who do not have fair habits of observation will say that they hear the tuning-fork better from the better ear, because they think that they *ought* to do so. A little care in urging such persons to notice the sound carefully will usually cause a correct answer to be given. Its chief value is, however, among persons who can be taught to observe what they actually hear, and who will allow their theoretical notions to remain in abeyance for a time. As Dr. Prout intimates, the great desideratum is an instrument which will give the same number of vibrations, of the same pitch and tone under the same conditions. It should also be a portable instrument, and which can be multiplied with accuracy to any number that may be wanted by those who test hearing power.

An interesting case occurred in my practice last spring, which shows the value of the tuning-fork in cases of slight impairment of hearing, and also exhibits the inadequacy of the watch as a test of hearing power.

Dr. W., æt. 33, consulted me March 12, 1872, in regard to an uncomfortable, "stuffy" sensation in the right ear, attended by a slight impairment of hearing. His history was that he had had nasal catarrh for some months; for two days he has observed the aural trouble. On testing the hearing power by the watch, it was found to be normal, or $\frac{4}{4}\frac{8}{8}$ on both sides; but the *tuning-fork was heard better on the affected side,* and the patient, a busy physician and an exact

observer, was sure that his hearing power was somewhat impaired upon the right side, although the watch did not detect it. The membrana tympani was slightly injected along the handle of the malleus.

I diagnosticated the affection as sub-acute inflammation of the middle ear of the right side, and treated it by the use of the Eustachian catheter, Politzer's method, and a gargle, as well as by the application of a leech to the tragus. After the first use of the catheter and Politzer's method, the tuning-fork was heard with equal distinctness on both sides, thus confirming the diagnosis and illustrating the value of the test. The patient recovered perfectly in a few days; but at each visit before the ear was inflated until his ear was fully restored to the normal condition, the tuning-fork was heard more distinctly on the affected side.

According to Politzer,* *E. H. Weber* was the first to show the facts that have been stated with regard to the increase in intensity of the sound of a tuning-fork, on the side of the meatus that is closed by the finger. *Mach*, quoted by Politzer, explained this fact by the theory that the reflections of the waves of sound from the ear was prevented by this closure of the auditory canal. Politzer concludes, as the result of experiments, which may be found in detail in the first volume of the *Archiv für Ohrenheilkunde*, that the increased perception of sound that is felt in one ear depends upon two causes:

1. The waves of sound that have been carried from the bones of the skull to the air of the external auditory canal are reflected back on the membrana tympani and ossicula auditus.

2. In accordance with Mach's theory, the passing out of the waves of sound which have reached the labyrinth and cavity of the tympanum, through the bones of the head,† is prevented by the obstacle they meet in the closed ear.

It will thus be seen that Mach and Politzer explain the phenomenon of increased perception of sounds conveyed through the skull, in an ear whose peripheric portions are obstructed by disease, or by some mechanical cause, entirely by the theories that the loss of sound is prevented by the obstruction to its reflection from the auditory canal, and that the force of the waves is also intensified by their being thrown back upon the nerve.

* Reprint from Wiener Medizinischen Wochenschrift.

† Archiv für Ohrenheilkunde, B. I., p. 321, 1868. Politzer, l. c.

Erhard* believes that the increased intensity of the sound in an ear whose outer opening is closed, is due to the fact that the force or impression of sounds that otherwise disturb and distract the mind, is diminished by the closure of the meatus. This reasoning seems to me plainly fallacious.

Cases of disease of the middle ear that are connected with disease of the labyrinth, or cases in which the middle ear is sound on one side, while the nerve is affected, and just the opposite state of things exists on the other side—that is, the middle ear is diseased and the nerve sound—will of course render the value of the tuning-fork less positive, and a differential diagnosis difficult.

Dr. Politzer† attempted to make the tuning-fork test more objective, that is to say, less dependent upon the statement of the patient, by the use of a diagnostic tube with three arms. The patient has one in each ear, while the surgeon alternately interrupts the sound communicated by the vibrating tuning-fork through these arms to his own ear, by compressing one of them with the finger.

If the sound of the tuning-fork be heard to pass more distinctly through one branch or arm than the other, it is concluded that there is some obstruction in the middle ear of that side, which intensifies the impression of sound produced on the sensorium of the listener as well as that of the patient.

As I understand Politzer's objective test, the ear of the examiner is placed in the same condition as that of the patient. If it be applied to a person in whom we are positively certain that the lesion is in the canal or middle ear, and when the patient hears it more distinctly on that side, the sound from the corresponding arm of the tube will usually be intensified to the listener.

I have placed a plug of cotton in one meatus of a person whose ears were of equally good hearing power, and have then used *Dr. Politzer's* triple-armed diagnostic tube, and thus far I have heard the sound more intensely in the arm of the tube that was in the plugged meatus. Other observers have at times come to a different conclusion in the case of the person

* Klinische Otiatrie, p. 88.

† Archiv für Ohrenheilkunde, l. c.

whom I examined in this way, so that the test is not wholly reliable.

It requires too many precautions to be generally available. It is valuable as a physiological test, however.

The diagnosis of a slight impairment of the caliber of the Eustachian, which is always, as I believe, attended by more or less catarrh of the tympanic cavity, is rendered easier by the use of the tuning-fork, as was illustrated by the case on the preceding page.

If, however, in a decided case of catarrh of the middle ear, the tuning-fork is heard better on the normal side, we must conclude that there is some lesion of the labyrinth—perhaps as Politzer * and Schwartze suggest, "a fluxion towards the labyrinth with serous exudation in the nerve structure." In cases of this kind, as the pressure upon the labyrinth is removed by a decrease of the catarrh of the middle ear, the tuning-fork will be heard better on the affected side.

Politzer † explains the fact that in some cases of perforation of the membrana tympani, the tuning-fork is heard better on the affected side by two reasons:

1. The mobility of the ossicula auditus, by which the passage outward of the waves of sound that have once reached the labyrinth is retarded, is lessened.

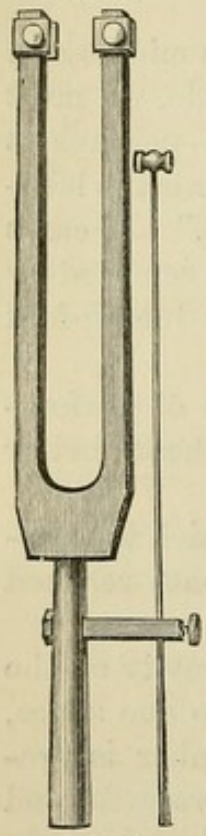
2. By the perforation of the drum-head, the cavity of the tympanum and auditory canal are converted into one space, and a greater resonance from the larger air-chamber is produced, which acts upon the *fenestræ ovalis* and *rotunda*, and increases the intensity of the perceptive power of the labyrinth.

The tuning-fork used by Politzer in his experiments and in his practice, corresponds to the second C in the base, vibrating 512 times in the second. On striking it, we notice particularly two distinct tones—one the ground tone or dominant, the other the upper tone or musical fifth; either one or the other predominates, according to the density of the substance against which the tuning-fork is struck. In employing it for diagnosis, the predominance of the upper tone is often very confusing to the patient, and the cause of error.

* L. c., p. 5. † L. c., p. 12.

In order to get the pure dominant, it is only necessary to affix a pair of metal clamps to the ends of the branches; this is done by means of small screws. If the tuning-fork is now struck even with a hard substance, only the dominant is perceptible. Dr. Schaar,* of Vienna, diminishes the intensity of the upper tone by gentle pressure upon the lower portion of the branches.

Fig. 8.



Blake's Tuning-Fork.

The value of the tuning-fork in testing the perception of different musical tones has been much increased by the discovery that, by fixing the clamps at different points upon the branches, it is possible to obtain all the tones and semitones up to an octave above the musical fourth of the dominant tone of the tuning-fork.—(Politzer.)

Dr. Blake,† who has written a good digest of this subject, says that "Itard used a bell which was struck by a pendulum, the force of the blow being determined by the space through which the pendulum passed before striking; in this way the difficulty as to control of the intensity of the sound was overcome, but the tone remained the same." Following this idea, Dr. B. caused to be constructed the tuning-fork as represented in the accompanying wood-cut (one-third size), that is, the common instrument with the clamps as used by Dr. Politzer, but with the addition of a hammer, the head of steel, one face being covered with soft rubber. "Lucæ proposed the use of a hammer faced with some elastic material for striking the tuning-fork. The handle of the hammer is a steel spring, sliding in a bar affixed to the stem of the fork, and fastened in place by a small set screw. By using either the steel or rubber face of the hammer, either the upper or lower tone will be rendered most prominent. By affixing the clamps as Politzer directs, we obtain the variety of tone, and by the distance to which the hammer is sprung can reg-

* Blake, Reprint from Boston Medical and Surgical Journal, p. 3.

† Blake, l. c.

ulate their intensity. The adjustment is simple, and obviates the necessity of employing any other musical instrument."

THE INTERFERENCE OTOSCOPE.

Dr. August Lucæ,* of Berlin, proposes a new method of examining the ear for physiological and diagnostic purposes by means of what he terms the interference otoscope—interference apparatus would be, I think, a more appropriate term.

Dr. Lucæ proves by experiment that the human membrana tympani does not receive the complete intensity of the waves of sound, but that it reflects a portion of these waves; also, that with the increase of the tension of the membrana tympani, the reflection outward increases, and the reception of the waves inward decreases. He then describes his apparatus, which is made after that of *G. Quincke*, for explaining the reflection of sound waves.

It consists of a vertically placed glass tube, of about 10 inches in length, in the centre of which is a joint of glass, for the application of a horizontal tube of gutta-percha, which is placed in the ear of the person to be examined. The sounds are conveyed through the upper end of the vertically placed glass tube, to the bottom, and thence through a second rubber tube to the ear of the observer.

The lateral or horizontal tube passing into the auditory canal of the person to be examined, should be one-quarter the wave length of the sounds that are to be experimented with. (The wave length from a tuning-fork of the note C' is 48 Parisian inches.)

A cork with a handle is placed in the end of the lateral glass tube, which can be pushed backward or drawn forward, and thus increase or decrease the length of this tube according to the wave length of the sound employed.

As will be seen, the sounds divide in the middle of the tube into two parts. One part passes directly down to the ear of the examiner; the other, after it has been reflected from the end of the lateral glass tube that is stopped by a cork.

Lucæ's apparatus is made for the tone C' with 264 vibrations. Its wave lengths are 48 Paris inches. The interference piece is therefore 12 Paris inches in length.

By the aid of this apparatus, experiments were made on a glass model, the ears of a dead subject, and those of living persons.

For the sake of convenience, Lucæ modified his apparatus. It now consists of a double otoscope, like the differential stethoscope of Scott Allison. These arms are attached by a glass tube, shaped liked the letter X, to two tubes: one for the ear of the examiner, the other for the resonator or sound receiver into which the arms of the tuning-fork look. The fork is placed on a stand and caused to vibrate by means of a hammer. The resonator should be made of paste-board. The metal ones may injure the ear.

* Archiv für Ohrenheilkunde, Bd. III.

The interference arms are also made of gutta-percha. By alternately pressing together one and the other tube of the double otoscope we may decide how much the sonorous waves are reflected from each ear. The practical value of the interference diagnostic tube depends upon Lucæ's conclusion that there is a greater reflection of the waves of sound of the worse ear, if there be disease of the peripheric parts of the organ of hearing. If, however, there is a *weaker* reflection from the worse ear, it is concluded that there is disease of the nerve.*

Lucæ's theory of the increase in intensity of a sound when the meatus is closed, or when there is peripheric disease, is that the intra-auricular pressure is increased, which intensifies all sound, although it may prevent their being distinctly perceived.

If this were so, it would seem that all persons whose hearing is impaired from middle ear disease, which causes a secondary pressure upon the labyrinth—for example, in cases of anchylosis of the stapes—should be disturbed by the intensity as well as the indistinctness of sounds.

Lucæ† in a subsequent article amplifies his views and does not accept the theories of Mach and Politzer, that the closure of the canal or of the cavity of the tympanum prevents the passage of the waves of sound outward. Indeed he does not believe that waves of sound that have reached the labyrinth through the bones of the skull, return through the membrana tympani and ossicles. When we speak of the exit of sound waves from the ear, we can only, according to *Lucæ*, understand those undulations which are carried to the air of the auditory canal from its walls and from the membrana tympani.

The conduction of sounds to the labyrinth is diminished by increased tension of the membrana tympani. Still, when this increased tension causes a slight but positive variation in the pressure upon the labyrinth, the perception of deeper sounds may be increased. The increased intensity of sound, when the external auditory canal is closed, chiefly affects the low tones, and is chiefly to be explained by the resonance of the short column of air in the passage.

Lucæ admits the full diagnostic value of the tuning-fork

* Herr Schäfer, instrument maker, in Berlin, furnishes Lucæ's interference otoscope for 3 Prussian thalers; the C' tuning-fork for 5 thalers and 10 silver groschens; the resonator or sound receiver for 2 thalers and 15 groschens. The whole apparatus would therefore cost about $10 in gold.

† Archiv für Ohrenheilkunde, Bd. V., p. 98.

for all cases of peripheric disease, such as impacted cerumen, affections of the cavity of the tympanum, *if one side only be affected*, and he says that in all such cases, where the prognosis is good, the tuning-forks C, C, C′, placed on any part of the skull, will be heard better on the affected side; but he does not accept the theories of Mach and Politzer to explain this phenomenon, and he limits the value of the tuning-fork in diagnosis to acute and dangerous suppurative inflammations of the middle ear, in which, if the tuning-fork be constantly heard better on the affected side, the brain is not in danger.

VON CONTA'S METHOD.

Von Conta,* of Weimar, some years since, recommended that the tuning-fork be used to the exclusion of the watch, in testing the hearing distance. In his method an elastic tube is used through which the waves of sound are conducted, instead of through the uninclosed air. The number of seconds or minutes during which the gradually decreasing vibrations of the tuning-fork are heard, becomes the measure of the hearing power. The fork is struck upon the knee of the examiner, and then immediately placed in the outer extremity of the tube, which has been previously placed in the patient's ear. The instant he ceases to hear the vibrations he informs the surgeon by the word "now," who has noted the time with the watch in hand, when the fork was placed in the tube.

This method is certainly not without value, but the desideratum, namely, a method by which the ability to hear sounds resembling the human voice may be accurately estimated, is yet to be obtained.

In testing the visual power we have exact means which indicate the practical loss of sight which the patient may have suffered. It is to be hoped that the physiology of acoustics may at no distant day present us one for the accurate estimation of a loss of hearing power.

* Archiv für Ohrenheilkunde, Bd. I.

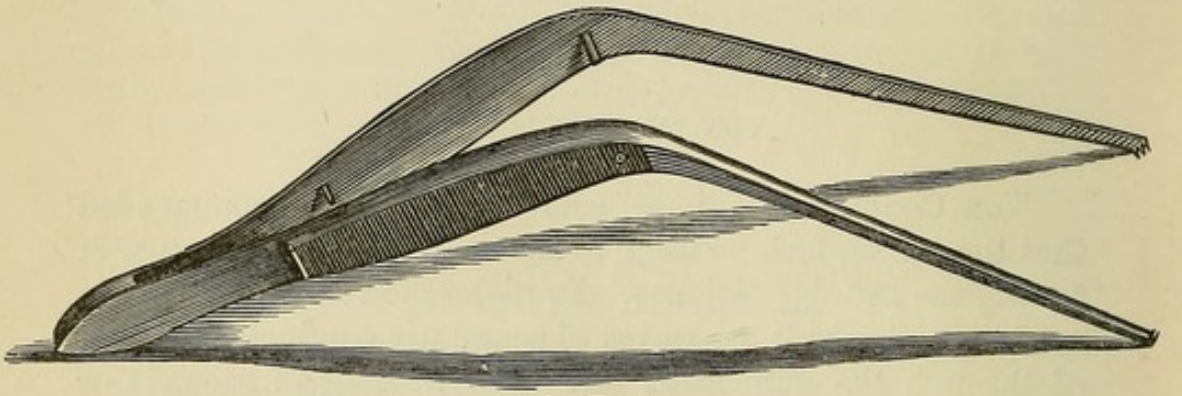
EXAMINATION OF AUDITORY CANAL AND MEMBRANA TYMPANI.

The next step after noting the hearing power in the examination of our imaginary patient, is the exploration of the auditory canal and the membranæ tympani.

It is, of course, implied in this that an affection of the auricle needs no special assistance for examination.

For the purpose of examining the external auditory canal three instruments may be necessary: a pair of angular for-

FIG. 9.

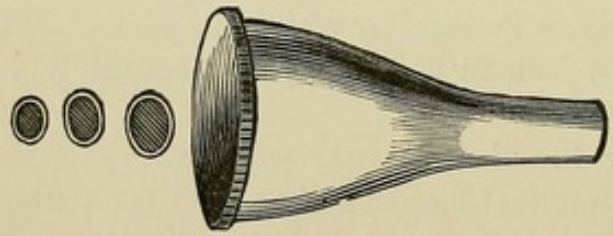


Angular Forceps.

ceps, an aural speculum, and a concave mirror or reflector. The first is of use to remove any temporary obstructions which may prevent a view; the second dilates the canal; and the third throws the light into it.

According to Wilde,* Dr. Newbourg, in a memoir published at Brussels in 1827, recommended an instrument which is the origin of all the tubular ear specula now in use. It was a slender horn tube, four inches long, with a bell-shaped outer

FIG. 10.



Gruber's Speculum.

orifice. Subsequently this instrument, which was much too long, was improved by shortening it, by Dr. Ignaz Gruber, of

* Treatise on Diseases of the Ear, p. 60.

Vienna, and generally introduced to the profession by Sir William Wilde, in 1844. After a fair trial of the bi-valvular instrument of Kramer, and the funnel-shaped one of Toynbee, I now use the conical speculum, either that of Wilde, Tröltsch, or Gruber. I do not think that any one of these has any great advantage over the others. The practitioner will do very well with any one of them. Too much stress is sometimes laid on a little change in shape. I prefer that the interior surface of the speculum be brilliant, and not black, as those of Gruber are sometimes made.

Those who consider that there is an advantage in a funnel-shaped instrument, will find the one here figured preferable to Toynbee's, because the transition from the wide orifice, which dilates the cartilaginous part of the canal to its fullest extent, to the narrower, which exposes the osseous portion, is gradual, and thus prevents the reflection of many rays at this point.

The speculum should be made of coin silver, for ordinary use. For the purpose of applying acids or caustics, one of hard rubber, porcelain, or glass is to be preferred.

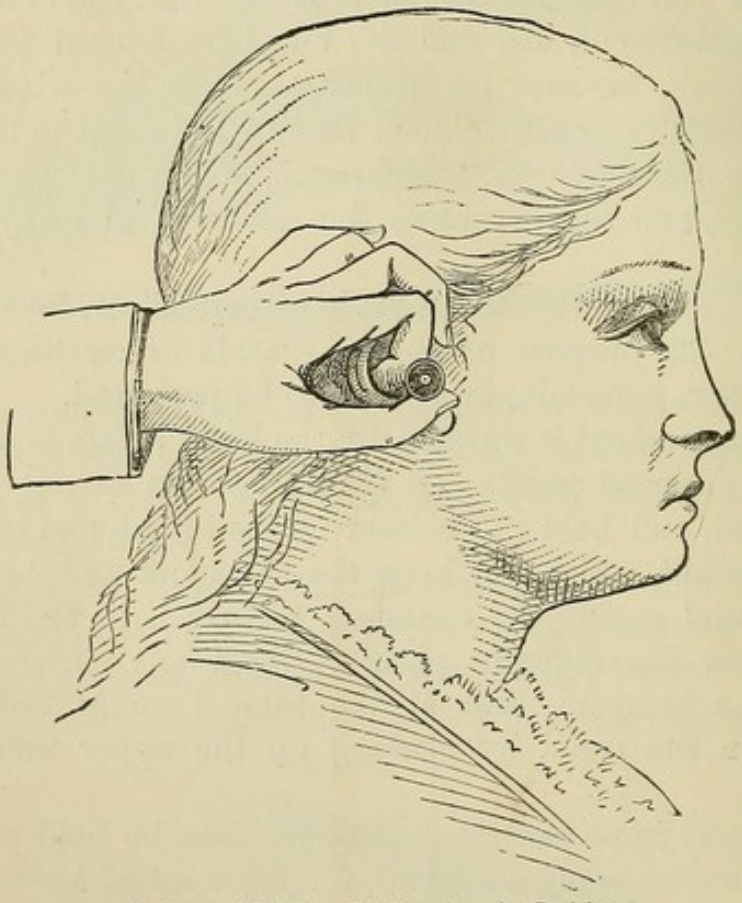
The instrument is warmed by the hand before being used, and then inserted gently and slowly into the meatus with the right hand, and held in position by the thumb and index finger of the left, which will keep the speculum under complete control, and enable the examiner to turn it so as to successively view the different parts of the whole surface of the membrana tympani, and at the same time to thoroughly straighten the canal by pushing up the upper wall of the canal.

It is very important that the speculum be held properly, for I have seen many a student, for the want of knowledge of this simple manipulation, labor for a long time without getting any view of the membrane, while the instrument was resting on some portion of the projecting wall of the meatus.

Having thus dilated the canal, the light may be thrown into it by means of the otoscope or reflector of Von Tröltsch, which is a concave mirror of about three inches in diameter, having a focal distance of about six inches. Ordinary daylight is the best source of illumination for this mirror, although

sun light, lamp light, gas light, that of a candle, or the reflection from a light-colored wall, may each be made available in this method of examining the outer parts of the ear. This is a very simple process, although many make a difficult one of it. If we but use the skill we acquired in our juvenile days in throwing a dazzling light upon a desired object by means of a bit of broken mirror, it will serve us in good stead here. The mirror is held very lightly in the hand, and the light is condensed upon any desired part by a very slight movement.

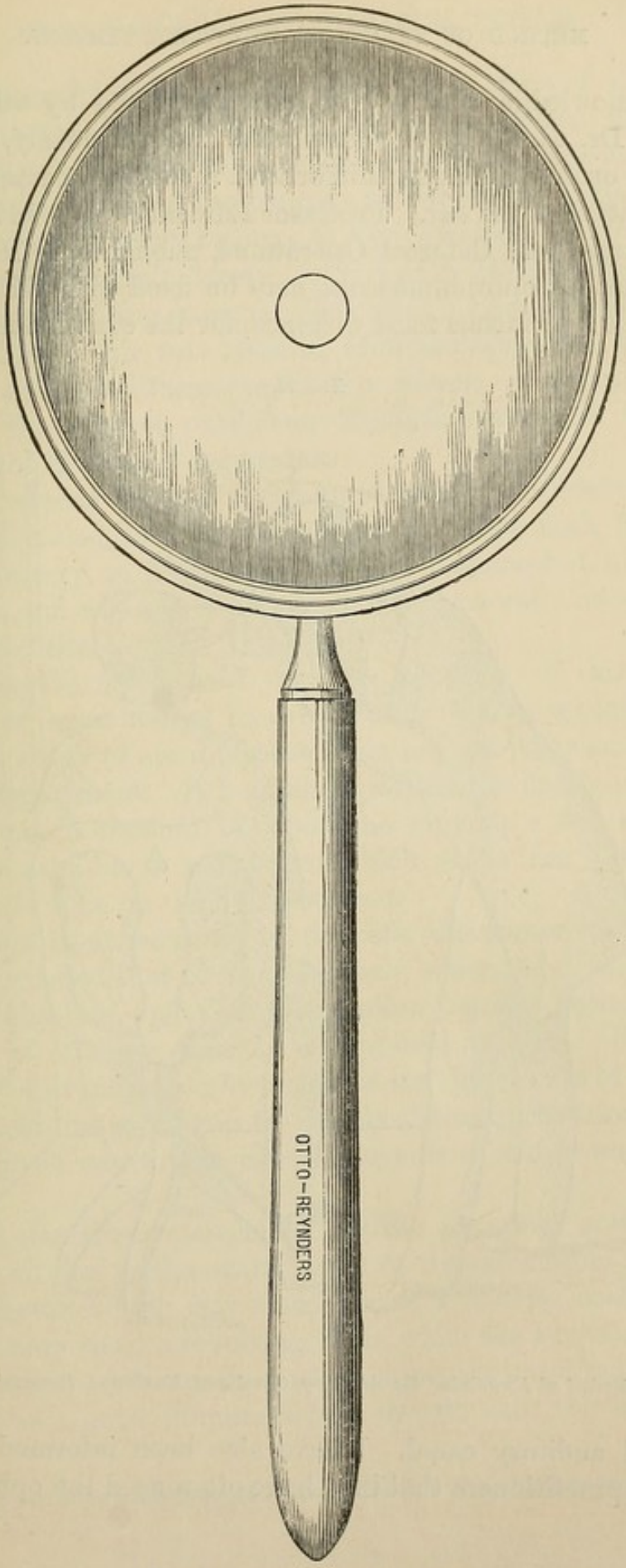
FIG. 11.



Method of holding the Speculum in Position.

It is now almost universally conceded by the profession, that this method is altogether the best that has yet been suggested for the examination of the membrana tympani. It has the unequivocal endorsement of such otologists as James Hinton of London, Schwartze of Halle, Politzer and Joseph Gruber of Vienna. It was first introduced to the profession at large by Professor Anton Von Tröltsch, in 1855, without pre-

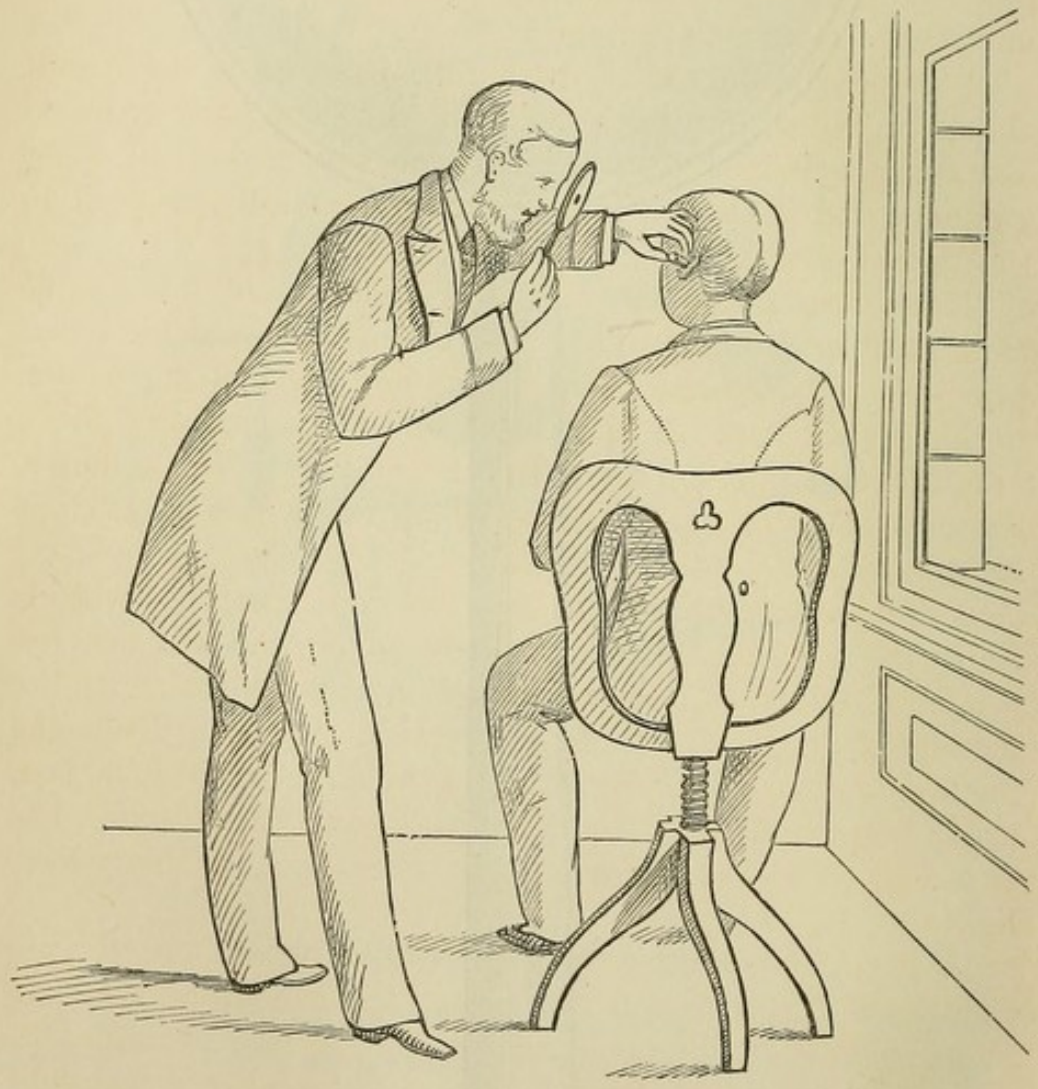
FIG. 12.



Von Tröltsch's Otoscope, actual size.

vious knowledge that it had been suggested by others, although Dr. Hoffman, of Westphalia, had previously, in 1841, used an ordinary shaving mirror with a central opening for the examination of the ear. Professor Edward Jaeger, in his work on Cataract and Cataract Operations, published in 1853, suggests that his ophthalmoscope may be used with the concave mirror of four inches focal distance, for the examination of the

FIG. 13.



Method of Examining the Auditory Canal and Membrana Tympani.

external auditory canal. I have also been informed by numerous practitioners that they have often used the ophthalmo-

scopic mirror for examining the ear; but in spite of all these statements, and the fact that Frank,* in his work on the Ear, gives a sketch of Hoffman's otoscope, the credit of the introduction into general use of the concave mirror for the examination of the ear as certainly belongs to Von Tröltsch, as the invention of the ophthalmoscope to Heinrich Helmholtz. It is somewhat surprising, however, that after the description which Frank gives in his text-book of Hoffman's method, and the drawing which he furnishes of the mirror, no attention was paid to the subject until Von Tröltsch revived it, without knowing of Hoffman's apparatus.

I introduced the use of the aural mirror, or otoscope as it should be called, into the practice of the New York Eye and Ear Infirmary, in 1863, where it soon superseded all other methods, and whence it has been very generally adopted in the United States.

It may be safely said that 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 minutes, learn to examine a membrane which not a few physicians have never seen on the living subject.

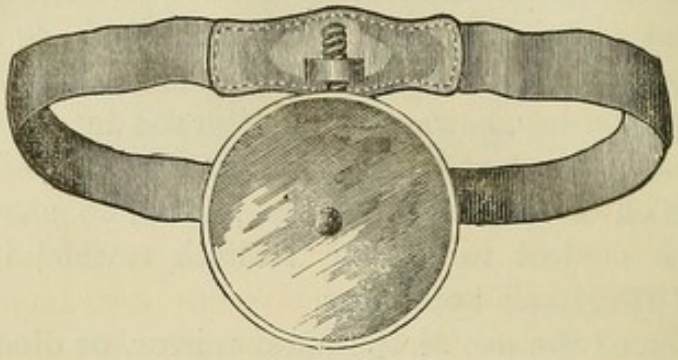
I deem it unnecessary to describe the numerous methods which preceded that of Von Tröltsch, since they are fast becoming obsolete, and their description belongs rather to the history of otology than to a practical treatise. Even the method of examination by means of the direct rays of the sun, which held out so long in the hands of some practitioners, has at last given way to the use of the mirror and ordinary daylight.

It is sometimes convenient for the examiner and the patient to sit during the examination of the membrana tympani, and sometimes both may stand, or, as I usually examine, the patient may sit in a revolving chair, while the surgeon stands. The position of the patient will not be an important matter, so long as a good illumination is thrown into the canal. A

* Practische Anleitung, zur Erkentniss der Ohrenheilkunde, p. 49.

forehead band is essential in making applications to the ear, and it is often convenient at other times. I cannot see any

Fig. 14.



Forehead Band.

great advantage in the various complicated and expensive bands with ball-and-socket joints, but I use a simple screw attachment by which the mirror is fastened to the head-band. The head-band should be of elastic material, such as india-rubber webbed cloth.

Dr. Di Rossi,* in a very recent paper on binocular otoscopy, proposes the use of a microscopic object-glass set at an angle of 70° in a spectacle frame, as a simple and efficient binocular otoscope. This suggestion has just met my eye as this volume is passing through the press, and I am inclined to think that it is a very useful one.†

Dr. Di Rossi's first instrument‡ consisted of an arrangement of prisms behind a concave mirror. The prisms are plane, one of 90°, the other of 10°. The diameter of the concave mirror is 7 centimetres. Its focal distance is 16 centimetres.

The central opening in the mirror is of an elliptical shape. The instrument differs from the binocular ophthalmoscope of *Dr. Giraud Teulon* in the following respects :

1. The mirror is much larger, inasmuch as ordinary daylight is used as the source of illumination.
2. The focal distance is less.
3. The prisms are of a higher degree.

I think the advantages of binocular vision in examining the ear are not sufficient to atone for the loss of simplicity and

* Monatsschrift für Ohrenheilkunde, Jahrgang VI, No. 7.

† Mr. H. W. Hunter, optician, will furnish the apparatus.

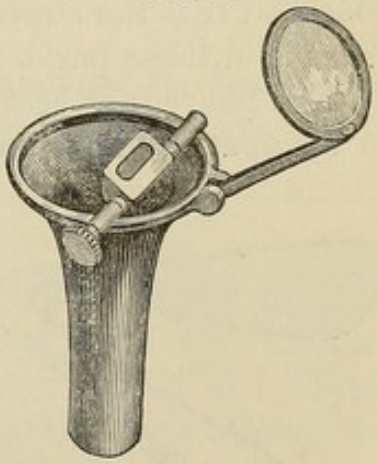
‡ Monatsschrift für Ohrenheilkunde, No. 12, 1869.

cheapness in the instrument used for examination that occurs when the binocular otoscope is substituted for Von Tröltsch's monocular concave mirror. A little practice enables the surgeon to judge with sufficient accuracy as to the depth of objects in the canal or upon the drum-head, or beyond it, upon which he is operating; for it is only in operating, for example, in puncturing the membrana tympani, that I have ever felt any difficulty in judging of the depth of the surface which it was desired to touch.

Mr. Edward S. Ritchie, of Boston, at the suggestion of Dr. Clarence J. Blake,* has made an instrument which is designed to overcome the disadvantages attending the exclusion of one eye from the visual act in operating upon the membrana tympani:

"It consists of a hand rubber speculum (Politzer's) of the largest size, fitted with a metallic rim, to which is attached a revolving prism and an arm, bearing at its outer end a lens of about an inch focus; this arm is movable, but sufficiently firm to remain fixed at any angle at which it is placed. The prism is just within the focal distance of the lens, and its incident face is armed with a small metal shield, having an opening in the centre corresponding in its short diameter to the diameter of the pencil of light falling upon it from the lens.

Fig. 15.



Blake's Operating Otoscope.

"The advantage of the prism over a mirror or other reflecting surface is, that we have almost total reflection; and but little of the light concentrated upon the prism by the lens is lost.

"In operating, an assistant is required to draw the auricle upward and backward, and keep the speculum in position, with the pencil of light upon the opening in the shield of the prism. It is not claimed for this instrument that it at all supersedes the head mirror of Von Tröltsch, but it is certainly of great advantage in the more complicated operations, where

* Late Contributions to Aural Surgery. Boston, 1870.

a steady and uniform illumination is indispensable. The instrument, as a whole, weighs only about one hundred and fifty grains, and can be made much lighter; so that when once firmly inserted in the meatus, it remains in position, and there is no necessity for holding it nor fear of its slipping out of place during the operation."

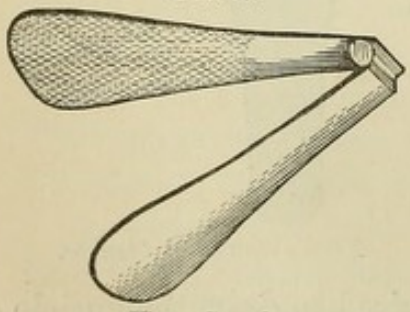
The practitioner will often be obliged to examine the ear and pharynx of a patient who is too ill to get up from the bed. The light from a candle then becomes a very convenient and ample means of illumination. The finest changes on a membrana tympani and in the auditory may be observed by the aid of the otoscope and such a light.

EXAMINATION OF THE PHARYNX AND EUSTACHIAN TUBES.

After having heard the patient's history, and having ascertained the amount of hearing, we may proceed to the examination of the pharynx and nares, and mouths of the Eustachian tubes. Although the profession has been a long time in coming to an appreciation of the fact, it is now generally conceded that the starting-point of a large percentage of aural cases is in these parts.

The pharynx is best examined by turning the patient's face to an open window, and holding the tongue by means of a Turck's or a simple hinge speculum. Turck's instrument is to be preferred to others, because the hand of the examiner does not obscure the view in its use. I often, however, use a reflector and ordinary daylight for an inspection of the pharynx, and it has some advantages over a direct illumination.

FIG. 16.

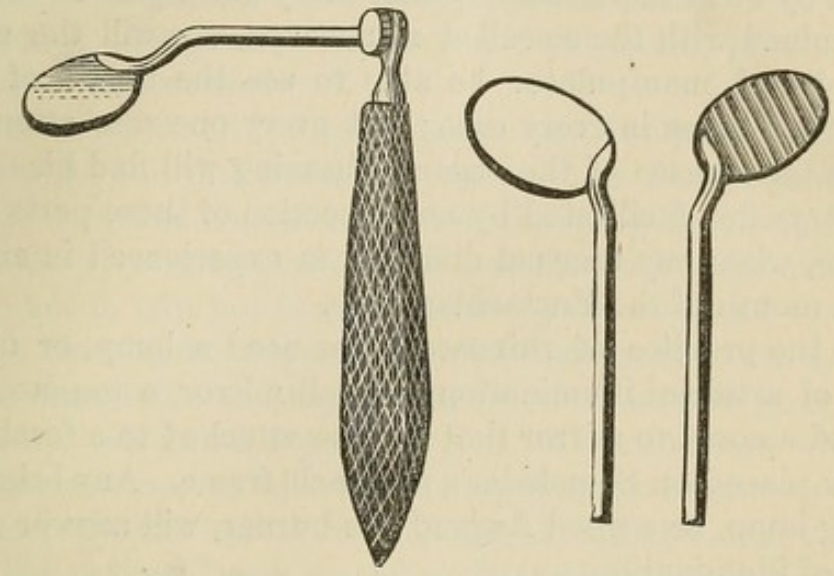


Hinge Speculum.

Some surgeons prefer to use artificial light in examining the pharynx as well as other parts of the body, but I much prefer ordinary daylight for all examinations, when it is possible to use it, to that from any artificial source, or to the *direct* rays of the sun, since it seems to me that the natural

hues are thus best observed. In the evening, of course, artificial light must be used. A reflector should then be em-

Fig. 17.



Turck's Speculum.

ployed. It is well to have the reflector attached to a forehead band, as in the practice of rhinoscopy or pharyngoscopy, which will be immediately described; but I may defer any description of what to observe on examining the fauces and pharynx until we come to speak of pharyngeal disease.

RHINOSCOPY.

Rhinoscopy, as a practical method of examining the posterior nares, was suggested by Sir William Wilde in his treatise on aural surgery, having previously been spoken of by Bozzini, as a possible method of examining the parts behind the hanging palate, in a book published in Weimar in 1807.*

Professor Czermak, of Prague, following up Turck's investigations on the larynx, was the first to actually introduce rhinoscopy into anything like general use; while *Dr. Semeleder*, Surgeon to the Gumpendorf Hospital in Vienna, and afterwards Surgeon to the Archduke Maximilian, while in Mexico, gave us the first full account of what was to be ob-

* Laryngoscopy and Rhinoscopy. By F. Semeleder. Translated by Dr. E. T. Caswell, 1866.

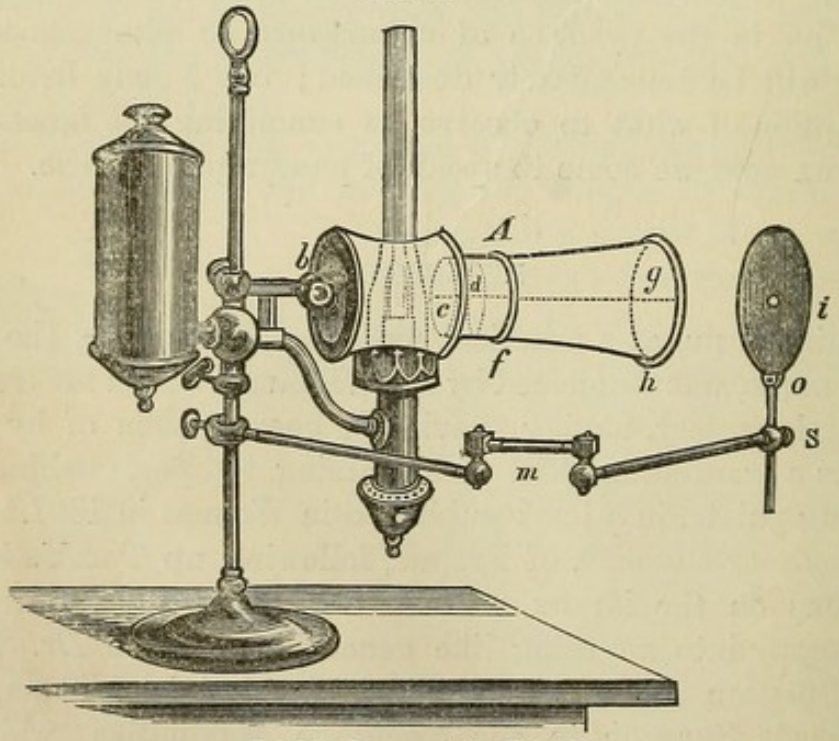
served by this means, with some interesting cases. *Voltolini*, of Breslau, has also added much to our knowledge of the value of this means of diagnosis.

It is by no means necessary that every aural patient should be examined with the so-called rhinoscope, nor will the most accomplished manipulator be able to see the mouth of the Eustachian tubes in every case; but every one who attempts to treat the disease of the organ of hearing will find his diagnosis very often facilitated by an inspection of these parts; for example, when any unusual difficulty is experienced in entering the mouth of the Eustachian tube.

For the practice of rhinoscopy we need a lamp, or other source of artificial illumination, a small mirror, a tongue spatula, and a concave mirror that may be attached to a forehead band or placed on Semeleder's spectacle frame. Any brightly burning lamp, or a good Argand gas-burner, will answer as a source of illumination.

Various kinds of costly apparatus for the purpose of con-

Fig. 18.



Tobold's Lamp. After Tobold.

densing the light have been suggested and employed. If the surgeon be not satisfied with an ordinary lamp, perhaps the

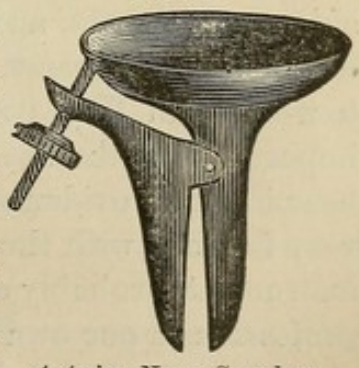
apparatus of Tobold will be found the best. In some instances, although not always, an instrument for holding back the uvula is required. Various appliances have been suggested for this purpose, nooses, hooks, spatulas, and so on, for any of which a surgeon of ordinary tact will find or provide a substitute when wanted.

It is above all things requisite that the patient should be tractable, and this tractability is perhaps more common than many surgeons imagine. Those who precede all their manipulations by an appeal to their patients to be very quiet, to be sure not to stir, not to mind a little pain, etc., and who at the same time make a great show of instruments, will generally have intractable and timid patients; but he who goes quietly to work, will find few patients that will not submit with more or less patience to all such manipulations as are required in rhinoscopy, the use of the Eustachian catheter, and the like.

The patient being seated in front of the examiner, with a good light at one side, the mouth is well opened, and the tongue held by means of the depressor mentioned above. The surgeon should be careful in placing the tongue depressor, so that he may not cause undue pressure, which will produce gagging, and prevent all further manipulations. The light is then turned upon the pharynx by the head mirror, so that it is accurately focused, when the parts will be well illuminated.

Having secured a good view of the pharynx, uvula, and tonsils, the throat mirror is to be introduced. This instrument is first warmed by holding it for an instant over the flame of the lamp; its heat is then tested by placing it on the back of the head, after which it is gently and quickly introduced, with its reflecting face upwards, into the space between the soft palate and cavity of the posterior pharyngeal wall. There are some patients, however, in whom it will be impossible to make a rhinoscopic examination, on account of the small space between the uvula and posterior wall of the pharynx. A very few, also,

Fig. 19.



Anterior Nares Speculum.

have such irritable throats as also to render such an examination impracticable.

The examination of the nostrils anteriorly—anterior rhinoscopy, as it is called by *Cohen**—is often an important part of the examination of a case of aural disease.

It is very often sufficient to place the patient in front of a good light, and open the nares by pressing upon the tip of the nose. If an instrument be necessary, I find that the one figured on the preceding page serves a very useful purpose. I am sorry that I do not know the name of the inventor of this little instrument.

EXAMINATION OF EUSTACHIAN TUBE.

We may now turn, as the next step in our examination of a case of supposed aural disease, to the investigation of the condition of the Eustachian tube and cavity of the tympanum.

The means of this examination may be classified as follows:

I. The Eustachian catheter.
II. Politzer's method.
III. Valsalva's method.
IV. Eustachian bougies.

From the date of the promulgation of the use of the Eustachian catheter by the postmaster of Versailles, *Guyot*, until Toynbee's time, the views of the profession as regards the use of this instrument have varied exceedingly. At one time it was almost utterly rejected by the greater number of respectable practitioners, and at another time has been considered by them as a panacea in the treatment of aural disease. The text-books of Wilde and Toynbee, which attached very little importance to the use of the Eustachian catheter, and which bear intrinsic evidence that the authors did not choose to be very familiar with the details of the proper employment of the instrument, probably did more than anything else to cause the profession in our own country to settle down, until a few years since, into the belief that the Eustachian catheter was always a useless and sometimes a dangerous instrument. I well remember the discouraging response of a prominent American

* Diseases of the Throat, p. 75.

practitioner, who had then had large experience in aural disease, to my statement, at the beginning of my active professional life, that I proposed to use the Eustachian catheter in the treatment of diseases of the ear, that he was glad to say that he never had used the instrument, and this was the common sentiment among our respectable practitioners until a very recent date. In regard to the change in sentiment in this regard, I only need to say, that nearly every American surgeon who now treats aural disease, attaches much importance to the use of this instrument.

We have now to speak of the Eustachian catheter as a means of diagnosis.

The material of which the instrument should be made may be either alloyed silver or hard rubber. For diagnosis the silver catheter is to be preferred; for the injection of warm vapors, the hard rubber instrument is the only one to be used, because the heat will very soon make it impossible for a patient to bear the metal instrument in the nostril.

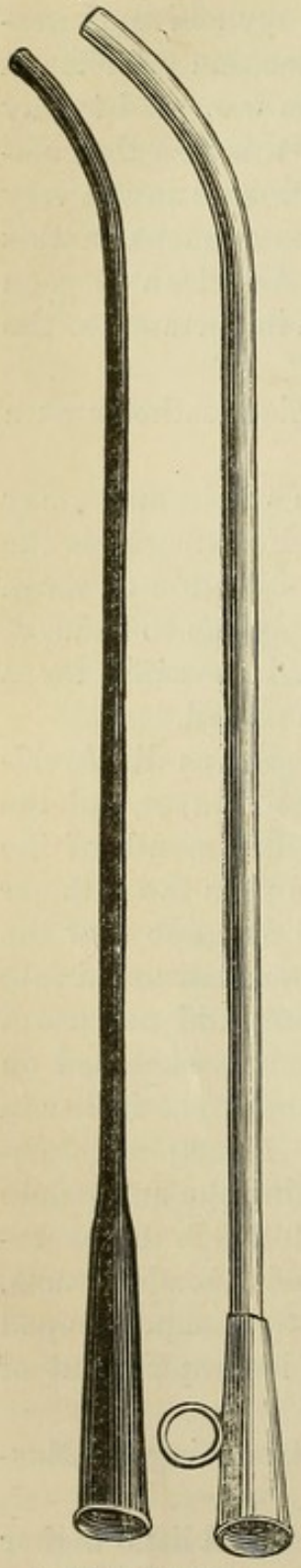
In the method of introduction, we proceed as did Archibald Cleland, an English surgeon, who, after Guyot, did the most to demonstrate the utility of entering the mouth of the Eustachian tube with an instrument, and we pass the catheter through the nostril. It is very difficult to imagine how the Versailles 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 sketched on the next page. It 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 pharyngeal 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

* For a fuller account of Guyot's operation, see Introductory Chapter.

Fig. 20.



Eustachian Catheters, actual size.

patient be a child, it can rest its head against a table or wall, or what is better, be supported by an adult.

I seldom use the Eustachian catheter in young children; for them I prefer Politzer's method of inflating the middle ear.

2. Let the patient blow his nose, so as to moisten the passage and remove any collections of mucus, while the surgeon takes the catheter thoroughly cleansed and warmed, and forces air through it in order to be sure that it is permeable.

3. The operator, standing a little to one side, draws down the upper lip with the left hand, and with the thumb and finger of his right hand lightly holds the catheter close to the funnel-shaped end, nearly in a vertical position, with the ring looking towards the median line of the body, until it has entered the meatus, when it is quickly turned to an approach to the horizontal position, so that the beak rests on the floor of the nasal meatus, close to the septum, with its convexity upwards.

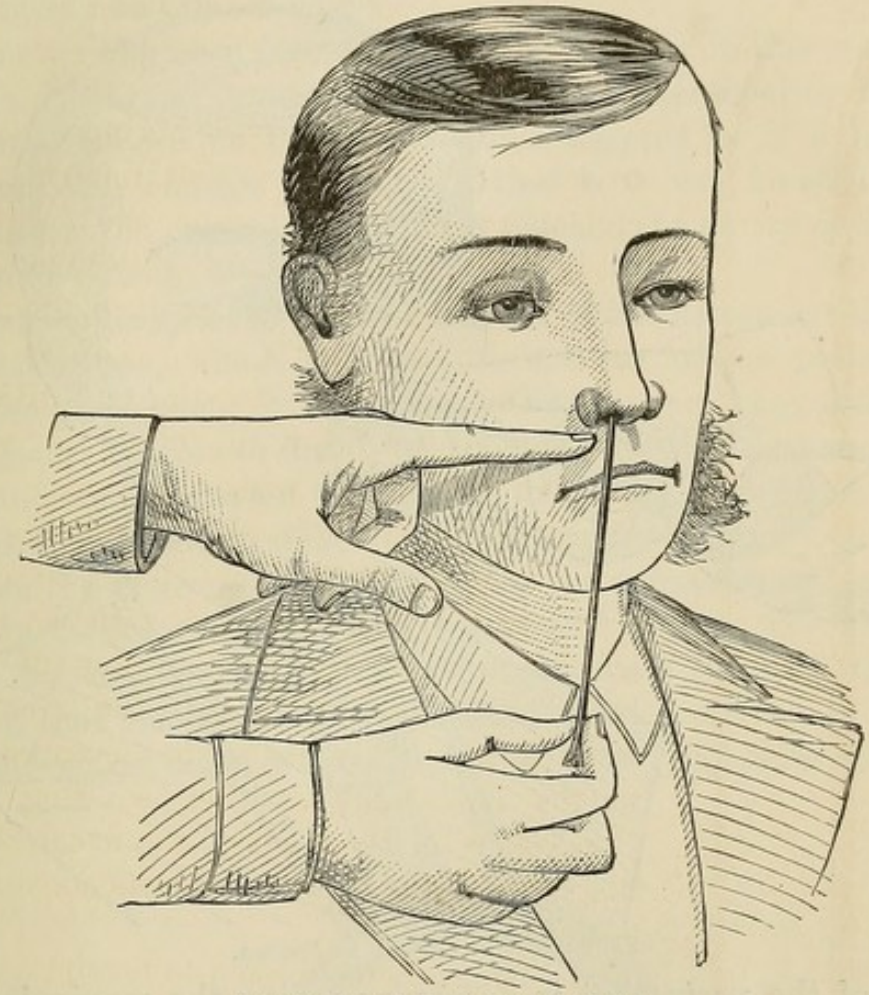
4. The catheter is then to be slid or insinuated backwards with a gentle motion, keeping it as close as possible to the floor of the meatus, gradually elevating the handle until the instrument becomes perfectly horizontal and the beak rests upon the posterior wall of the pharynx.

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 outwards. This mo-

tion lifts the beak of the instrument into the mouth of the Eustachian tube. This latter movement is aided somewhat

Fig. 21.



Introduction of Eustachian Catheter.

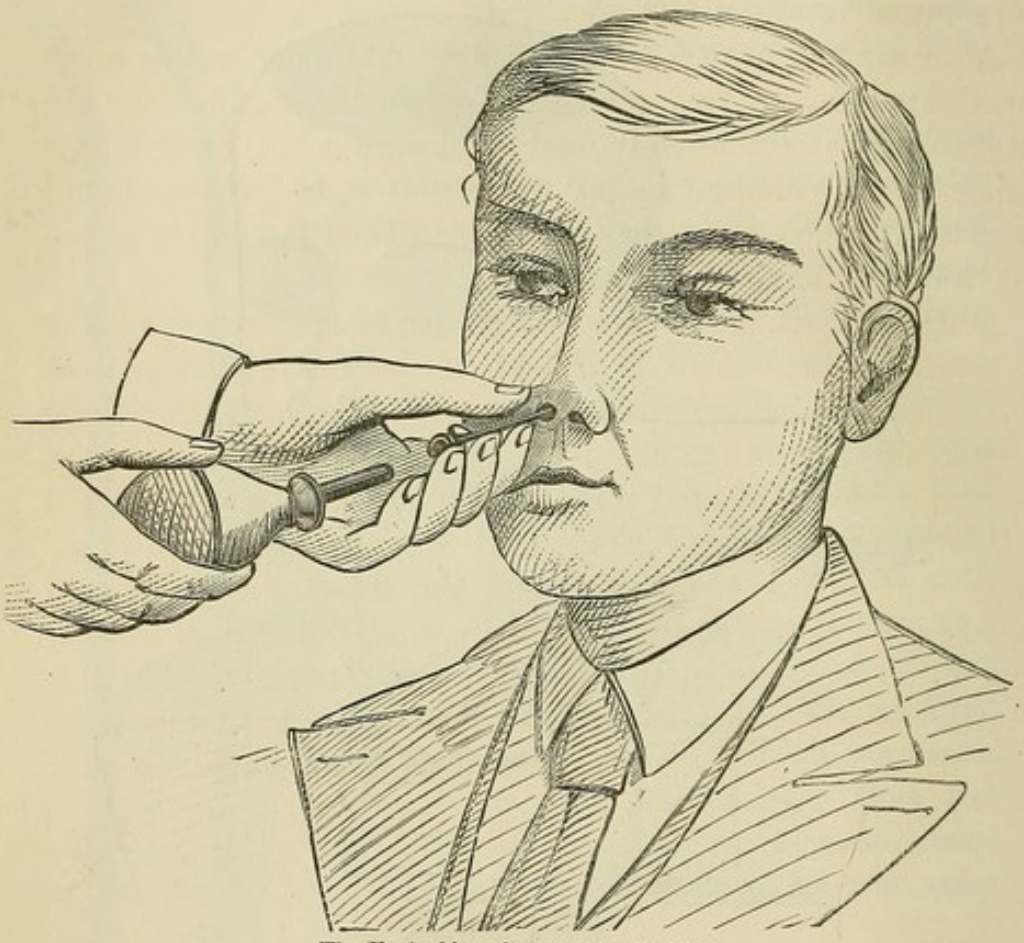
by the contraction of the soft palate, which performs a swallowing movement, raises itself, and lifts the beak of the instrument into the tube. Once in position the catheter should not cause the patient any inconvenience in speaking or swallowing.

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 (see Fig. 21) until he has got the beak well into 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 relaxa-

Fig. 22.



The Eustachian Catheter in Position.

tion 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. This difficulty usually passes away with the second or third use of the instrument, and sometimes it does not arise.

Fig. 23.



Air-Bag.

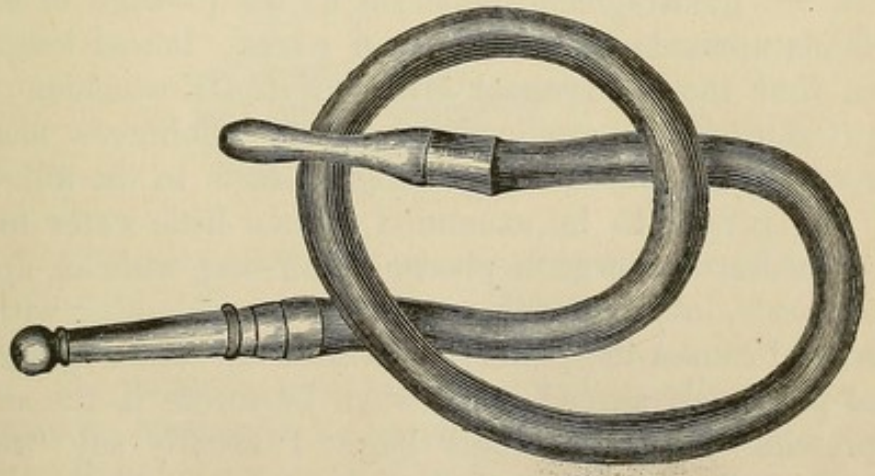
Having introduced the catheter we may force air through it into the cavity of the tympanum, by means of an air-bag whose nozzle should fit accurately into the funnel-shaped extremity of the nasal instrument. Air may also be blown in from the lungs of the examiner through a slender bit of rubber tubing, the tips

of which are placed in the opening of the catheter and the mouth of the examiner respectively. The use of the rubber bag or syringe is to be preferred to this method as being a more cleanly and delicate one.

After air has been forced into the middle ear in this manner, the membrana tympani should 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.

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 driven through the tube, and they claim to be generally able to decide as to whether the air enters by the sound communicated through the tube. I am constrained to think that it is very difficult to distinguish sounds proceeding from the pharyngeal mouth of the tube from those produced in the cavity of the tympanum, and I do not, therefore, attach that importance to the use of the stethoscope in this manner, that has been usually ascribed to it; but I rely more upon the appearances of the membrane of the tympanum after

Fig. 24.



Diagnostic Tube.

the air has been forced in, with some attention also to the sensations of the patient, as to where the air is felt, than upon the use of the so-called *otoscope*—although I would be very

far from wholly rejecting its employment, or from denying its value.

The otoscope consists essentially of a piece of elastic tubing with a tip on each end, designed for the ear of the patient and that of the examiner respectively. It should not be called an otoscope, but rather, as Kramer suggests, the diagnostic tube. The mirror for examining the ear should be called the otoscope, just as that for examining the fundus of the eye is named the ophthalmoscope; that for the throat, the laryngoscope, and so on.

POLITZER'S METHOD OF INFLATING THE EAR.

The next means of examining the condition of the Eustachian tube and cavity of the tympanum is named, from the gentleman who suggested it, Politzer's method. It is a means of diagnosis and treatment of very great value, and we owe very much to Dr. Adam Politzer, of Vienna, for this method of sending air into the middle ear.

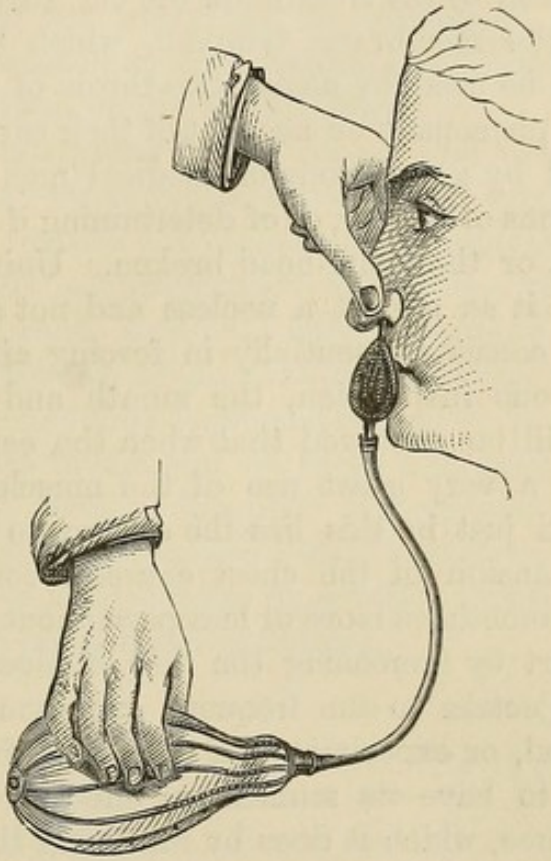
As is very well known, in the action of swallowing, the uvula rests upon the pharyngeal wall so as to shut off the upper from the lower pharyngeal space; so that persons affected with cleft palate, who cannot thus separate these spaces, are greatly inconvenienced by the passage of solids and fluids upwards to the posterior nares. It was long ago shown that the pharyngeal orifice of the Eustachian tube opened during the swallowing process. Politzer's method takes advantage of these physiological facts in the following way: the person to be examined takes a little water in the mouth, while the surgeon places an air-bag, with an appropriate nozzle, into one of the nostrils, closes the other with his finger, and causes the patient to swallow the water at a given signal previously agreed upon, when he forces in the air by compressing the india-rubber bag. I usually say "now"; upon which the patient swallows.

In examining children, I use, as suggested by Mr. Hinton, a piece of rubber tubing, and force the air from my own lungs, on giving a signal by raising the hand.

The effect of the air thus forced in upon the membrana

tympani is often almost wonderful. A person who has become deaf to ordinary conversation sometimes in an instant again hears the familiar tones of human conversation, and feels himself in a new world. In such a case, mucus has usually obstructed the calibre of the tube, and is driven away by the current of air, which must of necessity go against the

FIG. 25.



Method of Using Politzer's Apparatus. (*With Inhaler Attachment.*)

mouths of the tube, and will usually pass on into the middle ear. The patient's own testimony will usually, although not always, be conclusive as to whether the air entered the ear. The exceptional cases are those in which the Eustachian tube and the cavity of the tympanum have become so narrowed by a hypertrophy and sclerosis of the lining mucous membrane that only a very narrow, feeble current can enter. We shall have need to dwell upon the uses of Politzer's method when

we are discussing the affections of the middle ear, and I therefore content myself with this description of it, while we pass on to Valsalva's method of inflating the ear.

VALSALVA'S METHOD.

The distinguished anatomist Valsalva, who is well known to the profession by his treatise on the ear, suggested a means of inflating the membrana tympani, which has become so popular as to be used by nearly two-thirds of all the patients who come to physicians on account of their ears. It has been recommended by generations of medical men as a means of curing affections of the ear, or of determining if the Eustachian tube be open, or the drum-head broken. Universal as is its use, I regard it as almost a useless and not an entirely safe method. It consists essentially in forcing air into the ear, after a vigorous inspiration, the mouth and nostrils being closed. It will be observed that when the ear is inflated by this method, a very great use of the muscles of the chest is made; and just in this lies the danger to the ear. This vigorous expansion of the chest causes a congestion of the ear which is sometimes more or less permanent, and materially harms the part by increasing the flow of blood to it. There is another objection to the frequent employment of the Valsalvian method, or experiment, as it is sometimes styled. It soon ceases to have its momentary effect of increasing the hearing distance, which it does by rendering the membrane of the drum tenser, and then the membrane becomes relaxed and flaccid, so that I have sometimes seen the membrana tympani of patients who have been in the daily and perhaps hourly habit of forcing air into the ears, flap to and fro like a valve on the slightest movements of the nostrils.

This latter objection, of course, applies to Politzer's method if it be very frequently practised; but as it must be done by means of an apparatus, patients are not so apt to take it into their own hands.

I do not now advise the use of the Valsalvian method in the treatment of aural disease, and as a means of diagnosis it

is, in most cases, vastly inferior to the use of the catheter or Politzer's method.

I may add a word about the last-named means of examining the Eustachian tube, namely, bougies. Filiform catgut bougies may sometimes be employed with advantage in determining if the non-entrance of air by the catheter or Politzer's method be due to a stricture; but the need for their employment occurs only in a very limited number of cases, and when they are used great care and judgment are necessary. This subject will be fully discussed in the chapter on Chronic Non-suppurative Inflammation of the Middle Ear.

It will be understood by the reader that very many cases of aural disease—for example, those of the external auditory canal—will not require the exhaustive examination that has just been detailed, yet many cases *will* require a systematic and complete observation, such as I have attempted to delineate, in order to a diagnosis which shall be exact and consequently valuable. The time thus consumed is sometimes considerable, but not as great in amount as those who simply read these descriptions will perhaps imagine. The details occupy more in description than in execution; and their strict performance will of themselves in time make those who carry them out good observers of the phenomena of disease.

CHAPTER IV.

THE DISEASES OF THE AURICLE.

A FINELY formed auricle is justly esteemed one of the marks of personal beauty. The celebrated physiognomist, Lavater, also attached considerable importance to this part in determining character. A humorous German critic, quoted by Voltolini, in speaking of Lavater's ideas of physiognomy, says: "It would be very queer of Dame Nature, if she had hung every one's character on the nose, so that any one who was a master in physiognomy could read it. Perhaps fearing this, some people shut their eyes and are ashamed to look one in the face." A French author, Dr. Amédée Joux, quoted by Von Tröltsch, goes much farther than Lavater in his estimation of the signification of the auricle; and besides the part which it plays in indicating human character, he claims that, more than any other organ of the body, it descends with its particular form from father to child, and that by the shape of the auricle we may be assisted in determining the legitimacy of children, and the conjugal fidelity of a mother. He says, "*Montre-moi ton oreille, je ne dirai qui tou es, où tu viens, et où tu vas*," or, as we should say in English, "Let me see your ear, and I will tell you who you are, where you came from, and where you are going."

I am inclined to think that this view of the importance of the auricle is Gallic, rather than truly physiological. Recent authorities, such as *Gruber* of Vienna, believe that the grace and beauty of the auricle have little influence upon the functions, whatever may be the physiognomic or other significance of the part. It makes very little difference as regards the

* Diseases of the Ear. 2d American Edition, p. 14.

hearing power, however much it may affect personal beauty, whether the auricle lies exactly at a proper and graceful angle on the head, or whether it be closely adherent, and thus simply form an ugly appendage; and yet the auricle has functions, although, like the muscles which move it, these functions in man are comparatively unimportant and rudimentary. We all know, however, that there is some importance attached to this part by persons with impaired hearing; for all of us have seen such persons place the hand behind the auricle when listening intently, in order to facilitate the conduction of sound into the auditory canal.

Voltolini* considers the auricle to be a reflector, condenser, and conductor of the waves of sound. As a reflector, the fossa of the concha throws the sound-waves against the tragus, whence they pass into the auditory canal. This author is inclined to the belief that when the auricle is small the concha is deeper, in order to compensate for the loss. The auricle is a condenser of sound, just as is every other firm and elastic body. Its chief function, however, according to Voltolini, is that of a conductor of sound. If it were merely a reflector and condenser, it would have done its work better if formed of bone. It is to be considered as an external membrana tympani. This outer membrane is placed in different degrees of tension by reflex action, just as is the true membrana tympani by the tensor tympani muscle. This may be illustrated by observing the operation of syringing the ear. At the entrance of each stream of water, the auricle moves, and at times this motion is sufficient to cause a backward current of the water from the ear. Again, many persons with impaired hearing can hear the watch, if it touch but the outermost tip of the auricle, while it cannot be heard if held but a line removed from the part.

Voltolini sums up his consideration of the auricle, by saying that "the auricle may be considered as the outer orifice of a hearing or speaking-tube, of which the external auditory canal is the tube proper—and since the sound receiver is so large in proportion to the calibre and length of the tube we

* Monatsschrift für Ohrenheilkende, Jahrgang II, No. I.

may see what nonsense it is to recommend the so-called invisible ear-trumpets, which are simply short aural specula."

A full consideration of the affections of the auricle belongs rather to general than to special surgery, inasmuch as diseases of the auricle rarely cause marked impairment of the hearing; and yet, for the sake of completeness in this work, I may call attention to the principal symptoms, with the general pathology and treatment of malformations and acquired affections of this part. We may conveniently classify them as follows:

I.—Malformations.
II.—Tumors.
III.—Malignant disease.
IV.—Injuries.
V.—Eczema.

MALFORMATIONS.

Many of the so-called malformations are the simple results of ill treatment of the auricle. Many women cover their ears so tightly with their hair, cap, and hood, as finally, by the excessive pressure, to obliterate the natural ridges and depressions which go to make up a finely shaped ear. 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."

All the attention which we as medical advisers may give to such acquired malformations, is to warn those who thus improperly treat this appendage of the risk they are running of becoming deformed.

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, coloboma iridis, etc., but unfortunately they are also cases for which our art can do nothing. I refer to those cases in which the auricle is congenitally absent, or where it exists only in a rudimentary form. In such instances the middle and internal ear are usually also in a deficient condition, and the auditory canal closed. Cases

have been seen, however, where the auricle was absent, while the other parts of the ear were in a normal condition, and in which there was a good hearing power. The description of a case recently reported by Dr. Knapp, of New York, will serve as a description for the whole class:*

"In a healthy child of three months, the left auricle consisted of a slightly tortuous ridge, two lines in height and three-quarters of an inch in length. It felt tough to the touch, like a healthy auricle, being undoubtedly composed of cartilage and skin. Its shape represented the rudiments of the helix and lobule; the other parts of the auricle were not visible. Immediately in front of the middle of the rudimentary auricle, there was a small round depression, indicating the situation of the external meatus." An incision through this point showed that the auditory canal was filled up by bone, or rather that there was no canal.

The experience of the profession is against the attempt to open a canal to an organ which will probably be found so imperfect that sound cannot be perceived by it. By means of the tuning-fork we may always determine in the case of any persons of sufficient age whether the central apparatus be or be not unimpaired. If the canal be closed, while the labyrinth is intact, the vibrations of a tuning-fork whose handle is placed on the teeth or forehead will be heard more distinctly in the affected than in the sound ear. The reflection of the sound waves is diminished by the stoppage of the auditory passage, just as in cases of inspissated cerumen and thickening of the mucus membrane of the cavity of the tympanum and the Eustachian tube, or perhaps there is no nervous apparatus on that side to receive the sound waves.

Superfluous auricles sometimes occur, just as do supernumerary toes and fingers. They are objects of anatomical curiosity rather than of therapeutical interest. 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.

* Transactions American Otological Society, p. 14. 3d Year.

† Krankheiten des Gehörorgans, p. 108.

The tumors found in the auricle may be divided into the following classes :

I.—Fibro-cartilaginous.
II.—Sebaceous.
III.—Vascular.

FIBRO-CARTILAGINOUS TUMORS.

The first-named form is a simple hypertrophy of the normal structure of the auricle.

According to Billroth,* these tumors consist chiefly of fusiform cells and connective tissue, and are nothing more than hypertrophy of a cicatrix such as occurs on other parts of the body after injuries.

They seem to occur much more frequently among the African than the Caucasian race. I have removed several of these growths from the auricles of negro women, while I have but rarely seen them among whites. I am also informed that they occur very frequently among the Africans of the East and West Indies, where they grow to an enormous size.

The etiology of these growths is very simple, if my own experience may be trusted on this point. They occur as the result of the irritation of the lobes produced by the truly barbarous custom of piercing the ears in order that ear-rings may be worn. They are much more apt to be found in the lower classes, because these use brass ear-rings much more commonly than wealthier persons, although the growths may occur even if gold ear-rings are used. They sometimes reach an enormous size, and become a very serious deformity. If these ornaments are considered indispensable, as no doubt they are, ladies should wear them by causing them to be clasped around the auricle by means of a suitable contrivance now sold by the jewellers and very much used.

One of the older authors, Frank, gives illustrations of the proper instruments with which to pierce the ears, with a detailed account of the operation; but the efforts of the medical adviser should be towards the prevention of the barbarous custom rather than increasing the facilities for retaining it.

* General Surgical Pathology and Therapeutics, p. 551. Translated by C. E. Hackley, M.D.

Fibro-cartilaginous tumors should be removed if they attain such a size as to be at all troublesome. The removal is readily effected by a V-shaped incision made with strong scissors. The edges of the wound are then brought together by sutures. The resulting deformity is usually very slight, and is much less than that from the tumor.

Sebaceous tumors should be removed by enucleation. Erectile tumors occurring on the auricle are, perhaps, best treated by means of the galvano-caustic apparatus, of which more will be said when we come to the subject of aural polypi.

OTHÆMATOMATA, OR VASCULAR TUMOR OF THE EAR.

The peculiar effusion of blood which quite often 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 quite an amount of discussion among scientific observers. Virchow* and E. R. Hun,† of Albany, N. Y., are the authors who seem to me to have given us the clearest and best accounts of this interesting affection, and, in what I am about to say, I shall avail myself of their labors, together with some experience of my own on this subject.

The so-called othæmatomata may be divided into those of idiopathic and traumatic origin. The idiopathic form occurs chiefly, though not exclusively, among the insane. I have seen two cases occurring in people of sound mind, which corresponded very well with the descriptions of those occurring in the insane as given by Dr. Hun, whose observations seem to have been confined to this class. My friend, Dr. E. G. Loring, has also seen one idiopathic case in a sane person. The symptoms of the idiopathic form of the affection are as follows: Before the tumor appears we find the ear or ears, as the case may be, red and swollen, and the face and eyes give evidence of a strong determination of blood; occasionally, however, there is no redness of the skin, and there is merely some œdema of the auricle; among the insane there is no

* Die Krankhaften Geschwulsten, Bd. I, p. 135.

† American Journal of Insanity, July, 1870.

manifestation of general ill health. In a few hours, or it may be days, an effusion of blood takes place. The tumor occupies the concha in the main, but it extends over the auricle so as to obliterate its ridges and cause the usually beautiful part to 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, being hot and painful. The swelling is usually quite firm, but a careful examination will detect fluctuation.

The vascular tumor of the auricle, judging from Dr. Hun's statistics, is much more common among men than women. He reports twenty-four cases, of which twenty-three occurred in males. The form of insanity was general paresis in eight cases, melancholia in six, acute mania in four, chronic mania in four, and dementia in two. These statements accord with the views of other authors, so that we may conclude that 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, sometimes with such violence as to spirt the blood to a distance of several feet, or, unless interfered with, is gradually absorbed. Spontaneous rupture is more common than absorption.

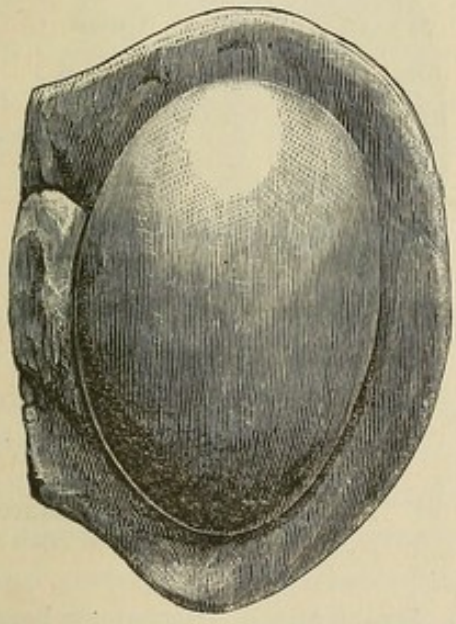
Dr. Hun's observations show that the traumatic and idiopathic othæmatomata are not alike ; for in one case which he details, an insane person, already suffering from hæmatoma of one auricle, received a blow from a broom-handle on the other, which produced *swelling and ecchymosis, but no hæmatoma.* We must, therefore, I think, strictly distinguish the idiopathic from the traumatic form.

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. The second factor in producing hæmatoma auris, centripetal irritation of the sympathetic from strong emotions, is especially

active among the insane, because their emotions are not under the control of the will.

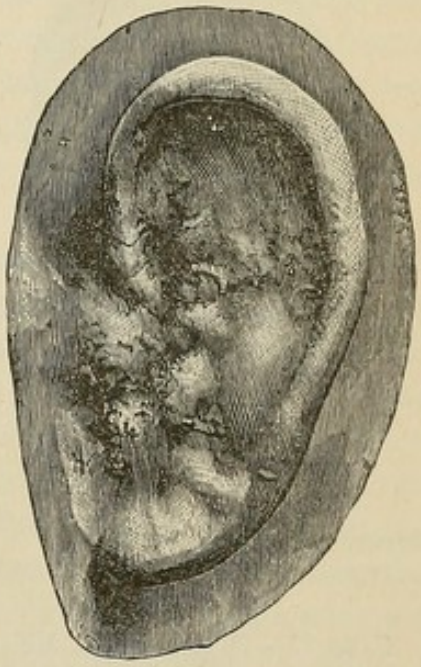
Virchow has made the pathology of othæmatomata very plain, both by his descriptions and the excellent illustrations which he furnishes in his great treatise on tumors. He says that "the older authors described the affection as erysipelas of the auricle occurring in the insane. It was supposed that in the hyperæmia and general change in the system a hemorrhage occurred, which caused a separation of the perichondrium from the cartilage; but in true othæmatomata, pieces of the cartilage become attached to the perichondrium."

Fig. 26.



Othæmatoma.
From a Photograph taken from a plaster cast, when the tumefaction was greatest. After Hun.

Fig. 27.



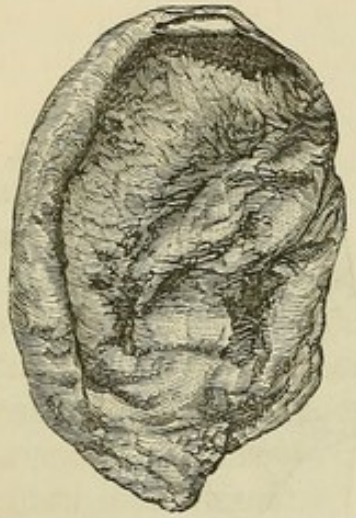
The same Ear after rupture and contraction had taken place. After Hun.

Case I.—J. A. C., æt. 34. General Paresis. Admitted January, 1857. Insanity hereditary in his family. Discharged June, 1858. Re-admitted May, 1859. July 24, a simple sanguineous cyst was observed in each ear. Effusion rapidly took place until the outlines of the auricle were obliterated. Sept. 30, the tumors have gradually subsided. Patient died May 10, 1860.

According to the Berlin pathologist, the morbid process seems to be primarily a softening or deliquescing one, induced by general disturbances of nutrition, or *possibly*—although

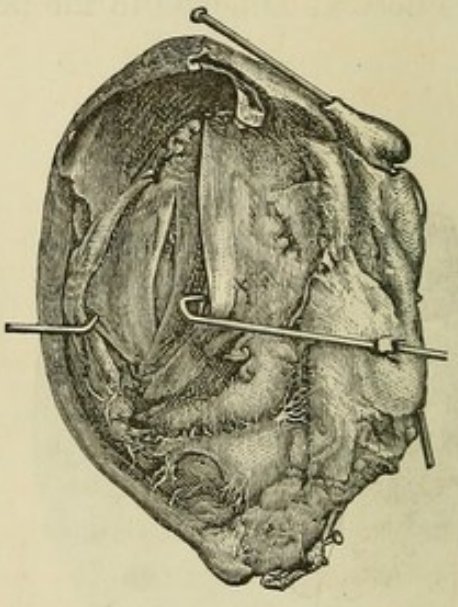
this class of cases seems to belong to itself—by local injuries of the cartilage. The tumor disappears either by gradual absorption, spontaneous rupture, or by the puncture of the surgeon. Coagula often form, which make a delicate coating over the separated portions, and these afterwards serve as means 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.

FIG. 28.



Showing amount of contraction after rupture of cyst. After Hun.

FIG. 29.



Shows separation of perichondrium from the cartilage. After Hun.

CASE II.—D. M., æt. —. Melancholia. Second attack. Hæmatoma began May 18, 1869. On July 3, had hæmatoma on both ears. Aug. 1, the left auricle burst at upper portion of concha, and the contents, consisting of fluid and clotted blood, were thrown to the ceiling a distance of 12 feet. Died Sept. 9, 1869. A section of auricles showed that the perichondrium was much thickened, and separated from the auricular cartilage on its outer aspect, so as to leave a large, smooth cavity, lined with a smooth, shining membrane, and containing a few drops of serous fluid.

The authorities differ as to the proper method of treating idiopathic othæmatomata. Dr. Hun says that puncturing or laying open the sac does more harm than good. He believes that the least amount of deformity is obtained when the effusion is gradually absorbed. Dr. Gray, of the Utica Insane

Asylum, proposes to ligate the pŏsterior auricular artery. Gruber advises the evacuation of the fluid and the coagula, and the use of a compressive bandage. My own limited experience inclines me to Gruber's method of treatment.

Vascular tumors caused by violence should not be confounded with those occurring idiopathically.

Gudden, a German writer and physician for the insane, quoted by Virchow, has shown that the auricles of ancient statues are very frequently ornamented by tumors resembling the vascular effusions seen among the insane. In the gallery at Munich the head of Hercules has such ears. These misshapen auricles are the typical marks of the ancient boxers or pugilists. Such fighters wrapped their hands in leather, and, thus armed, struck the ears of their antagonists; consequently in the figures of Hercules, Pollux, and other classical fighters, a deformed auricle is a regular appearance. Other historical personages—the Trojan Hector for example—are represented as having othæmatomata.

To conclude from these observations that the othæmatomata are *always* the result of traumatic influences, that they are more frequent among the insane because they are very apt to injure themselves or be injured by their attendants, seems to me to be manifestly incorrect, judging both from Dr. Hun's observations and from the fact that these tumors are very uncommon. Even the English writers, living in the land preeminent for pugilists, scarcely mention them. Wilde* describes and gives an illustration of one case, however, which seems to have been a hæmatoma, but was not recognized as such by the author. It was idiopathic in origin. It occurred in a male, aged twenty-four, and was about the size of a small pear. It occupied the upper portion of the left auricle, between the helix and the concha. It was treated by incisions, and considerable deformity resulted.

Toynbee† describes these cases under the head of cysts, and seems inclined to ascribe a traumatic origin to them, and he states that it is the opinion of Dr. Thurnam, physician to one of the County Insane Asylums of England, that they are

* Aural Surgery, English edition, p. 164.

† Diseases of the Ear, American edition, p. 53.

less frequent than formerly, on account of the fact that violence is not so much employed in the management of the insane. Dr. Thurnam evacuated the contents of the tumors, and used setons, and thus claims to have prevented the deformity to some extent. Toynbee mentions but one case, that of a boxer, that he has himself seen; but his description is not detailed enough to allow us to judge whether it was identical with those observed in the insane.

Dr. Hun is so strongly of the opinion that the idiopathic othæmatoma are symptoms of insanity, that he would consider any person having such tumor upon the auricle, even if sane, as a person to be carefully observed as to cerebral symptoms. This is an opinion of Dr. Hun's which the author gained in a recent conversation with him upon this subject.

I have also recently had a very interesting and instructive interview with *Dr. Brown-Séquard*, now of this city, on the subject of the etiology of vascular tumors of the auricle.

Dr. Séquard has found that sections of the restiform bodies, or largest column of the medulla oblongata, in animals (Guinea pigs), will produce a hemorrhage beneath the skin of the auricle in from 12 to 24 hours. This hemorrhage is soon followed by gangrene of the part. I had, through Dr. Séquard's courtesy, the opportunity of examining such ears, and of verifying the fact of the subsequent gangrene. The hemorrhage usually occurs in the fossa navicularis of the auricle. This hemorrhage usually takes place on the same side with that of the section.

Dr. Séquard also stated that sections of the sciatic nerve, by reflex action upon the medulla, would produce the same result, and that he had produced in his own person flushing of the auricle by pinching the sciatic nerve.

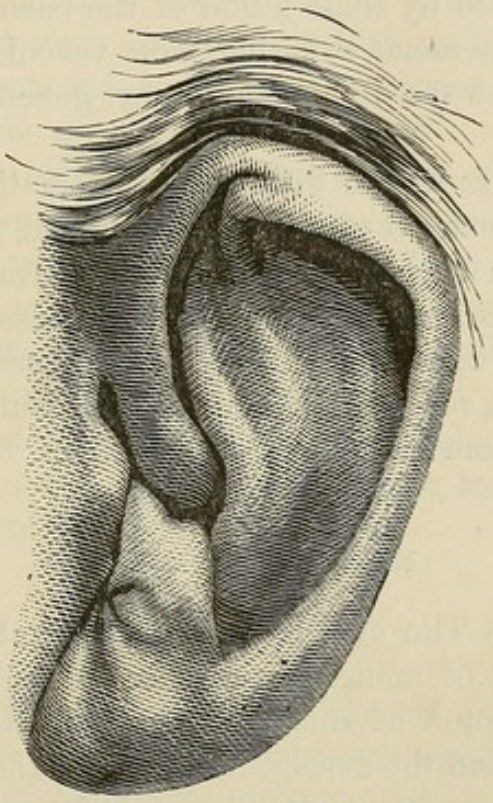
Dr. Séquard believes that disease of the base of the brain, which is, however, not always attended by insanity, is the cause of hæmatoma auris. In the human animal, gangrene is not apt to result from the hemorrhage; probably because the thicker tissue of the human auricle has a greater resisting power.

It will thus be seen that Dr. Séquard's views confirm those

of Dr. Hun, while they shed a new light upon the valuable clinical observations of the latter.

Any inflammation of the integument, connective tissue, and cartilage of the auricle, leading to effusion of serum, blood, or the formation of pus, will be apt to cause a deformity of the part; but such a case should be distinguished from an othæmatoma.

Fig. 30.



Auricle Deformed by Inflammation.

The sketch from a photograph, which is here given, shows the result of what was at first an inflammation of the cartilaginous portion of the auditory canal. A polypus formed from the prolonged use of poultices, the inflammation extended to the tissue of the auricle, and after a long period of suffering, during which small abscesses were formed, which were evacuated, after pursuing a sinuous course in the integument, the auricle attained the shape which is here shown. The hearing power is unimpaired when the very small meatus is kept open.

From all that has been written of vascular tumors of the

ear, and from my own experience, I think 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 occur among the sane. It is probable, however, from Brown-Séquard's experiments, that the affection is caused by some lesion of the base of the brain, so that although persons suffering from vascular tumor of the ear may not always be insane, they generally have brain disease.

Third. The traumatic form differs from the idiopathic in being a simple extravasation of blood from vessels ruptured by violence. In such cases the deformity resulting from the spontaneous effusions does not occur, unless among professional pugilists, where the violence is frequently repeated, and the auricle, from repeated hemorrhages, assumes a shape like that resulting from a true othæmatoma.

MALIGNANT DISEASE.

Epithelioma.—The auricle is sometimes, although not frequently, the seat of malignant disease. I have observed one case of epithelioma of this part, in which the whole auricle was destroyed, and the disease had invaded the auditory canal. I lost sight of the patient after some weeks, and I can give no account of the subsequent course of the disease, which was unchecked by the treatment adopted—the application of fuming nitric acid. Dr. J. Orne Green, of Boston,* also reports a case, and quotes one from Velpeau.

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. When the auricle alone is involved, this is very

* Transactions American Otological Society, third year.

easily accomplished. In the healing process care should be taken, as suggested by Dr. Green, to prevent the closure of the meatus by the cicatrix, a result which followed in the case reported by him, in consequence of the refusal of the patient to remain under observation until the wound was healed.

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, causing external otitis, 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.

Vascular Neoplasia.—Angioma, a form of vascular tumor which, at first sight, according to Gruber, resembles an othæmatoma, may occur on the auricle. The treatment that has been attempted in angioma is, in general terms, cauterization with various substances, or inoculation with vaccine lymph, the application of tartar emetic ointment, or subcutaneous injection of dilute tincture of the sesquichloride of iron; but the simplest and only effectual remedy is the amputation of the affected portion.

ECZEMA.

Eczema of the auricle is not one of the most frequent affections of the ear, as shown by the statistics of eye and ear hospitals and writers on otology; but a large number of cases never come under the attention of special observers, and are, consequently, not found in their statistics. 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, from 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, and the condition is unpleasant in the highest degree. The disease, when left to itself, is apt to have a very chronic course, and yet it is very amenable to proper treatment. The causes of eczema are not very clear. I have usually observed it in persons of weak constitutions, and not among the strong and vigorous. 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.

According to *Ausspitz*,* formerly an assistant to Hebra, the great dermatologist of Vienna, eczema of the ear differs from the same disease as it appears in other parts of the body, in occurring with a greater amount of swelling and secretion of a serous fluid than is usual, together with the more frequent appearance of fissures in the tissue.

Treatment.—The treatment of eczema is simple, and I have usually found the results very good. The advice of Ausspitz, to do as little as possible in the acute form, is excellent. 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:

R Flor. Zinci..... ʒ ij
Pulv. Alum }
Amyli Pulv. } āā..... ʒ 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.

At the same time with this local treatment, as in all other diseases, the physician should carefully consider the general

* Archiv für Ohrenheilkunde, Bd. I., p. 124.

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 treatment which I have found usually successful is the following: The auricle is carefully poulticed with flax-seed meal until all the crusts can be removed, and is then anointed with an ointment of the sulphate of iron and simple cerate, in the proportions of from one to two grains of the former to a drachm of the latter. This ointment is applied as often as may be necessary to keep the part constantly anointed, until the vesicles have ceased to form.

The local treatment of the auditory canal is often unsuccessful 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—deafness. 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, for the simple reason that an ointment will again 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 very valuable in the treatment of chronic eczema of the canal. It allays itching sensations, and is usually very grateful to the patient. The use of the douche may be entrusted to the patient himself. It is well to use it very often in the early periods of treatment, say once an hour. The warm water is a direct antiphlogistic ; I have seen its use alone, cure most obstinate cases of inflammation of the canal, that have existed for years.

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 very chronic cases I usually give Fowler's solution in connection with the local treatment, and it is usually of great avail.

I am aware of various other modes of treating eczema, and of the almost innumerable applications which are recommended ; but I feel confident that that which I have sketched will serve its purpose so well, when modified by individual judgment in practice, as to fulfil all reasonable requirements.

Calcareous formations are often found in the auricle, in persons of a gouty habit, as in other parts of the body. These symptoms of gout often cause a great deal of local pain, which is sometimes relieved by an unctuous application to the hardened and tender parts. *Dr. Garrod*,* of London, first called attention to these formations, which he found to be urate of soda. They were most frequently found by Garrod on the upper border of the helix, and were supposed not to exist on the lower part of the auricle ; but I found what seemed to be such a formation, in the concha of a gentleman who suffered from gout. Unlike those cases reported by Dr. Garrod, this spot was very painful.

* Von Tröltsch, Diseases of the Ear, p. 56.

CHAPTER V.

DIFFUSE AND CIRCUMSCRIBED INFLAMMATION OF THE EXTERNAL AUDITORY CANAL.

THE affections of the external auditory canal may be conveniently arranged as follows:

I.—Diffuse inflammation.
II.—Circumscribed inflammation.
III.—Vegetable fungous growths.
IV.—Inspissated cerumen.
V.—Eczema.
VI.—Foreign bodies.
VII.—Polypi.
VIII.—Exostoses and hyperostoses.
IX.—Syphilitic condylomata and ulcers.

To avoid any misconception, I would remark that while bony growths (exostoses and hyperostoses) are classed under the affections of the external auditory canal, they are actually consequences of inflammations of the middle ear. It will therefore be more appropriate to consider this rather important subject under the head of diseases of the cavity of the tympanum. An account of their pathology and treatment will be found in the chapter devoted to the Consequences of Chronic Suppuration of the Middle Ear. The subject of Aural Polypi will also be deferred until a subsequent chapter, for they are also much more frequently the result of inflammation of the middle ear, than of disease of the external auditory canal.

Otitis externa is the generic term for all the various forms of inflammation of the external auditory passage, but it is not specific enough for any exact study of these affections.

Inflammations of the external auditory canal are much more rare than those of the middle ear; of 1000 cases of the different varieties of aural disease observed by myself in private practice, but 132 were cases of affections of the outer ear. This proportion is about the same in the statistics of other authors and those of public institutions.

Some writers speak of the inflammations of the external auditory passage as being catarrhal in its nature; but as Von Tröltsch strongly insists, and as has already been said in the description of the anatomy of the auditory canal, there cannot be catarrhal inflammation where there is no mucus membrane. The lining of this passage is integument, and in no proper sense can we speak of a catarrh of the integument.

DIFFUSE INFLAMMATION.

I will first give an account of the diffuse form of inflammation of the auditory canal.

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

I speak of these symptoms in the order in which, on careful examination of the history of the cases, I have found they usually appear. It is true that patients often give a period later than the one in which the itching sensations occurred, as the one in which their ears first troubled them, but ears in a normal state have, so to speak, no sensations; that is to say, they are not thought of, and need no especial care. When an ear begins to require something to relieve itching sensations, it is already diseased.

The objective symptoms are impairment of hearing, redness of the canal and of the membrana tympani, swelling, and, at a subsequent period, suppuration of the epidermis and integument. In the lower part of the canal, dealing as we do with periosteum, the pain will be intense, like that from a paronychia. An inflammation of integument that is so tightly bound down to the bone as is this portion of the integumentary lining of the auditory canal, can but be essentially a periostitis.

Prolonged suppuration of the integument, or even suppurative action that has been of short duration, but violent, may produce polypi, or, as I prefer to call them, granulations, in the external auditory canal. I have the notes of four such cases. One, that of a lady, was complicated by a precedent inflammation of the cavity of the tympanum; but the inflammation of the external auditory canal was an independent one. Very large granulations, or polypi, sprang up in a few days after a poultice had been applied. This poultice was ordered by the attending physician to relieve the initial pain of an inflammation of the canal, such as sometimes occurs from the continued instillation of astringents. It was applied for some days through a misunderstanding of the damage that might ensue, and very large granulations formed.

The second case occurred in an Irish laborer, whom I saw at my clinic in the University Medical College. I removed a large polypus from the meatus, which the patient stated positively had occurred in a few days, and that he had never previously suffered from disease of the ear. After the treatment had progressed for some time, I found that the inflammation was confined to the canal and the outer layer of the drumhead, and that his statement as to the existence of previous disease was probably correct. I could find no cause for the rapid course of the inflammation.

The third case I saw at the Brooklyn Eye and Ear Hospital. The trouble in the ear had lasted seven days, and here also there was a large polypus.

The fourth case was that of a lady whom I saw in private practice. She suffered from what she supposes to have been an abscess or furuncle of the external meatus. It was lanced, and then poultices were applied. I saw her six days after. She had used the poultices nearly the whole of the six days. I found the canal blocked up by a polypus as large as a filbert, growing from the anterior wall of the canal. The final result of this case in deformity of the auricle, is seen in the engraving on page 113.

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

the cavity of the tympanum, which will be fully discussed in a subsequent chapter.

Although it is anticipating somewhat of what should be said under the head of treatment, I will here state that the undoubted cause of these growths, in two of the cases just given, was the prolonged use of the poultices. Von Tröltsch called attention to the fact that poultices produced tedious suppuration; but I believe this is the first intimation that they cause the sprouting up of exuberant granulations in the canal.

Causes.—The causes of the diffuse form of inflammation are various. Irritation of the ear by means of ear-picks, by hair-pins, favorite instruments with women; the instillation of such agents as Harlem oil, Cologne water, camphorated oil, and so on, are frequent causes of an inflammation of this part. There is probably some antecedent inflammation of the integument which causes a resort to those agents, to relieve the troublesome itching sensations. 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 seem to be chiefly local, if I may so speak; that is, the disease is caused by mechanical causes acting locally. There may, however, be an antecedent eczematous inflammation before the diffuse, non-eruptive form begins.

Of late an apparatus, consisting of a very small sponge attached to an appropriate handle, and called an *aurilave*, has been devised, and is sold largely by apothecaries as an instrument for cleansing the ear. It does a great deal of harm. By its use the secretions are packed in the ear, and inflammation of the integument or inspissation of the cerumen is very often caused.

Physicians are often asked if the outer ear should be protected from the cold air by a plug of cotton, ear muffs, 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 sit in a railway carriage which is going very fast, with the ear next

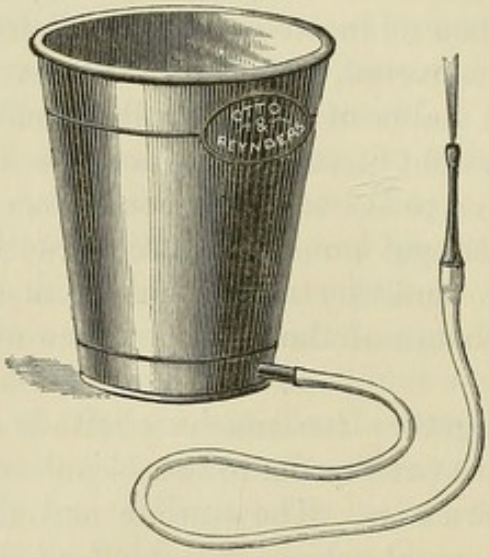
to an open window, or if the auditory canal and membrana tympani be exposed in any similar manner to a draught of air, an inflammation of the canal and of the tympanic cavity may ensue. But when there is no such draught upon the ear, as, for instance, when a person is walking or driving in the open air, 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. In cases of chronic aural catarrh, and in the other kinds of middle ear troubles, 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 cause the ears to become over-sensitive. As I have said, we do not usually get an inflammation of the ear from an exposure of the auditory canal, but from such causes as wet feet, an exposure of the whole surface of the body, and so on.

There is altogether too much solicitude on the part of mothers and other persons as to the cleanliness of their children's or 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 health of the canal.

Treatment.—An attack of *otitis externa diffusa* in an adult may be usually cut short by the use of leeches. They should be applied, as *Wilde* long ago pointed out, not on the mastoid process but on the *tragus*, for the reason which Von Tröltsch gives, that in 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 in their effects, however, as when used for an inflammation of the middle ear; when, as we shall see, they exert an almost magical influence, so rapid is their effect. 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, as recommended by Gruber, of Vienna. Warm water should also be allowed to run into the ear, by means of Clarke's aural douche, or any similar means.

Fig. 31.



E. H. Clarke's Aural Douche.

When patients are told to apply warm water to the ear, unless they are particularly instructed, they will almost invariably use the syringe, thinking that is the way in which the water is to be applied; but what is required is the steady flow of warm water upon the part, and this is best attained by means of the douche. 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. The douche is the same as the so-called nasal douche of Weber, and is very valuable in cases of aural inflammation. As has been seen in the first chapter, Hippocrates advised the use of warm water to the ear for

the relief of pain, but it fell into undeserved disuse until the value of its application was reinforced upon the minds of a profession filled with the idea of the virtues of composite "ear-drops."

Of late the cup has been made of soft rubber, and it thus becomes much more convenient to carry about. In the absence of the cup, a bit of rubber tubing and an ordinary bowl, by the application of the principle of the *syphon*, will make an efficient and simple douche.

The value of the aural douche is by no means limited to cases of inflammation of the outer portions of the ear. In acute inflammations and chronic suppurations of the middle ear, it becomes a very valuable means of alleviating pain and of cleansing the ear. For the latter purpose it is especially valuable among children.

If the use of the leeches, the employment of scarification, and the warm douche do not wholly subdue the pain—which is quite unlikely—a small flax-seed poultice may be applied *in* the canal; but the ear should not be covered by a large poultice, as is often done; such poultices relax the tissue to so great an extent that granulations or polypi are apt to spring up from the softened and loosened tissue, as we have seen in the cases that I have detailed. A poultice should never be applied to or on the ear for more than a few hours. They are almost as dangerous a remedy in aural as in ophthalmic practice, where they have caused the loss of many eyes.

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. By attention to these details much suffering will be spared the patient, and the course of the affection will be shortened. 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 internally. I have not found much advantage from the addition of narcotics to the warm water instillations, although there may be some benefit from their use. Magendie's solution of morphia is the agent I usually employ in the ear, using about one part to eight of water, dropped when warm into the

canal. The popular remedies for ear-ache, dependent upon whatever cause, are usually sweet-oil and laudanum, molasses, Harlem oil, glycerine, and 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. I have seen children, who had been suffering from severe pain in the ear, drop off to sleep in a few moments after a tablespoonful of warm water was poured into the ear; and yet I am very sorry to say that there are some rare cases where warm water seems to aggravate the pain; but the leeches scarcely ever fail us.

The onion acts just as the conical flax-seed poultice, and may be resorted to if the warm water fails, and leeches are not to be had. Harlem oil, and all similar stimulating applications, do nothing but harm, and increase the sufferings of the distressed patient. The laity resort to such applications, and submit for days to pain in the ear, without going to a physician, because they have been taught by sad experience that doctors pay very little attention to an ear-ache—and yet what pain is worse? Warm vapor of any kind, the smoke from a cigar, 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, who awake at night with ear-ache, may be quieted by breathing into the auditory canal.

Some practitioners are in the habit of indiscriminately advising blisters behind the ear in all forms of aural disease, whether acute or chronic. Whatever may be their virtue in chronic disease, they are only an aggravation in the acute forms of aural inflammation, and must give a patient an unfavorable idea of the benefits of counter-irritation. Speedy relief from the severe pain of otitis is as imperative as in peritonitis or iritis, and I have dwelt on the various remedies at some length, in order that the practitioner may be at no loss for some agent that will cut short the inflammatory action. I will tabulate the remedies in the order that I consider them valuable: 1. Leeches; 2. Scarifications; 3. Warm douche; 4.

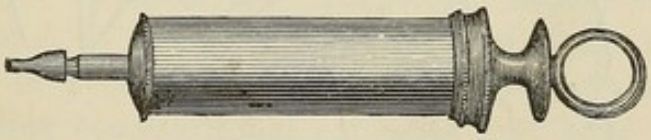
Conical poultice in the canal; 5. Steam or warm vapor; 6. Opium or chloral.

Dr. A. D. Williams, of St Louis, has recommended the use of a solution of a sulphate of atropia, two grains to the ounce, which is dropped into the auditory canal as a remedy for the relief of the pain from aural inflammation. I have not as yet had sufficient experience in its use to give an opinion as to the value of the remedy in this class of cases. A suggestion from such a competent observer is well worthy of attention.

Most adult patients go about while suffering from external diffuse otitis. During the more acute stages it would be better to keep them in-doors and in bed. If this can be accomplished, the use of diaphoretics will aid the local treatment.

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 many physicians are unable to carry out efficiently and with neatness. The appliances necessary for a thorough syringing of the ear are, first, a good syringe. I think the small hard-rubber syringe is the best, although a Davidson's syringe does very well. The glass syringes are of no use whatever.

FIG. 32.

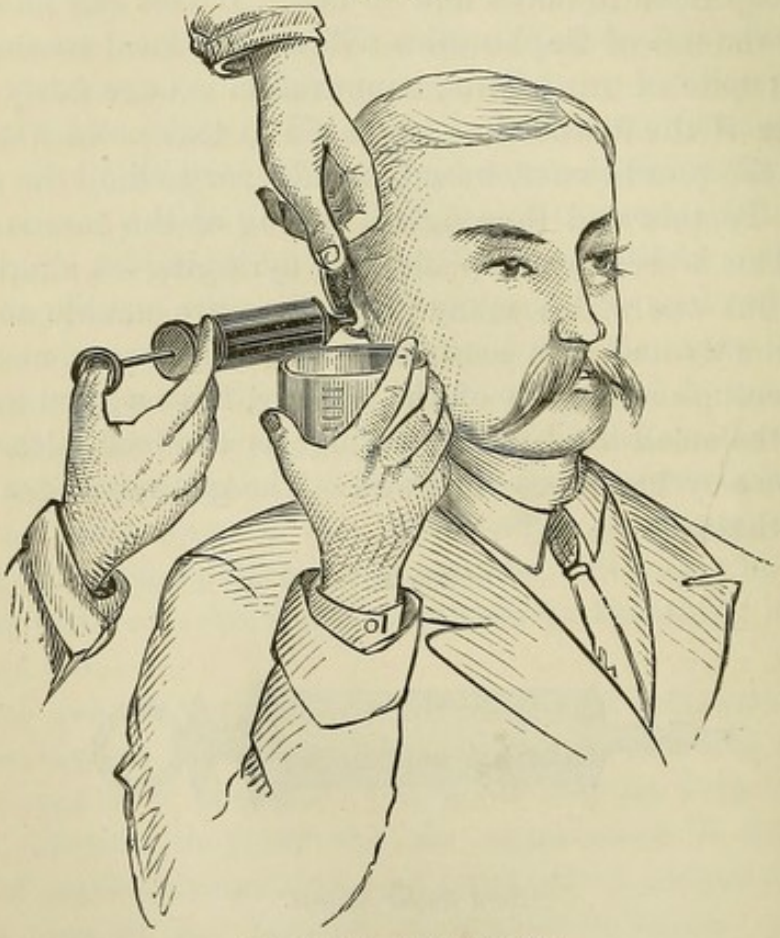


Hard Rubber Syringe.

Then we need a bowl—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. No towels or napkins are needed about the neck, to prevent spilling the water; no assistant beside the patient is required, if he be an adult, and if the proce-

dure be carried out as will be described. 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 thoroughly 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.

Fig. 33.



Method of Syringing the Ear.

It will be seen, that no patient is capable of thoroughly syringing his own ear, and that no person who has not been taught the simple process will be able to accomplish the object for which syringing is undertaken, that is, the cleansing of the auditory canal and the outer surface of the membrana

tympani. Notwithstanding these facts, patients suffering from an ulcerative process in the ear, and who require the daily removal of the pus as an essential to recovery, are often sent away without other instruction than the advice to syringe the ear. It is almost as difficult for a person to properly syringe his own ear, as to cauterize his own palpebral conjunctiva. We certainly should never think of leaving the latter manipulation to any but a person who had been taught to manage it properly.

The ear affected with chronic external otitis should be cleansed from one to three times daily, while the secretion is at its height. This cleansing should always be done under a good illumination by means of the otoscope attached to a forehead band. The parts should be then dried by means of cotton twisted about a thin bit of wood, or a steel cotton-holder.

The agents which may be used in checking ulceration are numerous. I prefer solutions of nitrate of silver, of alum, and of the sulphates of zinc and copper, to the others. The nitrate of silver I use in strong solutions, from 20 to 40 grains to the ounce, pencilled over the parts; the sulphates and the alum in solutions of from 1 to 4 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, which should be done at least three times a week, and, if possible, daily, by the physician himself.

What may be done for a neglected suppuration of the auditory canal, by the mere daily removal of the pus and the application of a caustic or astringent, however many alteratives and other constitutional remedies may have been taken in vain, is sometimes marvellous.

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 from the external

auditory canal, contrary to what has often been written upon this subject, and contrary to the opinion of most practitioners with whom I have conversed on this subject, is, judging from my experience, a rare disease. When it does exist, it is, if properly treated, by the free use of warm water astringents, and leeches, if need be, exceedingly tractable, and almost always curable.

CIRCUMSCRIBED INFLAMMATION OF THE EXTERNAL AUDITORY CANAL, OR FURUNCLES OF THE CANAL.

By circumscribed inflammation occurring in this part we simply mean furuncles. They generally arise in connection with the existence of furuncles in other parts of the body, and are, like them, very painful. They also produce deafness by mechanically closing the auditory canal. Tinnitus aurium—noise in the ears—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. The 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 mirror, or otoscope, and reflected daylight or sunlight. One or more circumscribed swellings are found in the caliber of the canal. Their usual situation is 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 no difference whether pus or blood be evacuated by the incision. The relief following is generally immediate in either case. The incision is best made with a sharp-pointed curved bistoury, cutting from below upwards, and not with a scalpel down upon it, as the books usually advise. It can thus be made more quickly, and does not cause as much pain

as when done with the scalpel. The ear should be syringed with warm water after the hemorrhage 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 some 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 cleansing 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. Steam may also be allowed to pass into the ear from any sort of a vessel.

Leeches do not seem to do the same amount of good in furuncular inflammation as in the diffuse form.

The vapor of chloroform passed into the auditory canal has been highly spoken of, but I do not know much of it by experience, having been generally satisfied with the method of treatment above indicated.

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.

Causes.—This brings us to consider the cause of this affection. I do not think I ever saw a furuncular inflammation of the external auditory canal in a patient who was in other respects in a physiological condition. It seems to be the evidence of a wrong state of the system of some kind.

Furuncles are very apt to occur in anæmic persons. I have seen several cases where they were troublesome after parturition, during which the system had been much exhausted, and perhaps the patient had not been under the most judicious management as regards the diet. When iron was administered, and nourishing diet substituted for slops, the boils ceased to recur.

Every spring I see cases of furuncular inflammation in young ladies who were zealous attendants upon the *German*, and who spent large portions of the night in the ball-room, for quite long periods. They were not particularly anæmic, but they had no proper appetite, and were evidently suffering from the effects of an improper mode of life. Regular hours, regular times for eating, exercise in the open air, soon relieved these cases, but those who would persist in their dissipations, did not recover until the season was over. In one case there were also hordeoli or styes, which are generally regarded as evidences of mal-nutrition.

It will be seen from this, that the local treatment is by far the lesser part of our labor in these cases of circumscribed inflammation of the auditory canal. We should be very careful to inquire as to the appetite, exercise, mode of life, and *specifically* correct anything which may be out of the way. It will not be enough to give general directions, such as, "You must take exercise and live well," but the amount and kind of exercise, the time of eating, variety of food, and so on, should be plainly indicated; at the same time some one of the preparations of iron will generally be required.

The ear should be kept from the influence of cold air, when the patient is out of doors, by cotton, or an ear-lap; but the habit of thus protecting the ears in the open clear air, where there is no draught, should be abandoned when the furuncles have ceased to recur.

NOTE.—I have lately found, after the suggestion of Dr. L. Fisher, that the use of a small cotton plug saturated with glycerine, is a valuable means of relieving the pain from a furuncular inflammation of the canal. The plug should be changed twice a day.

CHAPTER VI.

PARASITIC INFLAMMATION OF THE EXTERNAL AUDITORY CANAL.

SYPHILITIC ULCERS AND CONDYLOMATA.

It is not more than six years since the profession became generally aware of the fact, that vegetable fungi were germinated in the auditory canal, and that they caused or aggravated inflammations of this part and of the surface of the membrana tympani. By the publications of *Professor Schwartze* of Halle, *Dr. Wreden* of St. Petersburg, and many others whose names will be quoted in this chapter, this fact has now become well known, and has enabled us to more clearly understand and more successfully treat certain cases of otitis externa.

The history of the growth of the aspergillus fungus, as well as that of the other vegetable parasites that have been found in the ear, is so recent, that an account of it seems to be necessary as an introduction to the study of the diseases caused by it.

In 1867, Schwartze* reported a case of inflammation of the auditory canal, in which the aspergillus fungus was found. *Prof. J. Vogel* made the microscopic examination that settled the fact, and he called Schwartze's attention to two cases which had been previously reported; one by *Mayer* in Muller's Archiv, 1844, p. 401, and one by Pacini, quoted by *Kuchenmeister* in his work on Parasites, published in Leipzig in 1855. In both these cases the fungus was a species of aspergillus.

Mayer's case was peculiar. The fungus occurred in the ear of a child, having what he called scrofulous otorrhœa, and

* Archiv für Ohrenheilkunde, Bd. II, p. 7.

the parasite was contained in round and oval cysts, of the size of a cherry. The walls of the cysts were fibrous, filamentous, white in color externally, while within they were hollow, greenish and granular.

Pacini's case was like those that have since been observed:

A boy of fourteen years came from a sea-bath, and complained that water remained in his ear. Itching and painful sensations ensued, and at last nearly complete deafness. In the auditory canal small transparent vesicles were seen. Two weeks after a whitish membrane was found on the walls. It was removed by syringing with warm water; but it soon returned. The microscopic examination revealed the presence of a fungus. The parasite was removed by the injection of a solution of acetate of lead, of the strength of two grains to the ounce of water.

Dr. Robert Wreden* reported six cases of the growth of the aspergillus fungus the year after Schwartze's case was published. He gave the name of *myringomykosis* to the disease caused by the fungus. He subsequently added eight to these, and published the whole, with a very complete account of the appearance of the fungus, in a monograph.†

Since the publication of Schwartze's and Wreden's cases others have been reported by Orne Green,‡ of Boston, C. J. Blake, Knapp, and by myself§ and others. Indeed, the occurrence of such a fungus in an inflamed ear is now a well recognized fact, for which we are indebted to Schwartze.

Causes.—In order that we may correctly understand the nature of parasitic otitis, it should be remembered that it 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, especially if it occur in one who is taught to believe, as most patients are, that an aural disease will "wear away" of itself, or, at any rate, that medical assistance will be of no avail for it.

The disease which usually precedes the formation of a vegetable fungus in the ear, is usually, as I believe, an eczema.

The etiology of the affection is not, however, quite clear,

* Archiv für Ohrenheilkunde, B. III., p. 1.

† Die Myringomykosis aspergillina. St. Petersburg.

‡ Transactions of the American Otological Society, 1869.

§ American Journal of the Medical Sciences, Jan., 1870.

but I feel quite certain that I have not seen a case of the growth of the vegetable fungus in which the ear was sound before the growth occurred. Some kind of an inflammation which loosens the epidermis, has first occurred.

The fungus is actually a mould, such as clings to damp walls and adheres to bread that is not kept thoroughly dry. As we should expect, the habits of the Russians, living, as they are almost compelled to, in badly ventilated rooms during the long winter, are very favorable to the production of aspergillus.

There is hardly a doubt that these cases of vegetable fungous growths in the ear, were formerly mistaken for impacted cerumen, and otitis externa diffusa. Since my attention has been called to the subject, I recall two cases of very obstinate inflammation of the auditory canal, which I now believe were cases of the growth of vegetable parasites in the part. It is an interesting fact, that they both recovered from the affection without any use of the specific parasiticides.

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 pain.

As is well known, pain is not a common symptom of inspissated cerumen, although it does occur. Pain is, however, usually one of the symptoms of otitis parasitica. It is not, however, the severe pain of a furuncle, or of acute catarrh of the middle ear, but it 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 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, which should only be used under a good illumination by means of the otoscope, 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 evidences of a vegetable fungus will, however, not be apt to fail to recognize it in a subsequent case.

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

I.—Aspergillus { flavus, glaucus, nigricans.
II.—Penicillium glaucum.
III.—Graphium pencilloides.
IV.—Trichothecium roseum.

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, and to be found almost exclusively on this part of the body. Dr. William H. Draper, of this city, has, however, observed one case of the growth of the aspergillus fungus on the inner side of the thigh, and it afterwards appeared in the auditory canal.

Wreden was not able to find any penicillium fungus in his cases, but Blake * reports a case in which on the second attack of otitis parasitica, specimens of bastard penicillium were found.

Dr. Hassenstein,† of Gotha, has observed one case in which a patient suffering from the usual symptoms of aural catarrh was found to have a yellowish green secretion 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

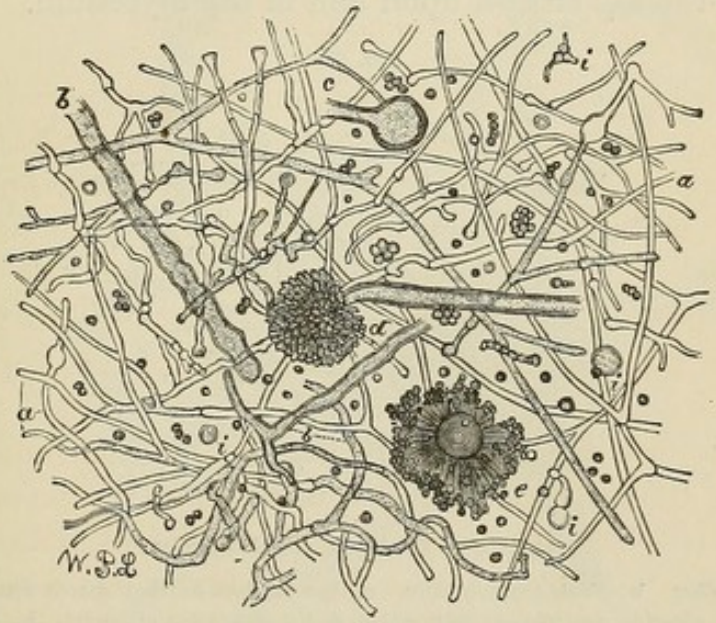
* Transactions American Otological Society, fourth year, 1871.

† Archiv für Ohrenheilkunde, Bd. IV., p. 164.

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 I am quoting, occurs in nature on wood, especially on elder-wood.

Dr. F. Steudener,* of Halle, describes another form of fungus which occurs in the ear, *Trichothecium roseum*. The evidence on this point is not quite conclusive, however, for Professor de Barry, to whom Dr. S. showed the specimen, said it resembled this fungus, although it could not be thoroughly examined, the specimen having been injured. Dr. Steudener then cultivated the actual trichothecium fungus

FIG. 34.



Aspergillus nigricans. 220 Diameters.

a. *Mycelium fibre.* b. *Fruit-bearing fibre.* c. *Naked sporangium.* d. *Sporangium covered with basidia only.* e. *More mature sporangium.* i. *Spores in a state of germination.*

upon some epidermis, and inasmuch as the spores and mycelium resembled those in the fungus removed from the ear, he thought himself justified in assuming that the latter were actually those of the trichothecium roseum. The evidence is therefore not quite positive as to the nature of the fungus.

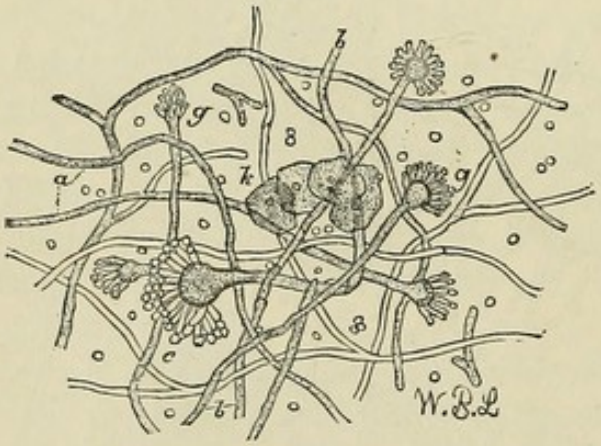
* Archiv für Ohrenheilkunde, B. V., p. 163.

The different varieties of the aspergillus fungus are by far the common kinds of vegetable parasites that have been found in the ear, although it is probable, now that attention has been turned to this subject, that others will be found.

The first two of the accompanying drawings of the aspergillus were made by my friend, Dr. William B. Lewis,* from specimens of cases occurring in my practice. The third engraving (Fig. 36) represents another specimen from the same source, which was drawn by my colleague, Dr. Charles S. Bull. Dr. Lewis describes the fungus as of three essential parts :

1st, the mycelium, a dense network or pseudo-membrane of delicate fibres, which form the groundwork or roots, as it were, from which the 2d part, or fructifying portion (fertile hyphen), arises perpendicularly ; and 3d, the free spores, which lie thickly strewn upon and in the mycelium.

Fig. 35.



Aspergillus flavescens. 220 Diameters.

a. *Mycelium fibre.* b. *Fruit-bearing fibre.* c. *Sporangium-bearing spores upon the basidia.* g, *Basidia, showing constriction preparatory to the separation of spores.* k. *Epithelium.*

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

The fibres of the pseudo-membrane 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).

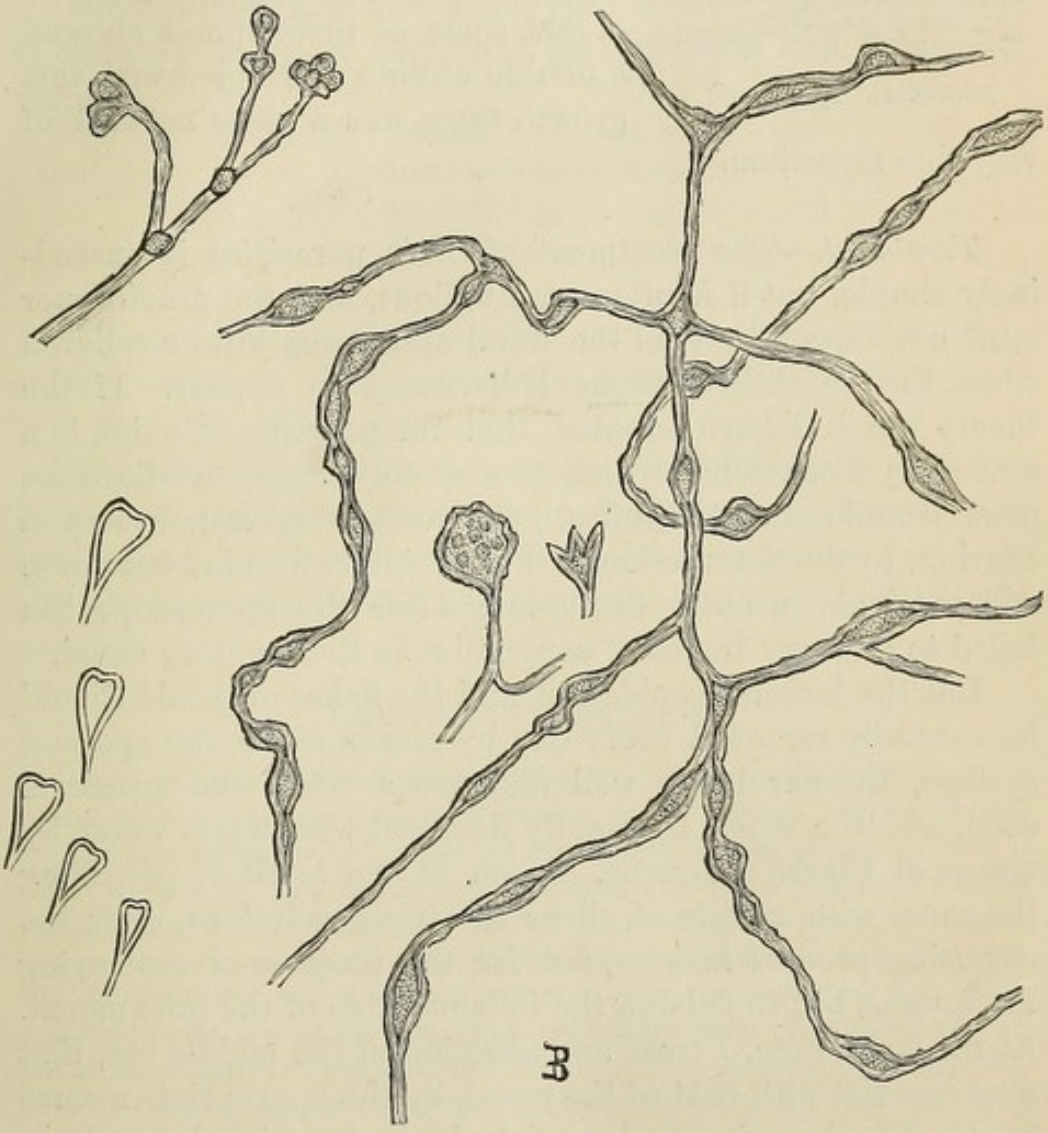
In the fruit-bearing portion are found the changes in form which establish

* American Journal of the Medical Sciences, Jan., 1858.

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.

Those who are interested in a fuller botanical description of the fungus will find it in the journal from which I have quoted, as given by Dr. Lewis, in an article furnished by Dr. L. and myself, and in Wreden's monograph.

Fig. 36.



Specimen of the Spores and fully developed Growth of the Aspergillus flavescens. Case III.

In Dr. Blake's case, which has been alluded to, a portion of the specimen was planted upon lemon-peel, placed in a closed glass vessel, at a constant temperature of 80° F., when it gave, at the end of the third day, a well-developed growth of the Leptothrix form of Penicillium.

The specimen represented in the accompanying wood-cut 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.

Fig. 37.



Penicillium. After Blake.

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. If the theory which I have adopted, that the parasitic affection is a secondary disease, be correct, 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, and the canal frequently douched with warm water by means of Clarke's douche. I am in the habit of pencilling the canal with nitrate of silver in strong solutions, after the cleansing process is over, not for the purpose of destroying the fungus, but to subdue the inflammation of the integument. At the same time, I treat any affection of the middle ear, that may co-exist with that of the canal, by the appropriate means.

Dr. Wreden gives a long list of agents which he believes to be useful as parasiticides. He mentions, among others, alcohol, bichloride of mercury, acetate of lead, tincture of iodine and carbolic acid. He prefers the hypochlorate of lime, which he recommends to be used in the strength of one to two grains to the ounce of water. The salt must be freshly dissolved in water at each application. Fowler's solution

ranks next to the lime as a parasiticide, according to Wreden. Solutions of tannic acid, gr. x ad ℥ j, are used by some authorities.

Drs. Orne Green of Boston, and Knapp of this city, concur with me in believing that a thorough use of warm water is the only parasiticide necessary.

Dr. Eugene Peuguet,* of this city, believes from experience in one very obstinate case, that the following formula is very useful.

R. Veratria..... gr. ij
Acid. Acet..... m. x
Aq. Rosa } āā... ℥ ss.
Glycerine }
M.

This is to be pencilled on the ear after the canal is thoroughly cleansed. I have used this formula but in one case.

The following cases will furnish a commentary on what has been said, and perhaps illustrate the nature of the affection better than any more extended remarks. The first two have already been published,† but the third has never before been printed.

CASES OF ASPERGILLUS.

Case I.—I was consulted, June 30, 1869, by J. F. B., a gentleman æt. 24, in regard to pain and impairment of hearing in the left ear. He stated that about a year before he had experienced a sense of fulness in the ear, as if it were "stopped up," and that, at the same time, there was considerable tinnitus aurium. He consulted a physician, who diagnosticated inspissated cerumen, and removed a large quantity of what seemed to be ear-wax from the canal. The relief afforded was of short duration, for the ear soon filled up. From that time to the present the patient has been in the habit of syringing the ear, and at times masses of some foreign substance were removed by this process. Of late he has noticed black particles strewn in the substance removed, which he thinks are due to the entrance of dust from the smoke-pipe of a steamer during a recent voyage from Europe. The patient now experiences very considerable pain in the ear, and it is the occurrence of this new symptom which has led him to consult me. The other symptoms—the sensation of fulness, tinnitus aurium, and impaired hearing, continue. Patient's general health is good, though he is very subject to naso-pharyngeal catarrh.

* American Journal of Syphilography and Dermatology, vol. iii, p. 209.
† American Journal of the Medical Sciences, l. c.

On examination, a watch which is usually heard at least thirty inches from the auricle is only heard one and a half inches, and the auditory canal is filled with a lardaceous mass, punctated by minute black spots. This mass was very adherent to the walls of the canal, and could not be thoroughly removed by syringing, but required the use of the angular forceps, under a good illumination by means of Tröltsch's otoscope and ordinary daylight. The surface beneath this mass, which peeled off from the canal, was red and very sensitive. After the removal of the foreign substance, a minute perforation of the membrana tympani was found situated in the anterior and inferior quadrant. There was no true suppuration, but mucus alone bubbled out from the opening during the inflation of the Eustachian tube. The Eustachian tube was shown to be permeable by Politzer's method, but there was very little sensation experienced in the ear when the air was forced in.

On the removal of the collection, the patient experienced immediate relief from the pain and tinnitus aurium, but the hearing was not very much improved. The diagnosis *catarrh of the middle ear* was made, while an exact definition of the state of things in the canal was delayed. Portions of the lardaceous, flaky substance removed from the canal were placed in glycerine.

He was ordered to use injections of warm water, by means of Clarke's aural douche, several times daily, and to drop in a solution of zinc. sulph., gr. ij ad aqua ℥ j, twice a day. The Eustachian catheter was used, and air injected through it into the cavity of the tympanum.

It was some days before the entire collection was fully removed, and in spots where it had been separated and taken out, it was renewed very rapidly, and each time reproduced the symptoms of pain and fulness. A weak solution of carbolic acid was then used; but it caused very great irritation, and inflammation was set up, which lasted many days. This was treated by the use of warm water, through the douche. When it had subsided, the lardaceous masses were removed by the forceps, and in some instances casts of the membrana tympani came away, although the walls of the canal showed the most disposition to a reproduction of the growth.

July 27, the opening in the membrana tympani had healed, and the hearing so much improved that the watch was heard six inches, and the symptoms completely relieved. There was still a slight tendency to the growth of the fungus, as it proved to be, on the posterior wall of the canal. The membrana tympani was lustreless and rigid, the handle of the malleus distinct, but there was no light spot. From the 1st of August I did not again see my patient until October 18th. Meanwhile he had used the aural douche daily, and the growth had not returned; but the catarrhal inflammation of the middle ear had not been materially benefited, as shown by the rigidity of the membrana tympani and the impairment of hearing. The membrane is now (November 19) somewhat translucent, and the patient is being treated, with benefit, by means of the injection of air, the use of a gargle, etc., for the middle ear affection.

The flakes, preserved in glycerine, were examined by my friend Dr. C. E. Hackley and myself under the microscope, and Dr. Hackley believed them to exhibit specimens of *Aspergillus nigricans*. At a later date, Dr. Wm. B. Lewis very kindly made a thorough examination, and confirmed Dr. Hackley's opin-

ion. In this case it is clearly evident that the growth of the fungus was secondary to the inflammation of the middle ear, for the patient never fully recovered his hearing power.

CASE II.—Sept. 28, 1869, I was consulted by Mr. S., æt. 51, on account of impaired hearing, vertigo, pain in the ears, and tinnitus aurium. Vertigo was the symptom upon which the patient laid the most stress, and of which he was most anxious to be relieved. He said that he was so dizzy whenever he attempted to walk about, as to be unable to attend to his ordinary business. His condition in other respects was excellent. The patient also stated he had heard perfectly well until two months since, when he was attacked with the aural symptoms narrated above, which had been aggravated since their inception. He had been treated by the instillation of oils, and so on. He could hear my watch about one inch on the right side, and not at all on the other. Both auditory canals were found filled with a tenaceous material, which could only be removed by the forceps. It was several days before I could completely remove the firmly adherent coating of the canal and membrana tympani.

The morbid product was immediately examined by Dr. Lewis, and found to be a specimen of the *Aspergillus flavescens*. Its removal gave the patient great relief; but on the reappearance of the growth, which was in two or three days after its thorough removal, the vertigo and tinnitus returned. The membrana tympani was intact, but lustreless and rigid. The Eustachian tubes opened sluggishly, and there was all the evidence of aural catarrh, beside the affection of the canal and of the outer layer of the membrane of the tympanum. The free use of warm water, with an astringent, finally subdued the morbid process in the canal, so that the patient was able to make a journey to the South. When he left my care, Oct. 18, the auditory canals were entirely free from abnormal secretion, the hearing was improved, so that the watch was heard from five to six inches on the right side, and from one to two on the left. The dizziness was entirely gone, and the tinnitus ceased to be annoying. The catarrh of the inside ear, as shown by rigidity of the membrana tympani, sluggish action of the tubes, and impairment of hearing, still continued. I saw this patient about a year afterward, and he was entirely well, his ears having returned to a normal condition.

CASE III.—Lt. L., æt. 30, U. S. N.—Dec. 2, 1872.—Since a child, has been more or less deaf in right ear, owing to a series of abscesses. This impairment of hearing was increased by his service near the frequent explosion of cannon. About a year ago he had an abscess in left ear (probably in auditory canal), with considerable purulent discharge having an offensive odor. For about two weeks he has had a series of abscesses in the left ear, with considerable discharge of black material.

Hearing distance, R. $\frac{3}{48}$, L. $\frac{0}{48}$.

The tuning-fork was heard more distinctly in the right ear when the handle was placed on the forehead or teeth. The pharynx is granular.

The right membrana tympani is very much sunken and is opaque.

The auditory canal of that side contains numerous scales of epidermis strewn with black spots.

The left canal is full of pus, and the membrana tympani is perforated.

The microscopic examination showed the presence of the aspergillus nigricans in both auditory canals.

The patient's general condition was excellent, except, as is the case with most aural patients, he was somewhat despondent on account of the loss of hearing.

The diagnosis of chronic suppurative inflammation of the middle ear, with aspergillus growth, was made as regards the left ear. In the right, there was chronic non-suppurative inflammation with the same fungus growth in the auditory canal.

The patient was seen nearly every day until December 24, and treated by the use of leeches, the syringe and warm water, with the subsequent application of nitrate of silver, gr. 40 ad ℥j, brushed over the canal and drum-head. The patient also caused his ears to be syringed at home, and instilled a solution of sulphate of zinc, two grains to the ounce, into the ears. The Eustachian catheter and Politzer's method were used to force air into the middle ears, and the patient used a gargle of chlorate of potash.

The aspergillus fungus disappeared in a few days, but the affection of the middle ear and canal lasted much longer.

On the 24th of December, however, just 22 days after he came under treatment, Lt. L. was discharged, with hearing distance for watch, R. $\frac{8\frac{1}{2}}{48}$, L. $\frac{13}{48}$. At 16 feet distance he could hear and carry on a conversation in the ordinary tone, with his face away from the speaker. The left canal still continued to swell, and the epidermis to scale off. The patient had eczema of the scalp and auricle. Some weeks after he was said to be still improved.

SYPHILITIC ULCERS. CONDYLOMATA.

I have not seen affections of the auditory canal which could be said to be the result of the poison of syphilis; but trustworthy authors* speak of secondary syphilitic ulcerations of the auditory canal, and of condylomata† occurring in the same part. Schwartze believes that polypoid growths in the canal are sometimes a local manifestation of syphilis. Inasmuch, however, as granulations exactly like those occurring in syphilitic cases are also found in the auditory canals of persons not affected with syphilis, it becomes very difficult to say that such growths are ever pathognomonic of the disease. This much is certain, syphilitic affections of the auditory canal are extremely rare, while it cannot be denied that the poison of syphilis once in the system will modify any affection that may occur in any of the organs of the body.

* Schwartze, Archiv für Ohrenheilkunde, Bd. IV, p. 262.

† Steudener, l. c., Bd. IV, p. 20.

I will, however, reserve the discussion of the effects of syphilis upon the ear, for a fuller treatment in a later chapter.

I need only further say, at this point, that whether ulcerations or growths in the auditory canal be or be not caused or modified by syphilis, the necessity for local treatment—at the basis of which is local cleanliness—remains as urgent as if there were no constitutional disease.

The most appropriate constitutional treatment can never do away with the necessity for local care.

CHAPTER VII.

INSPISSATED CERUMEN.

Among the laity, and even in the profession, hardening of the ear-wax is generally regarded as a very harmless affection. It is also considered by many as the most common of all the diseases of the ear. 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.

Now the facts are, that inspissation of cerumen is, comparatively, not one of the common affections of the ear, and that when it does actually occur, it is by no means the simple and harmless disease that it is often supposed to be. Of fourteen hundred and forty-eight aural cases observed by myself in private practice, only one hundred and one were what might fairly be said to be cases of inspissated cerumen; that is to say, cases in which the impaction of ear-wax was the chief cause of the aural symptoms.

It would be manifestly incorrect to class cases of chronic ulceration of the middle ear, or cases of chronic non-suppurative inflammation of the same part, in which impacted cerumen was also found, as cases of the last named disease.

My classification is founded on the principle that, the hardening of the secretion is not in any fair sense a primary or independent disease, where there is no positive relief either from the tinnitus aurium or impairment of hearing by the removal of the cerumen. It is possible that we shall some day come to believe that inspissated cerumen is very rarely, if ever, an independent affection, but rather a symptom of some disturbance of the nutrition of other parts of the organ of hearing than the auditory canal; or, perhaps, that it is due

to the mechanical closure of the canal by mechanical swelling. Admitting, however, that inspissated cerumen is a primary affection, the cases which have been alluded to should be omitted from any table prepared to show its etiology.

Toynbee tabulated 200 cases of inspissated cerumen; but if the above ideas be correct, many of his cases should not have been classified as cases of hardening of the ear wax. For the same reason the tables of many Eye and Ear Hospitals are open to criticism.

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.

The practitioner will not need to spend much time in determining the cause of such symptoms. 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 matter, or at least it will give us positive evidence as to the presence of the inspissated substance. It need hardly be said that the practice of probing the ear to determine if the wax be hardened, is an extremely unphilosophical procedure, while it is not without danger to the membrana tympani. I am obliged to say, however, that I have seen several cases in which this probing has been undertaken without ocular examination; and where inflammation of the lining of the canal, of the drum-head, and in one case even perforation of the membrane, had resulted from the manipulations in the dark.

The appearance of inspissated cerumen is very 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 *fills* the canal. 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 ob-

scured, by the useless habit indulged in by so many of the laity and of the profession also, of pouring sweet or other oils into the auditory canal on the appearance of any aural symptoms. A lady once came from St. Louis to consult a New York physician in regard to a loss of hearing. She had been seen by no less than six medical men, 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 the great impairment of hearing, and came to New York as a last resort. Having arrived here, she was sent to me. I found the ears 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, I did not imagine, until the ears were cleansed by the syringe, that impacted cerumen was the cause of the loss of hearing. I could scarcely believe that oils would be persistently dropped in an ear by so many different advisers before the membrana tympani had been examined.

The tuning-fork will be of use, if the inspissated cerumen be confined to one side in determining the prognosis; but practically the better plan is to defer any statement as to the prognosis until the cerumen is removed.

The loss of hearing from hardening of the cerumen, as has been intimated, is apt to occur very suddenly. I have seen several cases where patients could tell the very instant when the ear "closed up," as they often say. The jolting of a ride in a New York stage often displaces the hardened material, and presses it into the canal, causing troublesome symptoms in an instant; and, as I have said, 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, calls his attention to the ear.

Pain of the most distressing nature sometimes occurs from the impaction of cerumen. I remember one case where anodynes had been used for ten days to relieve a pain in the ear, which an examination showed was the result of the affection

now under consideration. In another case, that of a young lady, suppuration of the drum-head resulted from the long-continued impaction of cerumen. This suppuration was preceded by very severe pain, from which no relief was experienced until the mass of cerumen was evacuated spontaneously, like a cork from a bottle of champagne, and, as the patient stated, with a report like that of a pistol. The removal of a plug of cerumen from the auditory canal of the other side, a plug that was very tightly wedged in, saved the patient from a similar experience on that side.

Among the cases that are appended to this chapter, will be found another where excruciating pain was one of the prominent symptoms of a case of inspissated cerumen. Yet neither pain nor vertigo are the ordinary symptoms of this disease; impairment of hearing and tinnitus are the usual ones.

Causes.—I do not think the causes of inspissated cerumen are as plainly recognized as we could wish. It was once my opinion that it was usually a local affection, and while I still believe that there are some cases where the inspissation of the cerumen is the only disease which affected many ears that are found filled with hardened wax, I am persuaded that in the majority of cases, even after we have excluded such ones as those in which the cerumen hardens upon the remains of an ulcerating drum-head, or in an ear that has for a long time been affected by chronic catarrh of the middle ear, inspissated cerumen is a symptom of an inflammatory affection of the lining membrane of the canal.

In some cases it is possible to believe that this inflammatory affection may have passed away before the hardened cerumen is removed; so that after syringing, the hearing distance becomes normal, and the tinnitus is relieved. What this process is, I cannot say; but I look with suspicion upon any ear in which the cerumen hardens and becomes frequently impacted.

I have seen several cases in which impaction of the cerumen has occurred more than a dozen times in a few years, and I have found that some of these persons were beginning to suffer from disease of the middle ear. I have been unable to

see that increased activity of the other sudoriparous or sweat glands of the body, or, in other words, excessive perspiration, was at all a necessary accompaniment of these cases. 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. I think, therefore, we must reject this from among the causes of this disease.

I have no doubt but that 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, I think, be sought for behind this, and this is possibly 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.

I have observed that 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, as all my readers know, 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 many cases have come to me, in which there was a naso-pharyngeal catarrh co-incident with the impaction of cerumen, or with the aural symptoms.

I suppose a very slight swelling of the auditory canal would 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 canal 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 a

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 many cases require only local treatment, and that whatever inflammation preceded the evaporation of the fluid of the cerumen, was fully removed when the patients came under treatment.

Many patients suffering from chronic non-suppurative inflammation complain that their ears secrete no wax. This state of things is due to two facts:

One is, that such patients are very apt to syringe their ears very frequently, and thus remove all the cerumen as fast as it forms. The other is, that the chronic catarrhal, or proliferating process, probably extends to the auditory canal, and interferes with the functions of the ceruminous glands.

Under the guidance of Mr. *T. Wakely*, who published an account of the wonderful virtues of glycerine in the London Lancet,* the profession were at one time very much in the habit of recommending the use of this agent to re-establish the secretion of cerumen. Mr. Wakeley even published a work entitled "Clinical Reports on the Use of Glycerine in the Treatment of certain Forms of Deafness." Mr. Wilde showed that the reporter of these cases was not "conversant with either the normal or pathological appearances of the ear," and glycerine, after a fair trial, which is still kept up by some physicians, proved to be of no avail in relieving impairment of hearing.

Its use for the restoration of the secretion of cerumen was about as rational as the other instillations, of which an account has been given in the introductory chapter. Yet in our own century, a surgeon to a London hospital gravely recommended, as a portion of a new cure for deafness, "the finest curled wool on the sheep's *head*, carefully cut with scissors, and washed in hot water," and added "that the best wool is that procured from a small German sheep;"† while in the same city, Wakely's book was gravely noticed as a contribution to clinical medicine.

* Wilde's Aural Surgery, p. 38.

† Wilde, l. c., p. 43.

Treatment.—The treatment of inspissated cerumen is exceedingly simple. The hardened material should be removed by the use of the syringe and warm water. The syringing should be performed in the manner that has been depicted on page 128.

In the majority of cases but a few minutes are necessary to remove the mass. In some cases, however, we are compelled to use a solvent for a few hours prior to the syringing process. I usually use a saturated solution of the bicarbonate of soda for this purpose.

The cerumen is sometimes so hard, and so tightly wedged into the auditory canal, that a daily sitting for a week is necessary to its removal. I have notes of two such cases. In one of them I finally softened the mass by the use of fuming nitric acid, after having completely failed to make any impression upon it by alkaline solutions or oils.

Professor S. D. Gross recommends a pick and curette for the removal of inspissated cerumen. He says, "Ear-wax, however hard, or however firmly impacted, is more readily removed with such an instrument than with any other contrivance of which I have any knowledge."* I am constrained to say, that I consider such advice from so eminent a source as the distinguished Professor in the Jefferson Medical College, calculated to give a dangerous and false impression as to the proper method of removing ear-wax. The syringe and warm water will be found to be the only means that are necessary in ninety-nine cases out of a hundred. The use of the "pick and curette," or of any pointed instrument, is a dangerous means of removing inspissated cerumen, except in the hands of men of very large surgical experience, who have learned to treat ears as if they were soap-bubbles. It is only in the rare cases in which the syringe fails that the use of an instrument, employed under a good illumination by means of the mirror and forehead band, should be resorted to. In such cases I have found a Bowman's probe a very good means of breaking up the *hard surface* of the mass, after which the syringe will easily finish the work. I am indebted to Dr. Isaac Hay, of Philadelphia, for this suggestion of the use of the probe in lifting up the hard cover of the mass.

* American Journal of the Medical Sciences, October, 1864.

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. *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. I have seen two cases where the diagnosis was correctly made, and the syringing undertaken, and yet the symptoms were not relieved, because a small flake of wax was left upon the drum-head.

The membrana tympani is usually found very much reddened after the removal of the wax; but this is probably due to the injections of warm water. It is also sometimes pressed inward. This may be due to the mechanical pressure which has been exerted upon it by the cerumen, or to the catarrh of the tympanic cavity which so often accompanies this disease.

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, Politzer's method of inflating the middle ear, or the Eustachian catheter, should be employed to restore it to a normal position.

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. I have often found the ear in which the hearing was still unimpaired, quite as full of wax as the other, although it had not yet become pressed upon the drum-head, and thus had given no trouble.

I append a few cases, which illustrate what has been said, and which will, perhaps, contribute to a knowledge of the etiology of the disease.

The first was one of the last upon my case-book when this

chapter was finished, but it happens to be of interest, inasmuch as sudden and acute pain was one of the symptoms.

It is inserted, however, not for its peculiarity, but as an illustration of the ordinary type of these cases.

CASE I.—March 5, 1873, Mr. De. S., æt. 28, consulted me about a pain in his ear. Two days since he experienced a "buzzing noise" in the ear, and last night he had severe pain in it, which was relieved by some liquid application. The buzzing noise still continues, and he cannot hear well from the left side.

The hearing distance is—Right ear normal; Left ear, $\frac{P}{48}$, or the watch is heard when pressed upon the auricle.

Tuning-fork is heard much better on the left side.

Diagnosis—Inspissated cerumen in left ear.

The mass was removed by syringing, and the hearing distance became $\frac{36}{48}$ in a few moments.

CASE II.—A. B., coachman, at N. Y. Eye and Ear Infirmary, in 1864. The patient complained of head symptoms for some months. He ascribes them to a sunstroke. On cross-examination it was found that he had never actually suffered from sunstroke; but that since his head symptoms—chiefly buzzing in the ear and deafness—had begun, he imagined that they were caused by a fancied sunstroke.

He stated that he had been treated in a New York hospital for some weeks, but without benefit. His ears had never been examined, and he had concluded to have their condition investigated, as many of the symptoms which made him "bad in the head" were referred to his ears.

An examination showed inspissated cerumen in both ears. I have mislaid the record which gave an account of his hearing power; but all the troublesome symptoms were at once relieved by the removal of the mass, which was done by the use of the syringe.

This case is almost as striking as that related by Von Tröltsch, in which a poor fellow was blistered and cupped to the verge of severe depression, for a supposed concussion of the brain, which proved to be a case of inspissated cerumen.

CASE III.—The following case shows, I think, that a swelling of the canal may prevent the normal exit of the cerumen, and thus favor its impaction:

Miss Johnson, æt. 29, consulted me, March 23, 1873, on account of her ears, and gave the following history: For fourteen or fifteen years she had suffered at intervals from abscesses in both ears. The hearing has been seriously impaired on the right side from an ulcer resulting from scarlet fever, since she was five years old. For the past two or three months the hearing has been impaired in the left ear, and she has suffered from abscesses near the external meatus, which have caused great swelling and tenderness of the parts. The impairment of hearing was most marked in the morning. For the last four weeks she has been constantly deaf, although for a few moments a few days ago she heard very well; she then felt as if something had broken in the ear.

Hearing distance, tested by the watch—Right ear, $\frac{0}{48}$; L., $\frac{0}{48}$.

Diagnosis.—Right ear, chronic suppuration in tympanic cavity. Left ear, inspissated cerumen. A small furuncle was found in the outer part of the canal, which was a very narrow one.

The mass of cerumen was removed in about 20 minutes by syringing, when the hearing distance became $\frac{5}{48}$.

Politzer's method of inflating the ear was then employed.

March 6, H. D. $\frac{14}{48}$.

After the use of Politzer's method, the hearing distance became $\frac{30}{48}$.

The above case illustrates the theory of the preceding chapter, that inspissated cerumen is in reality but one of the symptoms of certain forms of inflammatory affection. In this case the inflammation had not fully run its course, for the canal was red and swelled. Perhaps, indeed, this was an habitual condition of the part.

The following case, which may be considered a remarkable one, illustrates not only the etiology of inspissated cerumen, but also the effect of quinine upon the ear; and I insert it as much to show the influence of this agent upon the auditory apparatus, as for its bearing upon the subject now under discussion.

It has already been published,* but I think it worthy a wider circulation than it has hitherto obtained.

Case IV.—On the 3d of May, 1870, I was consulted by Dr. N., æt. 34, on account of his throat and ears. He stated that he had had acute pharyngeal and laryngeal disease some ten years before. He also informed me that neither he nor his parents have any recollection of any serious difficulty with his ears prior to the date of the attack, from whose consequences he is now suffering. The laryngeal inflammation was followed by chronic naso-pharyngeal catarrh, and in 1863 he was obliged to take five-grain doses of quinine for some weeks on account of nervous prostration from malarial fever contracted in the Southern States. These doses were increased to ten grains, and cinchonism was produced. The symptoms of cinchonism were, ringing in the ears and dizziness. In 1864, the doctor again took quinine uutil the constitutional effects were produced, the dose finally reached being twenty to twenty-five grains, which was taken every other day. While employing the quinine in this manner a severe attack of otitis occurred. The patient states in a written history taken from his diary that he recovered from the otitis under antiphlogistic treatment.

After recovery from the aural disease, Dr. N. was obliged to resort to the use of the quinine on account of the constitutional disease,—a severe malarial neuralgia. He took one dose of fifteen grains, which was followed by pain in the ears. Several efforts were made to return to the use of the quinine, but pain in the ear supervened on each dose. "From this period, February, 1865,"

* Transactions of the American Otological Society, 1873.

to quote the exact words of the patient, "my ears began to give me constant trouble. I was incessantly annoyed by unnatural noises, which would frequently reach such a pitch, for a few moments, as to exclude all other sounds." The naso-pharyngeal disease also increased, and in March, 1865, he was seen, on account of the state of his ears, by a distinguished practitioner. The throat was considered the origin of the aural affection, and it was accordingly treated, and was improved; but the ears remained in the same condition, that is, they were sensitive and affected by tinnitus, and there was some impairment of hearing.

After the pharynx had been treated, until July of this year (1865), and while undergoing treatment, another attack of otitis media occurred, which was preceded by five weeks of facial neuralgia. The use of quinine for the relief of these attacks had been avoided; but at last, the patient, worn out by pain, took a fifteen-grain dose of the sulphate, upon which the ear disease immediately supervened. The quinine was taken on July 30th, and the attack of otitis media occurred on the next day. The otitis was of so severe a character as to place the doctor in a very depressed condition, and when he recovered from this and the neuralgia, which he did simultaneously, to use the patient's own language, he was "a perfect wreck."

He then sailed for Europe, and in the Scotch Highlands recovered from the malarial disease, never having suffered from it since up to the present time. The ears, however, became very sensitive to the air, and cotton plugs were resorted to, and Dr. N. has never from this time been able to leave the meatus open, even while in-doors, until the past week. The hearing power was also greatly impaired while in Scotland; the patient therefore went to the south of France, where his ears were still troublesome. The aural symptoms were tinnitus, a sense of pressure in the auditory canal, and frequent attacks of neuralgia of the fifth pair. The intellect also became somewhat obscured. After a year's stay abroad, Dr. N. returned home, when the naso-pharyngeal catarrh returned. He then, under the advice of a physician, began the use of the nasal douche for its relief, taking all the precautions that are enjoined, using a warm solution of common salt in water. It was observed, however, that in an hour or two after using the douche, there was an uncomfortable sensation in the ears which became more prominent after each application. The physician then advised "less pressure" in the use of the douche; but the next application was followed by severe pain, and this method of treatment was abandoned. The patient was then suffering from what was called an inflammation of the auditory canal; all treatment was given up until September of this year, when another attack of otitis media and of facial neuralgia occurred. The next two years were spent in Italy.

The general health of the patient was then excellent, but the hearing did not improve, and the patient was obliged to use the cotton plugs. Returning to America in the spring, the naso-pharyngeal catarrh, which had not appeared while in Italy, returned, and in April, pain occurred in both ears, for which he was treated by leeches, diaphoretics, and hot fomentations; after this attack the patient describes himself as totally deaf,—unable to distinguish the loudest sounds. "There was a feeling of spasmodic constriction, and fulness invading the cavity of the tympanum, and a sensation of pressure upon the

drum-head." On the third day the patient became able to hear what was said to him, if the words were spoken very loudly and with the mouth applied close to the ear; as time passed he became still more improved, so that he could hear conversation addressed specially to him at a short distance, and a watch usually heard at four feet, at a distance of two inches on each side, H.=$\frac{8}{48}$.

This was his condition when he first came under the writer's observation, on May 3, 1870. I found that the general nervous system of Dr. N., from his years of suffering, was in a highly sensitive condition. His pharynx was highly congested, the uvula very long, and both auditory canals were extremely sensitive and plugged with hard wax. For two weeks the patient was under my care, during which time I cut off the uvula, and made many attempts to remove the impacted wax by syringing, and the use of the forceps; but in all these attempts I failed, in consequence of the hardness of the cerumen and the tightness with which it was held by the auditory canal, and also because the ear was extremely tender to the slightest touch.

At the end of this time, the patient was suddenly called to Minnesota, and I did not see him again until June 26, 1872, when he presented himself and gave the following history of the time that had elapsed. The very small quantity of wax removed, and the cutting off of the uvula, had relieved the pharynx and ears to some slight extent, and, the climate being adapted to his condition, he did very well, except that the hearing was impaired.

On June 18, 1871, another attack of otitis occurred, which caused some considerable discomfort, although it was a less severe attack than those which had preceded it. The otitis again occurring, the patient came to me, on the date above mentioned; *more than two years from the first visit.* I found him suffering severe pain, for which he was taking anodynes; the ears were about in the same state as when I last saw him. The hearing distance was about $\frac{8}{48}$, the canals were plugged with hardened wax; the patient appeared in fair physical condition, but mentally he was excited and slightly irritable and depressed.

I proceeded to remove the impacted wax, and that from the right ear came away on the second day. It was so tightly wedged in that the removal, which was effected by the syringe and forceps, caused severe pain, although the walls of the canal were not touched. On the fifth day, after the use of various agents to soften the mass of cerumen in the left ear, I burned it with nitric acid, and then succeeded in removing it. This removal also caused great pain. The membranæ tympani were suppurating, that is, the outer layers, and they were somewhat sunken, especially along the handle of the malleus. The use of a solution, nitrate of silver 40 gr. ad $\overline{3}$ j, and inflation by Politzer's method, soon restored them to a normal appearance, except that the curvature remained altered. The sensitiveness of the ears was removed, so that they could be touched, applications made to the drum-head, and so on, without producing any unpleasant sensations. The hearing distance became $\frac{8}{48}$ on the right side, and was improved on the left, but to what extent I do not know, not having seen the patient for some time. He became able to sleep without an anodyne. The cotton plugs which had been worn for years were now removed, and he became altogether a different person, as regards his mental condition.

I think we must regard the otitis in this case, although to a certain extent

dependent upon the naso-pharyngeal catarrh, as chiefly caused by the use of quinine. By looking at the history and observing how promptly and invariably the pain in the ears occurred in several instances after the use of the agent, we are forced to the conclusion that quinine was the exciting cause of the aural inflammation. At what date the impaction of wax occurred, we cannot positively determine. I am disposed to believe that it was at the time the patient awoke profoundly deaf, in April, 1870, or more than two years before it was removed. The wax was certainly there one month after, in May, 1870, when I first saw him.

The condition of the patient's mind is illustrated by the fact that he should allow two years to pass away with no attempt to remove a foreign body, from whose partial removal he had obtained some relief, and which he believed to be one of the causes of his impaired hearing. I can only partially account for this delay, by supposing that my efforts at softening and removing the mass had so far succeeded as to lift the cerumen from the drum-head, and thus give partial relief. Indeed, the plug, which I took out on the second day, was on its way out, and would, I think, have soon escaped spontaneously, with one of the loud reports with which hardened wax sometimes shoots from the auditory canal. The structure of the plugs was that usually found, that is, *cerumen* in layers; but there was some *epidermis* exfoliated, and also some pus between the mass of wax and the canal.

The case seems to me to be one of those which have been reported, where inflammation of the integument lining the canal was one of the causes of impaction of wax, and it may be a contribution to the etiology of that disease. The earlier history also illustrates the effect of quinine upon the ear, which I am inclined to suspect is sometimes an inflammation of the conducting portions, as well as of the acoustic nerve or labyrinth. We have long known of the latter effect, but the former has not been often observed.

The following case occurred in my clinic at the Brooklyn Eye and Ear Hospital, and was reported by Dr. David Webster,* who was then House Surgeon.

It illustrates the serious inflammatory trouble that may be caused by inspissated cerumen, a fact which has been already alluded to in this chapter.

CASE V.—"D. H., aged 28, laborer, presented himself at Dr. Roosa's clinic, at this hospital, Nov. 1st, 1870. Five days previously his right ear was attacked with pain, tinnitus, and deafness, which symptoms had gradually increased up to date. He had slept but little for the last two nights, in consequence of the severity of the pain. He could hear the ticking of an ordinary watch at the distance of only one inch.

Upon examination we observed a little puffiness of mastoid process, and some swelling back of the angle of the lower jaw and of the walls of the meatus.

* Medical Record, vol. v., p. 536.

There was also some pharyngitis. Through the aural speculum the external meatus was seen to be plugged with hard wax. This was removed by carefully syringing the ear with warm water. Some pus was found in the canal, and at first the membrana tympani was thought to be perforated, but upon more careful examination it was found to be intact, though a complete examination of it was rendered impossible by the narrowing of the meatus consequent upon the swelling.

Politzer's method for inflating the middle ear was practised, and the patient was directed to fill his ear frequently with warm water.

Nov. 2.—He said that the pain was so relieved that he rested well last night, and complained more of a sensation of soreness than of pain. The tinnitus and swelling were undiminished, but the hearing distance had risen to ten inches. On using Politzer's method, the patient felt the air enter neither ear, and when this was done again, with the addition of the vapor of chloroform, the air was felt only in the left. He was directed to continue the use of warm water.

Nov. 3.—The swollen walls of the meatus had become more sensitive to the touch, and the pain had returned. He was treated by means of the warm aural douche, Politzer's method again used, and the entrance to the meatus stuffed with cotton in order to exclude the cold air.

Nov. 5.—The swelling had increased. Dr. Prout, who saw the patient for Dr. Roosa, made two incisions in the walls of the meatus—one backwards, the other upwards. Pus followed the knife in the latter. The pain caused by the incisions was immediately relieved by the warm douche (Clarke's aural douche).

Nov. 8.—He was again seen by Dr. Roosa. There was an abscess in the anterior wall of the meatus, just behind the tragus. This was opened, and a considerable quantity of thick pus evacuated. The meatus was as thoroughly as possible cleansed by syringing, and the use of pledgets of cotton.

Nov. 15.—The swelling had so far diminished that the drum-head could be properly examined. It was covered with bits of wax and epidermis, which were removed by gentle syringing. The hearing distance was twelve inches. A week later Dr. Roosa pronounced the patient cured, so far as the ear was concerned, all signs of irritation having disappeared, no tinnitus remaining, and the hearing function being restored to its normal condition. A gargle of alum and chlorate of potassa was used for his pharyngeal trouble.

A point of especial interest in this case is its causation. As the membrana tympani remained intact throughout, and inasmuch as, even after the swelling had subsided, small particles of wax still adhered tenaciously to the surface of the drum-head and of the walls of the meatus, we could not avoid the conclusion that it was due to the impacted cerumen acting as a foreign body.

This is the only case of the kind that has occurred in this hospital during the two and a half years of its existence, during which time about eleven hundred and fifty ear cases have been treated."

Dr. O. D. Pomeroy,* one of my colleagues at the Man-

* Transactions of the American Otological Society, 1872.

hattan Eye and Ear Hospital, has tabulated, from the records of that institution, 200 ears in which the diagnosis of inspissated cerumen was made. The cases were found to be accompanied or *caused by* middle ear disease in a very large proportion of cases, for the hearing was found to be normal after removal of the cerumen in but 27 ears. It must be remembered, however, that the diagnosis was evidently set down in this table, as in Toynbee's cases, as inspissated cerumen, when the predominant affection—for example, disease of the labyrinth, chronic suppuration in the tympanic cavity, and so on—should have been given as the true diagnosis.

Again, if a patient got nearly perfect relief from the removal of the cerumen, but the hearing distance was not quite normal, the case did not appear among those with perfect hearing, while it is possible that the normal hearing power was restored in a few days, when the mechanical effects of the packing of the cerumen had passed away.

Pain worthy of note was caused by the cerumen in 12 ears of the 200.

COMPOSITION AND FUNCTIONS OF CERUMEN.

According to *J. E. Petrequin*,* 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, according to the same authority, about one-tenth per cent of water, a mixture of oil and stearine, and a dry material not soluble in water, alcohol, and ether, in which chalk, 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 has already been given on page 63 ; but it may be well to repeat his statements at this point.† The contents of the ceruminous glands only dif-

* Archiv für Ohrenheilkunde, Bd. V., p. 230, from Comptes Rend. de l'Acad. des Sciences, 1869, xvi., pp. 940, 941.

† Stricker's Manual, The External Ear, by Kessel, translated by J. Orne Green, p. 951.

fer 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.

Those who are curious in regard to the opinions of the last century and the early part of the present one, on the subject of the functions of the cerumen and the affections of the ear caused by the suppression of the secretion, will find the book of Thomas Buchanan,* of Hull, interesting reading.

Mr. Buchanan ascribed most of the diseases of the ear to impaction of cerumen or stoppage of its secretion. He believed that it had a very important function in relieving the harshness of the waves of sound. If it were not for the lining of cerumen which is in the meatus, the waves of sound would fall irregularly upon the drum membrane and cause it to vibrate unevenly.

Mr. Buchanan also explained Mr. Everard Home's case of double hearing by his theory of deficient secretion of the cerumen. It was that of a music teacher, who found that after a cold the pitch of one ear was half a note deeper than the other, and that a simple tone was not recognized as one by both ears.

This is a specimen of the author's fanciful notions about the important functions of this lubricating and protecting secretion.

He makes a disease—*Tubulus Hirsutus*—of the growth of hairs in the canal, saying that no one with acute hearing has hairs growing over the surface of the membrana tympani.

He also tells a singular story of a man who became very deaf, in his opinion from years of loud talking to a deaf wife.

* Physiological Illustrations of the Organ of Hearing, more particularly of the Secretion of Cerumen, and its effects in rendering auditory perception accurate and acute, with further remarks on the treatment of diminution of hearing, arising from imperfect secretion, etc. Being a sequel to the Guide and to the Illustrations of Acoustic Surgery. London, 1828.

He imagined that the continued screaming at last lessened the sensibility of the *portio mollis*.*

The function of the ceruminous glands is probably that of the sudoriparous glands. They keep the parts in which they secrete pliable, and also prevent the ready admission of insects. There is no evidence that the cerumen has anything to do with the regulations of the intensity with which the waves of sound reach the ear.

Children are very rarely affected with inspissated cerumen. I have notes of but three such cases. Yet when children suffer from chronic suppuration in the tympanic cavity, it is not an uncommon occurrence to find hardened wax on the remains of the membrana tympani.

Foreign bodies, such as raisins, inserted to relieve pain, sometimes form a nucleus about which the cerumen hardens. Dr. Agnew, of this city, related such a case at one of the meetings of the New York Ophthalmological Society, where a mass of cerumen was removed, in which a raisin was found, which the patient, a person in middle life, remembered to have been inserted some thirty years before. I have removed masses of wax in several instances, in which insects were found embedded.

Mental hallucinations have been in rare instances relieved by the removal of inspissated cerumen. *Prof. Mayer*, formerly director of the Insane Asylum at Hamburg, is the authority for this statement.†

I once saw a lady who, though not regarded as a person of unsound mind, seemed to be such, and who complained greatly of tinnitus aurium in all its varieties. I found the ears full of impacted cerumen; but she utterly refused to allow me to remove it, and I never saw her but once. It would have been very interesting to know the effect of the relief of the tinnitus upon the mental hallucinations of which she seemed to be a victim.

* A good synopsis of Buchanan's book will be found in Lincke's Sammlung auserlesener Abhandlungen und Beobachtungen aus dem Gebiete der Ohrenheilkunde, Bd. III. Leipzig, 1836.

† Von Tröltsch on the Ear, 2d edition, p. 531.

CHAPTER VIII.

FOREIGN BODIES IN THE EAR.

THE usual point of entrance of foreign bodies into the ear is through the external auditory canal, although they very often pass beyond this part and become lodged in the cavity of the tympanum, or Eustachian tube, while in some rare instances a foreign body has entered the ear, through the Eustachian tube. I have therefore entitled this chapter, Foreign Bodies in the Ear, so that I might properly include all such cases in the descriptions that are about to be given.

The foreign bodies that are found in the auditory canal are very naturally placed under three heads: insects, or the like which creep into the passage; their larvæ which are generated there, and various articles, such as beads, buttons, peas, beans, and so on, which are pushed into the ear by children or silly adults.

INSECTS IN THE EAR.

When a live insect gets into an 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 laboring 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 do 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 ear-wig, and there was an ancient superstition that it crept into the brain through the ear. The *forficula auricularis*, or so-called ear-wig, has probably no more propensity to fly into the ear, than any other insect; any of the ordinary flies may do so.

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 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 Wilde and Von Tröltsch agree that this is an unnecessary waste of time. I have treated but two of such cases, and in both of these the insect was promptly dislodged by the use of the syringe, and I have no doubt that the simple filling of the auditory canal with water, 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, who is quoted by Blake,* 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 wriggling movements of the grubs in the ear, than of the pain.

The ancient works on aural diseases speak very much of worms in the ear and of the proper means of removing them.

* Living Larvæ in the Human Ear. Archives of Ophthalmology and Otology, Vol. II., No. 2.

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 since the habit of cleansing an ear from pus has become a well-recognized duty, the practitioner of the present time sees very little of worms in the ears.

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.

An Austrian physician, *Dr. Scheibenzuber*,* reports a case of a peasant ploughing in the field, who was seized in an instant, with a severe pain in the ear, which he ascribed to the flying in of a bug, but the surgeon found the ear full of well developed larvæ.

I have several times observed dead insects in the pus that was washed out from an external auditory canal, and it is undoubtedly true, as I have already suggested, 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*).

Dr. Blake† has 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.

Dr. Blake found that the apparatus by which the larva 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 frame-work. The larva burrows its way into the tissue

* Monatsschrift für Ohrenheilkunde, Jahrgang III., No. 3.

† Archives of Ophthalmology and Otology, l. c.

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.

Dr. 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 earth-worms. As I write, I have before me a number of specimens of the dead grubs. They are about a half an inch in length, and of the diameter of a large knitting needle.

Treatment.—I have found it 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 abraid the integument of the canal, and thus cause pain. I have used Labarraque's solution of chlorinated soda to kill these grubs, but simply because it was at hand when I saw the cases.

The larvæ have also been killed by forcing the vapor of chloroform into the cavity of the tympanum through the Eustachian tube. I believe, however, that it will be sufficient to force the vapor into the external ear, or to instill some such fluid as I have mentioned into the canal.

It need hardly be said, that the disease which allowed of the deposition of the eggs, and the hatching of the grubs, should be treated after they have been removed. Even those who are advocates of allowing a discharge from the ear to remain unchecked, will hardly defend such a neglect when the ear has become a disgusting receptacle in which larvæ are formed.

FOREIGN BODIES IN THE EAR.

The foreign bodies that are placed in the ears of children by themselves or their playmates, have, from the time of the first writers on otology, formed a fertile field for the labors of surgeons. The importance of the subject has been unduly magnified. 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 Shakspeare's times,* that poison poured into the ears was as 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. Unskillful or indiscreet attempts to remove a foreign body 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 that can 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.

* Play of Hamlet.

When, therefore, a child is brought to the practitioner, in whose ear there is, or there is supposed to be, a foreign body, 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 receipt for cooking this animal; and in imitation of this sage advice, the writer, taught by experience that the diagnosis of mothers and nurses is not always to be trusted, would urge upon his readers the wisdom of not attempting to remove a foreign body which he cannot *see*. There is nothing more deceptive than the tactile examination. Again and again have I seen physicians click what they supposed to be a foreign body, by means of a probe, 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 lead to a dangerous and mortifying failure.

Even when it is seen, a forcible or violent attempt is always a dangerous procedure.

Voltolini,* in writing on this subject, says, "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 downwards in the ear, and 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 see 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

* Monatsschrift für Ohrenheilkunde, Jahrgang II., No. xi.

—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 I have 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 meatus, 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. Thus Wreden* reports a case in which he removed a button from the outer ear, which had remained at the junction of the osseous and cartilaginous canal of a boy of seventeen, for twelve years, and without doing any 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 the latter has 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 pair of delicate forceps, or a probe, 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, Voltolini has adopted the following method 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

* Monatsschrift für Ohrenheilkunde, Jahrgang III., No. 12.

a plane with the upper wall of the auditory canal, that runs obliquely downward. The syringing is then performed as usual. In two cases Voltolini has succeeded in removing the foreign body by this manœuvre, when the ordinary method did not succeed.

Voltolini has also used the galvano-caustic 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, he inserted the needle "with lightning-like rapidity" into the body, and when it cooled, the bean broke with a snap audible to the patient and to those about. When sufficiently broken up, it was removed by syringing.

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.

I have seen quite a number of foreign bodies in the ear, and I have never but in one case failed to remove them, and then I saw the patient but once for a few moments. The syringing did not succeed, and I asked the mother to bring the patient to my clinic at the Hospital, where she might be placed under the influence of an anæsthetic, but she was not brought.

In one case, when the child first came under my observation, a button was lodged in the cavity of the tympanum by efforts to remove it. I syringed it in vain on several occasions. I then proceeded carefully with instruments, the patient being anæsthetized. This attempt also failed. I then ordered the mother to syringe the ear three times a day, which was necessary on account of the purulent otitis media which had been set up by the presence of the button in the cavity of the tympanum, and I also advised the careful use of poultices. To my delight, in about four weeks I had the satisfaction of removing the button from the canal, where it had been brought by the syringing and the use of the poultices.

I have now under my care a little child of four years of

age, who, according to her own statement to her nurse, put an ordinary shoe-button, made of papier-mache, in her ear. As soon as the nurse's attention was called to the case, she reported it to the family, who sent for a physician, who saw the button, and attempted to remove it, under chloroform, using for this purpose a small elevator. It is stated that half the button was removed in this way; but the other half could not be dislodged.

In a few days, the child having become very weak from the operation and the anæsthetic, from the chloroform, I was called in consultation. A careful examination was made. The membrana tympani was found to be gone, there was considerable swelling of the canal, but the button was not to be seen either by the physician or myself, although he thought he detected it with the probe.

Another surgeon was called in, and he was not able to find a foreign body, and the child has been under treatment ever since for a chronic suppuration of the middle ear, the membrana tympani and the ossicula being gone, and the hearing irretrievably injured.

I recite such cases in order to show what harmful consequences may result from the most conscientious attempts to remove a foreign body with instruments.

No engravings are given in this volume of the numerous hooks, forceps, perforators, 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 I firmly believe that 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 I should not hasten unduly, unless the body had become impacted in the tympanic cavity, or was causing unpleasant or serious symptoms. In such cases the ordinary armamentarium of the surgeon will 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.

The ancient suggestion of Hippocrates and Du Verney (see

page 36), to detach the auricle from the ear, will be found worthy of consideration when it is found impossible to remove a foreign body through the canal. It certainly cannot be 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.

Dr. Lowenberg* reports an ingenious method by which he removed a small ivory ball, from the tip of a quill penholder, 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 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. Clarke, who is quoted by Blake in the same report from which I have taken the description of Dr. Lowenberg's method, 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 certainly to be commended as both ingenious and safe.

It is possible that the reader is ready to believe, that I am attaching too much importance to this subject of the removal of foreign bodies from the ear: but I am sure that any one who has taken the pains to look over the literature of this subject, or who has seen many cases, will feel that too much stress cannot well be laid upon the necessity for skill and wisdom in the management of these cases.

I will, however, close the chapter by some statistics which

* Report on the Progress of Otology, by C. J. Blake, Transactions American Otological Society, 1872.

have been carefully prepared by Dr. Mayer, of Munich, which illustrate this subject, and with the insertion of a painful case, from Mr. Pilcher's book on the ear, which is one I have been in the habit of repeating to my class, as a warning to those who try to extract from an ear what they have never seen.

My distinguished countryman, Dr. J. Marion Sims, of this city, published an article, illustrated by three cases, in the American Journal for Medical Sciences, vol. ix., 1845, 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.

FOREIGN BODIES IN THE EUSTACHIAN TUBE.

Among the cases whose statistics will be given as reported by Dr. Mayer, two will be noticed 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 was a principal of a college, who had been accustomed to treat his own ears—which were affected with chronic catarrh—by the use of the Eustachian catheter.

Dr. Hecksher received a telegram one day from the patient, for whom he had occasionally prescribed, stating that he had got a foreign body in one of his Eustachian tubes. 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 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 practice 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.

CASES.

Dr. Ludwig Mayer† has collected the cases of foreign bodies in the ear that he has been able to find in the litera-

* Monatsschrift für Ohrenheilkunde, 1870, No. 1.

† Monatsschrift für Ohrenheilkunde, Jahrgang IV, No. 1.

ture of the fifty years preceding 1870. The whole number is 77. Of these persons

16 were between 1 and 10 years of age.
10 " " 10 " 20 " "
10 " " 20 " 50 " "
1 was over 50 " "

The age of the remainder is unstated.

In 66 cases the foreign body was in the auditory canal, 8 were in the cavity of the tympanum, and 3 in the Eustachian tube. Of the three cases in the Eustachian tube, two were at the pharyngeal orifice. In the third case, a barley-corn projected from the pharyngeal orifice, and at the post-mortem section—it is not stated of what disease the patient died—the foreign body was found to reach into the osseous tube.

In two of the cases the foreign body was in the ear but twelve hours before seen by the surgeon who reported them. In only 12 of the cases was the foreign body in but a short time, varying from days to weeks. In the remainder, they were in for years. Four were in for four years, two for twenty years, one for forty-five, and one for more than sixty years.

The substances found were—a needle, carob beans (6), beans (3), cherry pits (6), living larvæ (4), peas (1), a wisdom tooth of the upper jaw, a grain of coffee, a snail, pearls (2), point of a glass syringe, a glass ball, wads of cotton (6), a carious tooth, a piece of hard coal, a wad of paper, a gun cap, a piece of bone, a piece of bread, a bit of lead, laminaria bougies in the tube (2), a millet seed, a piece of coral, a barley-corn in the tube, and an agate stone.

Dr. Mayer finds, on an analysis of these cases, that the attempts to remove the foreign bodies had usually caused much more trouble in the ear than their presence.

In 48 of the 77 cases, functional and pathological changes are said to have occured as a result of the presence of the foreign bodies. In 11 of the cases it is reported, that the attempt at removal caused these disturbances.

Pain in the ear was generally the disturbing symptom in those cases in which the foreign body caused any trouble. This was chiefly due to the irritation of the lining membrane

of the canal, which is so closely allied to periosteum in its nature as to be subject to intense pain. Besides, as shown by F. E. Weber, the pain in the cartilaginous portion of the canal is severe on account of the fact, that the fibrous tissue of the cartilaginous canal is fastened to the squamous portion of the temporal bone, above and behind, by tense fibres. As has been shown, the canal is very richly supplied in nerves, and this serves to explain the severe pain experienced when a rough body is in the ear, or when the canal is abraded by attempts at the removal of a smooth and harmless one.

Polypi arose five times in consequence of the inflammation of the ear. Severe hemorrhage occurred five times, and always in consequence of attempts to remove the foreign bodies.

In one case there was delirium, and in three cases suppurative meningitis, and once a cerebral abscess, with, of course, a fatal result.

The membrana tympani was perforated, and the cavity of the tympanum inflamed, from the efforts at extraction in the three cases in which meningitis resulted.

In one case the patient, a child, attempted to push the foreign body—a piece of flint-stone—*out through the other ear*. Suppurative meningitis occurred, and death resulted in a few days. The stone was so firmly fixed in the mastoid cells that trouble was experienced in removing it, even at the post-mortem examination.

In one case on the section, a wad of paper was found in a cerebral abscess which communicated with a collection of pus in the tympanic cavity. It had probably been forced there by the attempts to remove it.

The disturbances of the nervous system were considerable in some cases, and they throw light upon the influence of chronic aural suppuration upon this part of the organism. In three cases there were general convulsions; there was paralysis of one side of the face in five cases, atrophy of the arm in two cases, twice there was anæsthesia of the whole of one side of the body. There were two cases of epilepsy. The facial paralysis was caused by a continuation of the inflammation to the Fallopian canal and the facial nerve.

The convulsions and the epilepsy were probably caused by reflex action through the medulla oblongata, due to peripheric irritation of the fifth pair of nerves.

The cases of atrophy of the arm and anæsthesia of the body are so imperfectly reported, that Mayer does not attempt any explanation of them.

Our limits do not allow of a complete transcription of the cases which Dr. Mayer has collected with such care; only a few of the more curious or important ones, can receive a further allusion.

In one case a horse coughed some oats into the ear of a man as he was going by the animal.

Deleau, Junior, removed a foreign body from the cavity of the tympanum, an agate stone, by an injection of water through the Eustachian tube. The reader will find this case fully reported in Lincke's collection of Monographs on the Ear.*

The case of atrophy of one arm, epilepsy, anæsthesia of one-half of the body, is the famous one of Fabricius Hildanus, quoted by Von Tröltsch.† The patient, a young woman of 18 years, is said to have been cured of all these symptoms by the removal of the foreign body, a glass ball, eight years after it was inserted.

Handfield Jones‡ saw a case in which hemiplegia with convulsions arose from the presence of insects in the ear.

Wederstrandt§ reports a case in which molten lead was poured into the right ear of a drunken man. The pain was not severe; the hearing power was gone. The patient was able to leave the hospital in eight days. The lead was not removed, and severe suppuration occurred. Seventeen months after he was in the same condition, with paralysis of the right orbicularis palpebrarum muscle; a polypus had grown over the lead.

In three of the cases death occurred, and in all of them it may properly be said to have been caused by attempts to

* Lincke's Sammlung, Bd. I, p. 154.

† Text-book, American translation, p. 490.

‡ Sydenham Society Year-book, 1861.

§ American Journal of the Medical Sciences, vol. ix.

remove foreign bodies, which, whatever disturbances of the system they might have produced, would not probably have led to death.

Mr. Pilcher, in his work on the ear,* reports a very instructive case in full 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, dressing forceps, which were both bent in 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,

* Treatise on the Ear, American edition, by George Pilcher. Philadelphia, 1843. Reprint.

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 mental delusions occur on this subject. I have seen several cases of the kind which are quite remarkable.

Two cases I saw at the New York Eye and Ear Infirmary, where the patients, who were women of the lower class in 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.

In another case a woman brought her son to my clinic in the University of New York, 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. Some of these pieces of coal were larger than the auricle. The boy agreed with his mother in her insane statements. I am sorry that they passed from my observation before I could fully investigate the cause or motive for the delusion.

In another part of this work* allusion will be again made to the cases, not uncommon, in which patients with chronic disease of the middle ear, and persons who perhaps were of sound mind, firmly believed, in spite of the negative result of my examinations, that there was inspissated cerumen in the auditory canal. Indeed, the sensation of fulness of the canal in chronic cases of disease of the middle ear, is often so decided as to render such a belief pardonable, in a person who has not full confidence in the surgeon who examines the ear.

It has been mentioned in the second chapter, that the hairs of the auditory canal sometimes drop on the drum-head, and thus become irritating foreign bodies.

* Chapter on Chronic Non-suppurative Inflammation.

PART II.

THE MIDDLE EAR.

CHAPTER IX.

ANATOMY OF THE MIDDLE EAR.

By far the greater number of aural diseases affect what is known as the middle ear. Of one thousand cases occurring in the private practice of the author, eight hundred and nine were diseases that involved these parts chiefly. The anatomy of this region, therefore, demands a careful and exact study.

By the term middle ear, we comprehend, strictly speaking, only the cavity of the tympanum, the mastoid cells, and the Eustachian tube; but since the structure of the membrana tympani is in part identical with that of the cavity of the tympanum, and since it is always involved in any considerable affection of the middle ear, I have thought it wise to consider its anatomy in the same chapter, with that of the other parts with which it is so intimately connected.

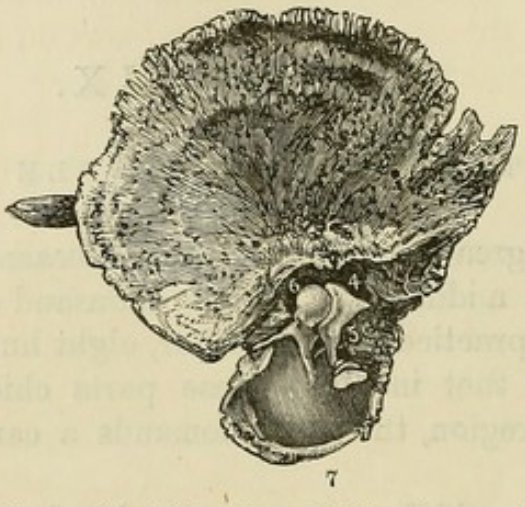
THE MEMBRANA TYMPANI.

The membrana tympani, or drum-head, forms the 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 7mm. nearer to the entrance of the external auditory canal than the lower. The posterior border is about 5mm. 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°. The inclination of the two membranes to an angle opening upwards is one varying from 130° to 135°. In the

newly born, the membrana tympani is more in a horizontal position than in the adult, and lies almost in the same line with the upper wall of the external auditory canal.

Fig. 38.

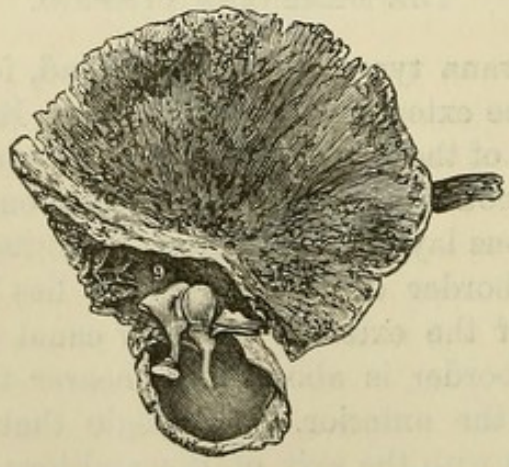


*The Right Temporal Bone, without the Petrous Portion, in connection with the Ossicula Auditus of a newly born Child, seen from within. After Rüdinger.**

4, *is above the incus, whose short process is directed nearly horizontally backward.* 5. *The long arm of the incus, which extends freely into the cavity of the tympanum.* 6. *The malleus, in articulation with the incus.* 7. *Long process of the malleus, which runs under the crista tympanica, in a furrow, to the fissura petroso-tympanica.* 8. *The stapes, in articulation with the incus.*

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

Fig. 39.



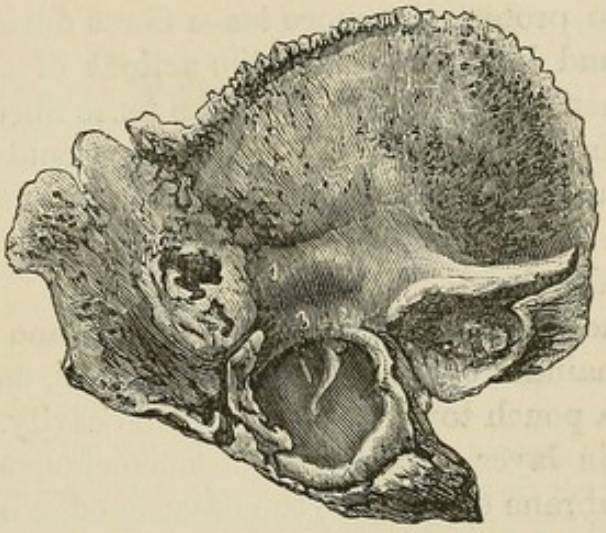
Left Temporal Bone of the same Subject as preceding Figure.

* Atlas des Menschlichen Gehörorganes. München, 1867.

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*.

FIG. 40.



1. *The right temporal bone of a newly born child, with a dried membrana tympani. (After a photograph. Rüdinger.)* 2. *The malleus bone, its apex reaching to the centre of the membrane.* 3. *The long process of the incus, seen through the transparent membrane. It is also sometimes observed on the living subject in cases of atrophy of the membrane.*

The long axis of this ellipsoid runs downwards and forwards, the shorter backwards and downwards. If the diameters of the membrane are measured in the direction of the axes of the ellipsoid, that of the long axis is 9.5-10mm., and the horizontal is 8m. Measured in the usual manner, the horizontal diameter is 8-8.5, and the vertical 8.5-9mm.

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 turns 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 upward, 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, was first described by *Mr. Henry Jones Shrapnell*,* and named by him the membrana flaccida. It is often called Shrapnell's membrane. Mr. 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 towards the tympanic cavity. It consists of a very thin layer of cutis and of mucous membrane. 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, 1717, by Rivinus,† a professor in Leipsic, until the present day. Professor Patruban,‡ of Vienna, found such an opening in 300 membranes, part of which were healthy, part diseased. He allowed a fine stream of quicksilver to pass into the so-called canal, and it always appeared on the other side of the membrana flaccida.

Professor Joseph Gruber§ has also found the foramen in many specimens. Inasmuch as he oftener found it in pathological specimens, he thinks that its

* London Medical Gazette, vol. 10, p. 120. Several German authors speak of Shrapnell as *Odo* Shrapnell; but his name, as it appears in the original of his articles, is as I have given it.

† According to Von Tröltsch, the so-called foramen of Rivinus was first discovered by *Glaser*, in 1680, who was then professor in Basle. Bochdalek, however, claims the discovery for *Colle*.

‡ Monatsschrift für Ohrenheilkunde, Jahrgang III., No. 1.

§ L. c.

size is at least increased by disease. Gruber does not believe that it is an opening always to be found; but that it is one frequently observed, and that it would be an interesting inquiry as to how far it is the result of disease.

Dr. Politzer* thinks that the Rivinian foramen is a constant appearance, not an anomaly or result of disease.

Hyrtl† denies the existence of the membrane, and says that he has never found it, either on the adult or infantile cadaver. The ability to blow tobacco-smoke from the ears is the result, he thinks, of a want of development in the upper part of the membrane.

Professor Bochdalek, of Prague, rediscovered the opening at the upper margin of the membrana tympani, one-third to three-fourth lines. from the edge, and reopened the discussion which Hyrtl seemed to have closed.

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 with a magnifying-glass, in order to find it. Bochdalek‡ describes his discovery of the opening as follows: "To my great astonishment I saw, by means of a magnifying-glass, on the posterior portion of a small depression on the membrana tympani, and a little behind the malleus, a very small canal, in which was perceived, although very indistinctly, a punctiform opening. By means of a very fine bristle I succeeded in entering a narrow groove, not more than one-third of a line long, which ran in an oblique direction from above downward, and somewhat anteriorly, into the cavity of the tympanum, so that the bristle passed immediately beneath the handle of the malleus, and just as closely beneath the *chorda tympani*. On pushing the bristle still farther, it passed under the tendon of the inner muscle of the malleus, and struck on the inner wall of the cavity of the tympanum."

Dr. Bochdalek also found the foramen in the opposite membrane of the same subject, as well as in sixty-three other preparations of the membrana tympani. Forty of them were from fresh subjects, the remainder had been preserved in alcohol. In two cases only the opening was not found. In both these cases morbid changes (thickening?) had occurred in the drum-head.

Kessel§ believes that the foramen is the result of inflammation. He says that he has convinced himself of the correctness of this view, by dissections and by examination of the living subject at Gruber's clinic.

The author believes in the existence of the foramen of Rivinus, from the clinical fact that he has heard a whistling sound, seemingly through the membrana tympani, in several cases, when the Valsalvian experiment was made, when neither he nor other observers could detect the slightest opening with the eye. I have also been startled, in one or two instances, on blowing my nostrils violently, by hearing the air whistle through the drum-head, as it seemed. On one occasion, I immediately consulted a friend who has large experience in examining the membrana tympani, and he decided that it was

* L. c.

† Anatomie des Menschen, p. 520.

‡ Prag. Viertel. Jahrschrift, January, 1866.

§ Stricker's Hand-book of Histology, p. 953.

not perforate, as did several others who soon examined the ear. Indeed, I have never suffered from any disease of the ear that led me to suppose the drum-head could be perforate.

I cannot escape the subjective conviction, however, that the foramen of Rivinus exists, and that air may be occasionally heard to whistle through it, although the opening itself cannot be seen.

Mr. Wharton Jones* described the circular and radiating fibres of the membrana tympani in his article on the organ of hearing.

Sir Everard Home† supposed that these fibres were muscular, and he thought that by this muscle "accurate perceptions of sounds were conveyed to the internal organ." Mr. Home admitted that the muscles of the malleus stretched and relaxed the membrana tympani, but only in order to bring the radiated muscle into a state capable of acting.

Mr. Home reports a case of double hearing, which has been before alluded to (see Chapter VI.), and he explains it by a defective action of the radiated muscle, which was not exerted with the same quickness and force in one ear as in the other, so that the sound was half a note too low, as well as later in being impressed upon the organ.

The patient, judging from the history, evidently had a catarrh of the tympanic cavity, and the double hearing probably arose from unequal pressure on the labyrinths.

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. I am now speaking of the membrane, 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 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 larger than the posterior. The attachment of the malleus between the layers of the drum-head will be described in the description of these parts.

At the extremity of the handle of the malleus is situated the apex of the light spot. This point is also the place of

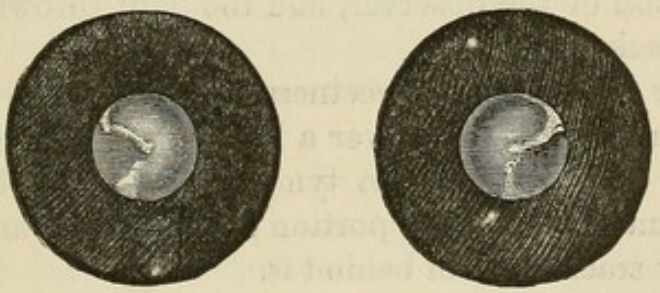
* Cyclopædia of Anatomy and Physiology, vol. ii.

† Philosophical Transactions of the Royal Society of London, 1800. Part I.

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, as will be seen in the chapter on chronic non-suppurative disease of the middle ear, 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.

FIG. 41. FIG. 42.



View of Membrana Tympani, showing Handle of Malleus and Triangular Spot of Light.

An account of the normal color of the membrana tympani will be found in the chapter on Chronic Non-suppurative Inflammation. Until the investigations of Von Tröltsch and Politzer, this was described as seen in the dead subject; but the post-mortem appearances of this membrane are no guide to its appearance on the living subject. The ordinary breadth of the light spot, at its base, is from one and a half to two millimetres.—(*Politzer.*) It is sometimes interrupted in its continuity.

The chief causes of the existence of the light spot, according to Politzer,* 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

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

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

Helmholtz* also states that the triangular spot of light is due to reflection. Voltolini† claims that the light spot may be seen when no auditory canal is present; indeed, even when the membrane is completely removed. This seems to me to be a mistake; for while there is a reflex from any generally convex brilliant membrane, such as the drum-head, although it has a central concavity, there is no such *triangular* and fixed one, as when the auditory canal is present, and this is the whole point of the theory of *Politzer*.

Voltolini is correct, however, in calling attention to other modifications of the light spot, than its inclination in the auditory canal. If it become thickened, inflamed or infiltrated; in other words, if from mechanical or chemical causes it cease to be a brilliant membrane, and it does not reflect light as well as formerly, the light spot will no longer be triangular in shape, and perhaps not exist at all; but neither the concavity nor polish of the membrane have all to do with the existence of the light spot, as Voltolini asserts. Any person can prove this for himself by a few simple experiments, with a membrane stretched over the end of a tube.

* Monatsschrift für Ohrenheilkunde, Jahrgang VI., No. 8.

† L. c.

The light spot depends 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 millimetre in thickness (Henle)—about as thick as very fine letter-paper or gold-beater's skin (Von Tröltsch). This thickness varies within small limits.

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

1. A thin layer of integument.

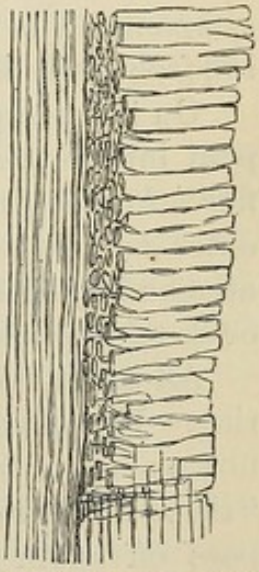
2. A fibrous layer. This layer forms the principal thickness of the membrane.

3. A mucous layer continuous with that of the tympanic cavity.

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 towards the handle of the malleus ; they then increase and are thickest on the outer edge of this bone.

FIG. 43.
$\frac{300}{1}$



Vertical Section of Fibrous Layer of the Membrana Tympani. After Henle.

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 millimeters.

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 cutis, 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 to 0.0108 millimeters in thickness. Sometimes they appear to be homogeneous, but they are actually fibrillated. Chromic acid, chloride of gold, and osmic acid bring out the fibrillated structure.—(*Kessel.*)

The fibrous layer might be well described, according to Kessel, "as a deep layer of the corium changed and adapted for physiological purposes." The slits or 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. Von Tröltsch called these cells the corpuscles of the membrana tympani. The larger spaces contain encapsulated nuclei, and are frequently filled with amæboid 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.* (*See engraving on page* 201.)

All the layers of the fibrous layers are united to the osseous ring. Kessel confirms Gruber's observation 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 towards 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 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 ½mm. 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,* say that while this cartilage exists—that is to say, that 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.

Kessel found on sections of the ossicles in embryos from three to nine months, that the malleus is surrounded by an independent periosteum distinct from the elements of the fibrous layer, and only united with the mucous layer by a duplicature of the mucous membrane. In place of the short process there is a quantity of glistening nucleated cells under the periosteum and in the tissue duplicature. These elements remain through life as cartilage cells, and form a a solid mass with the osseous portion of the small process.

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 frame-work beneath it. On the inner side of the membrane, at the upper part of its posterior half, is found an irregularly triangular fold, 3 to 4mm. high and 4m. 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 Von Tröltsch,† who described it, "the posterior pouch" of the membrana tympani.

The best view of this duplicature is seen by viewing the

* Stricker's Hand-Book, p. 955.

† Von Tröltsch, Lehrbuch der Ohrenheilkunde Vierte Aufgabe, 1868, p. 38.

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 living subject. The tissue of the pocket is the same as that of the fibrous layer.—(*Von Tröltsch.*)

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 towards 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, by the bony process of the malleus, by the anterior ligament of the malleus, 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 Von 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.

According to the recent investigations of Kessel, there are blood-vessels, nerves, and lymphatics in all the layers of the membrana tympani. It had been previously taught by nearly all the writers, that there were no blood-vessels or nerves in the fibrous layer of the drum-head, although according to Gerlach, there was a capillary anastomosis between the mucous membrane and the cutis on the periphery of the middle or fibrous layer. Kessel* also claims to have first described the lymph vessels.

According to Kessel, 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 net-work in the fibrous layer communicates with the cutis and the mucous membrane.

The blood-vessels that pass from the auditory canal down

* L. c., p. 958.

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.

The blood supply of the outer layer of the membrane may be very readily traced in many cases of inflammation, or after injecting the canal with warm water. The whole circumference of the membrane is usually found injected in connection with redness of the lower part of the canal. Larger vessels run immediately behind the handle of the malleus to the *umbo*, where they pass off in radii to the edge.

NERVES OF THE MEMBRANA TYMPANI.

Nerves are found in each layer of the membrana tympani. The larger nerve-trunks accompany the chief vessels. They divide as these do, and frequently unite together like the capillaries. They form thick networks under the epithelium of the cutis, and also under that of the mucous membrane. A fundamental plexus, a capillary plexus near the vessels, and a sub-epithelial plexus may be distinguished.

The chief nerve-trunk consists of medullated fibres, which is provided with a sheath of Schwann, and lies on the boundary between the cutis and the fibrous layer. It passes on to the membrane at the upper part of the posterior segment. Besides this chief trunk, several small branches enter the membrane at different parts of the periphery.

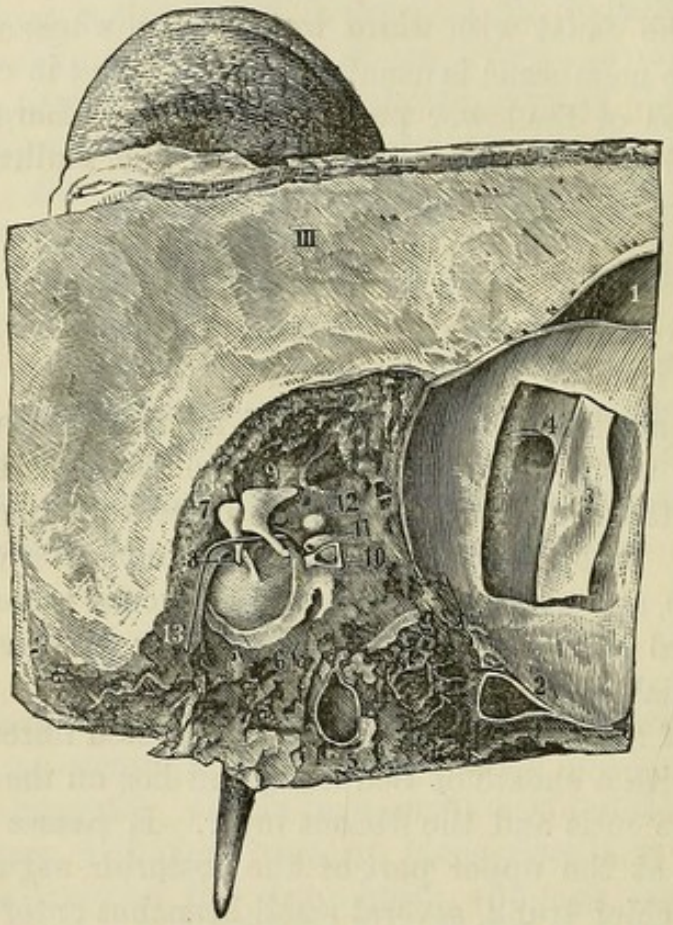
In addition to the openings in the fibrous layers, with their contents, Kessel found a large number of nucleated swellings, provided with two or more processes, that unite with the nerve-fibres, and which lie above and between the single fibrous layers.

The greater part of the cell elements found between the fibres of the fibrous layer, must be considered, according to Kessel, as belonging to the blood and lymph vessels, and to the nervous system.*

* Kessel, in Stricker's Handbook, p. 962.

The nerves of the mucous membrane of the membrana tympani are also more numerous, according to the author from whom I have just quoted, than has been hitherto supposed. There is a plexus near the vessels, and a sub-epith-

Fig. 44.



The Membrana Tympani, in connection with the Ossicula Auditus of the Right Temporal Bone. From a Photograph. Rüdinger.

1. *Transverse section of the fossa sigmoidea, in which is the transverse sinus.* 2. *Lower section of the transverse sinus.* 3. *Inner side of the transverse wall thrown back, which causes,* 4, *the emissarius mastoideus to be opened.* 5. *Carotid canal.* 6. *The membrana tympani connected to the mucous membrane of the cavity of the tympanum.* 7. *The malleus on the anterior and upper portion of the handle; the pockets of the membrana tympani are seen.* 8. *The divided tendon of the tensor tympani muscle.* 9. *The incus.* 10. *Stapes lying by the stapedius muscle, on the pyramid, which is opened.* 11. *Stapedius muscle.* 12. *Section of facial nerve.* 13. *Chorda tympani nerve.*

lial 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 peri-

phery, 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.*

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, which often interlace with the blood 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.

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

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 into the cavity through the upper part of its anterior wall.

* Kessel, p. 963.

† Kessel, Handbuch der Lehre von dem Geweben, p. 851.

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

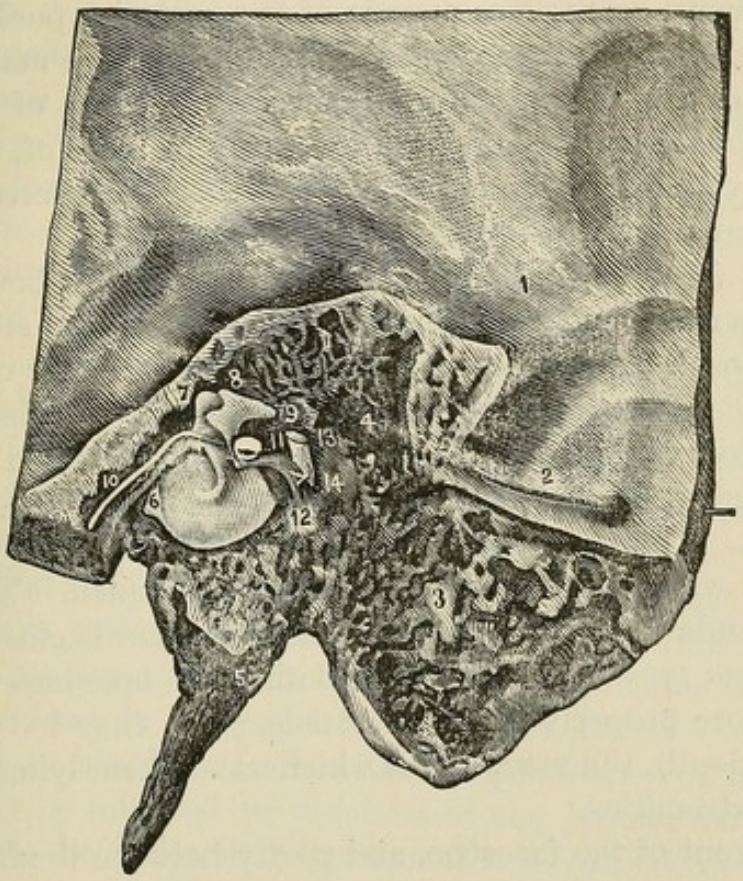
Antero-posterior diameter	.	.	13mm.
Vertical	"	at anterior part,	5 to 8mm.
"	"	at posterior "	15mm.
Transverse	"	an anterior "	3 to 4.5mm.
"	"	opposite the drum-head,	2mm.

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 strong bony plate.

* Text-book, American translation, p. 171.

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

FIG. 45.



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 number* 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.*

The outer wall of the tympanic cavity is composed, for the most part, of the membrana tympani; but it extends much further backwards 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 the margin of the membrane, and gives entrance to the chorda tympani nerve. The nerve then runs upwards under the long process of the incus, on the free margin of the posterior pocket of the membrana, then forwards 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 fenestræ, and partly between them, lies the *promontory*, a projection of the outermost turn of the cochlea. Upon it may be seen three shallow grooves for branches of the tympanic plexus. In front of the 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 Fallopian 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, so that the tympanum forms a part of the cranial cavity.

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, it is usually covered, in cases of purulent affections of the middle ear, by a large quantity of pus. It is perforated by the glosso-pharyngeal nerve and a minute vessel.

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 hemorrhage, also 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 by only a thin plate of bone, which may even be deficient in many places. Indeed, swelling of this nerve, causing temporal facial paralysis, or destruction of it, producing permanent paralysis, is not uncommon in connection with a suppuration in the middle ear.

OSSICULA AUDITUS.

3. The three small bones of the ear, the *ossicula auditus*, which serve for the conduction of the sonorous undulations through the tympanum to the labyrinth, are the malleus, or hammer; the incus, or anvil; and the stapes, or stirrup.

FIG. 46.



The *malleus* may be described as consisting of the head, neck, short process, manubrium or handle, and the long process or processus gracilis.* 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 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.

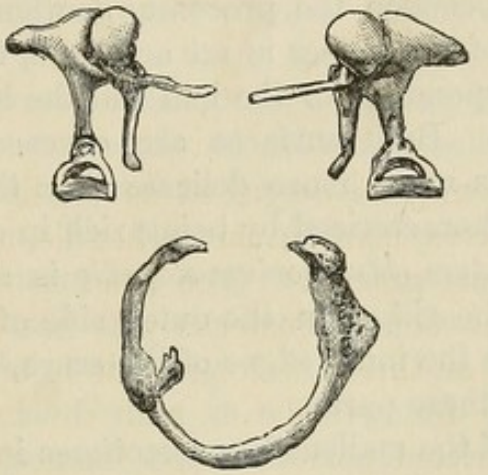
The *incus* lies just back of the malleus, and may be described as having a body and two processes. On the anterior and inner surface of the head is seen the surface for articulation with the malleus. The short process projects backward and articulates with the posterior wall of the tympanum. The long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

* Some writers call the handle of the malleus the long process.

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 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

FIG. 47.



The Ossicula Auditus of the Left Cavity of the Tympanum, seen from within.

1. *The malleus, with the handle running downwards, and the processus gracilis running to the right.* 2. *The incus, with its short process running to the left, and its long process in articulation with the stapes.* 3. *The stapes.*

The Ossicula Auditus of the Right Cavity of the Tympanum, seen from within.

1. *The head of the malleus.* 2. *The processus gracilis.* 3. *The long process, or handle.* 4. *Long process of the incus.* 5. *The short process of the incus.* 6. *The stapes.*

The Right Annulus Tympanicus, or Long Ring, of the Newly Born, seen from without.

1. *The anterior thicker part, in the newly born, lies next to the Glaserian fissure, which is quite wide, and just behind the condyloid fossa unites with the squamous portion of the temporal bone.* 2. *A process on the posterior half of the ring, about the middle, which is always present in varying degrees of development.—(From Rüdinger's Photographic Atlas des Menschlichen Gehörorganes.)*

inward, to be inserted into a thin plate constituting the base, which lies upon the membrana tympani secundaria. On the outer side of the base is a delicate ridge running from the extremities of the crura and into which is inserted the abturator stapedis.

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 0.04mm. 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 lies sometimes in contact with the roof of the tympanic cavity. More frequently it is connected with the roof by the cylindrical *lig. mallei superius* (*Sœmmering*). 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.

5. 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 at the extremity of the canal turns outward and runs nearly at a right angle with the muscular part to the base of the manubrium mallei.

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 head of the stapes. This is the smallest distinct muscle of the human body.

6. 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 Von Tröltsch asserts 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 frame-work which separates 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 tympanum receives its nutrition from five sources:

1. The tympanic branch of the internal maxillary which supplies the membrana tympani.

2. The stylo-mastoid branch of the posterior auricular which supplies the back part of the tympanum and mastoid cells.

3. The petrosal branch of the middle meningeal and branches of the ascending pharyngeal and internal carotid.

The veins of the tympanum empty into the middle meningeal and pharyngeal.

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 nerves that make up the tympanic plexus, according to Von Tröltsch,* are

1. Several carotico-tympanic nerves, branches from the plexus of the sympathetic in the carotid canal, which enter the cavity of the tympanum through special foramina.

2. A twig of the superficial petrosal nerve, entering the cavity from above. It is regarded by some as a connection between the otic ganglion and bend of the facial. Others consider it a continuation of the tympanic nerve (Jacobson's) to the otic ganglion.

3. The ramifications of the tympanic nerve, arising from the glosso-pharyngeus.

The otic ganglion is situated near the foramen ovale of the greater wing of the sphenoid bone, in front of the middle meningeal artery, on the outer side of the cartilage of the Eustachian tube, and the point of origin of the tensor tympani muscle.

It is made up of motor fibres from the third division of the fifth nerve, of sensory fibres from the glosso-pharyngeal, and of fibres from the great sympathetic.

Its branches of distribution are to the tensor tympani and the tensor palate 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. —(*Von Tröltsch.*)

The chorda tympani nerve seems to pass through the tym-

* Treatise on the Ear, American translation, p. 97.

panic 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 (*μαστός, 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 passes a vein to the transverse sinus and a small artery.

This 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.

Gruber † has seen emphysema of the neck and of the occipital region result from the inflation of the cavity of the tympanum in cases where such external openings existed under the skin.

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 mastoid portion is continued below into a conical projection, which is the true mastoid process. To this process 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 (see cut on page 197). In this groove 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 size, which are called the mastoid cells.

* See Chapter X. for an account of the functions of the chorda tympani.

† Lehrbuch, p. 32.

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; and since it exists even in the infant, before the development of the mastoid process, it has been suggested that the name of "upper cavity of the tympanum" would be more appropriate. The second part of these cells, lying in the mastoid process of the temporal bone, are below the horizontal part. The whole consist of a great number of irregular spaces of varying sizes—sizes that also vary much in different individuals. The whole are enclosed 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. The latter layer contains numerous nerves, and blood and lymph vessels. The upper layer very frequently separates itself at the free edge of the cells, like a membrane, and becomes attached to more closely lying tips or projections of bone. By this means the cavities of two cells lying next each other become separated. In the larger cells these membranes are stretched horizontally, like curtains, by means of processes which arise from them.—(*Kessel.*)*

At birth the mastoid process is but the rudiment of what it is afterwards to be. It is a small tuberosity, and contains but

* Handbuch der Lehre von den Geweben. Vierte Lieferung, p. 864.

one cell of any considerable size, which afterwards becomes the mastoid antrum.

Dr. Giovanni Zoja,* of Pavia, examined sixty-eight fresh preparations, and one hundred dry ones, in order to get the average size of the mastoid process and its cavities. The result of his investigations is, that the breadth of the mastoid is 19 millimetres, its thickness 13mm., and its length 12mm. About one millimetre should be deducted from these measurements in the bone of the female subject. Zoja does not confirm Velpeau's view, that the mastoid process is more developed in advanced life. The cortical layer, according to these examinations, has an average thickness of from one to two millimetres.

In two of the sixty-eight 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 membane 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.

Dr. Zoja thinks that the development of the cellular structure goes on in a kind of system. They become gradually larger, they are lined with a peculiar membrane, in the spaces a gelatinous mass is found, which becomes gradually serous, and is either taken up by the vessels of the cavities or passes into the cavity of the tympanum, where it is absorbed.

In five of the sixty-eight specimens the antrum was found to be separated from the other cellular spaces by a membranous partition.†

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.

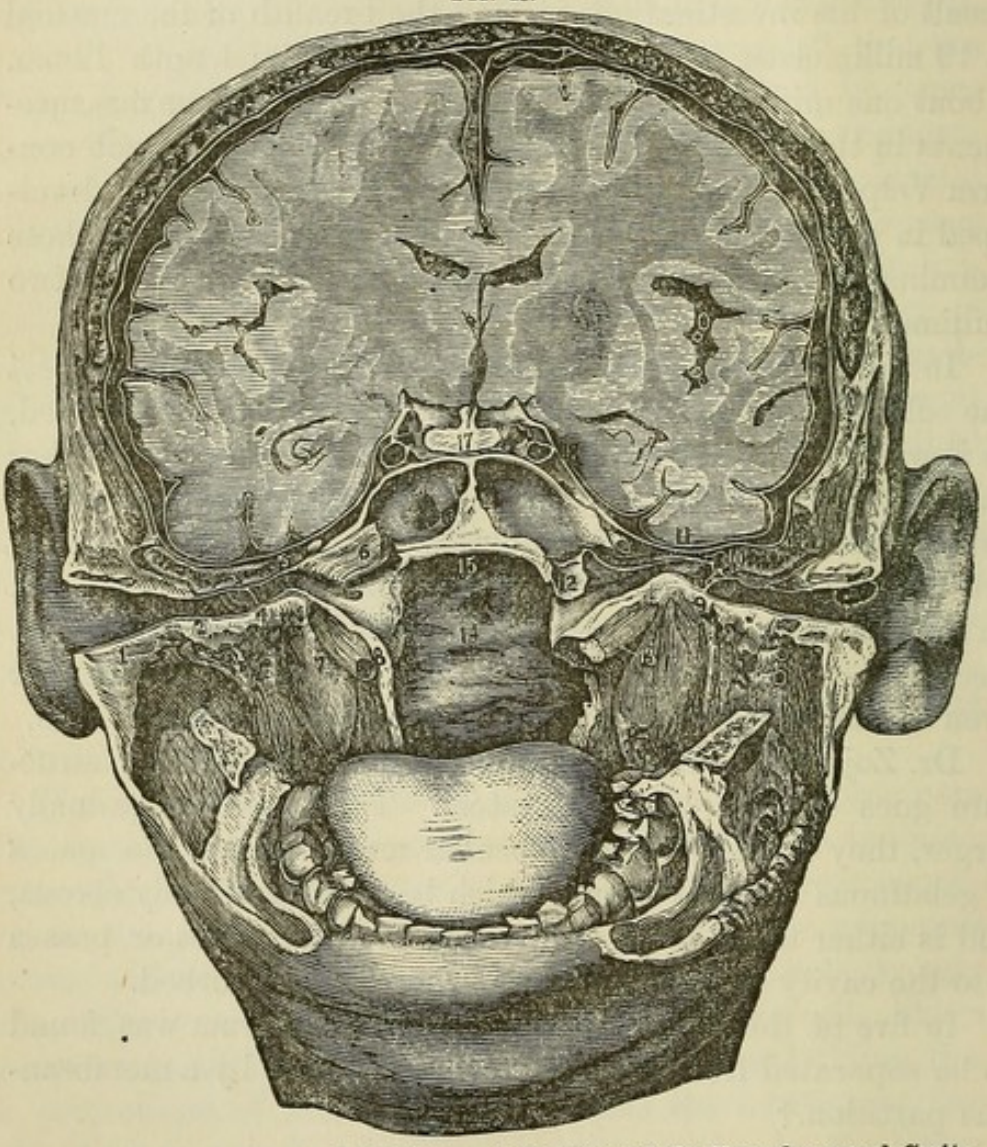
* Gruber's Lehrbuch, p. 33.

† Henle, Lehrbuch, p. 751.

THE EUSTACHIAN TUBE.

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

FIG. 48.



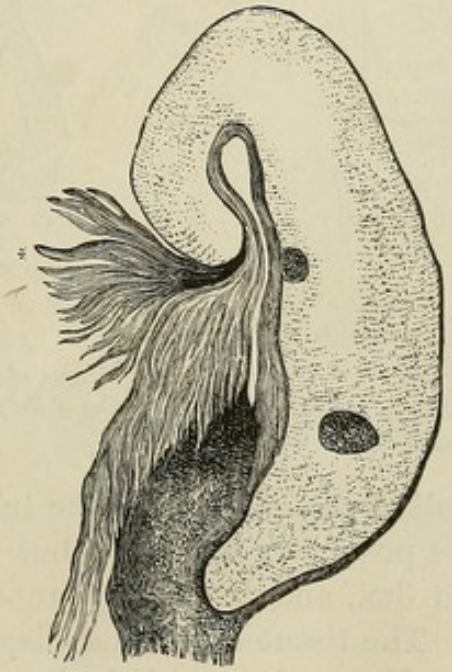
Section of the Head, showing the Divisions of the Ear and the Naso-pharyngeal Cavity. After a Photograph—Rüdinger.

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.*

measures 11mm., the latter 24mm., so that the whole length of the tube, from its opening into the tympanic cavity to its pharyngeal orifice, measures 35mm. 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 2mm. 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.

FIG. 49.



Transverse Section of the Upper Part of the Eustachian Tube. After Henle.

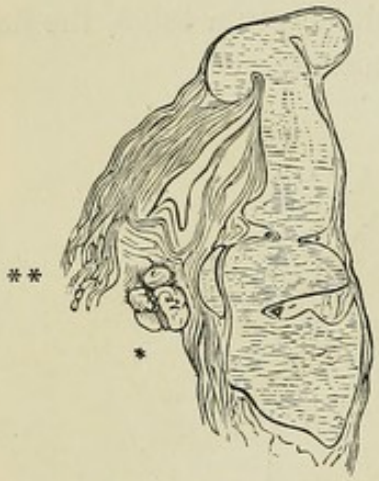
** Fibres of the spheno-staphylinus muscle.*

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 9mm. high and 5mm. 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.

FIG. 50.



Transverse Section through the Lower End of the Eustachian Tube. After Henle.

** Mucous glands. ** Fibres of petrostaphylinus muscle.*

FIG. 51.



Transverse Section through the Lower End of the Eustachian Tube. After Henle.

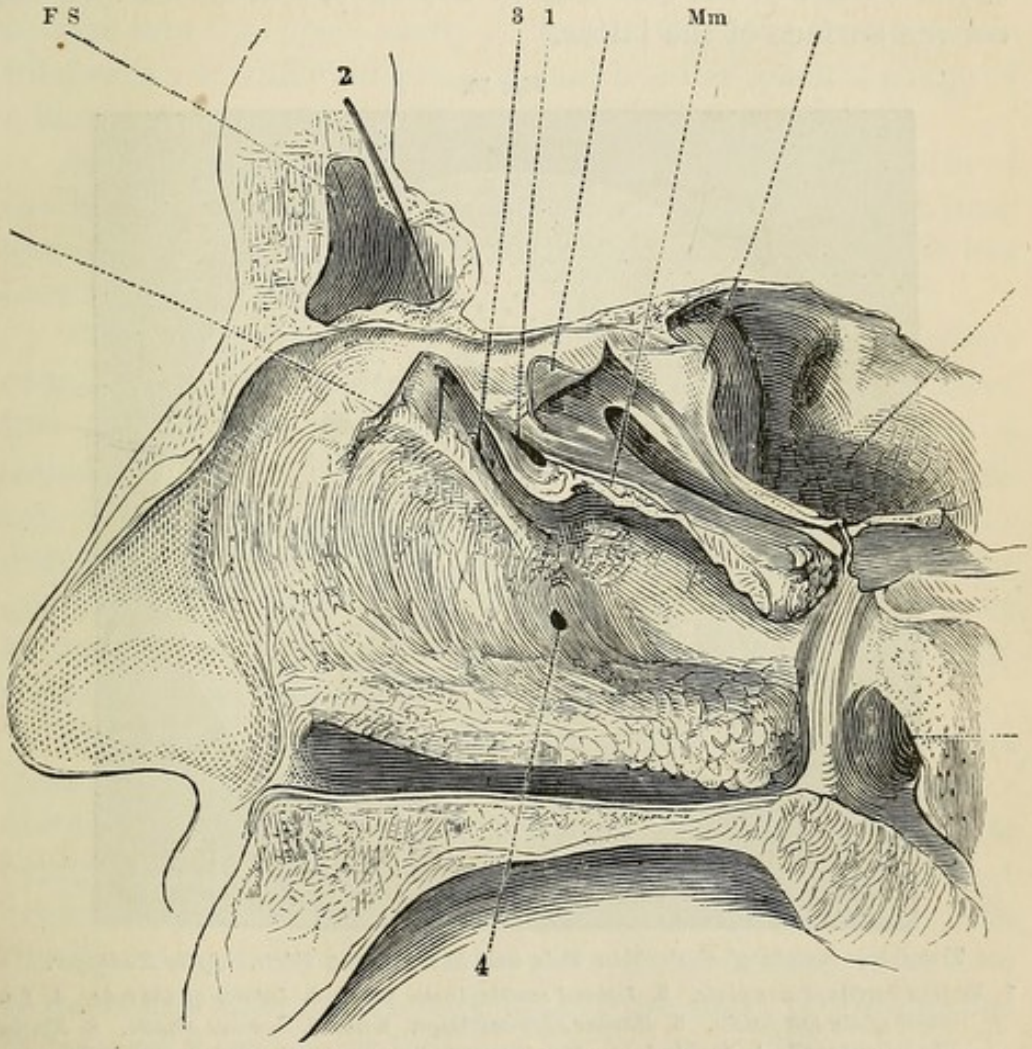
** Mucous glands. ** Transverse section of the petrostaphylinus muscle.*

The median wall of the cartilage of the tube is below 1mm. in thickness on its posterior extremity, but increases in size gradually to $2\frac{1}{2}$ to 3m., and on its free anterior border may even reach 7mm. 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 caliber up to the vicinity of the pharyngeal orifice to a plane surface, is 0.6mm. thick at its densest portion. It is connected to the perichondrium by loose connective tissue. It is made smooth by numerous acinose glands of about 0.6mm. in diameter and 0.15mm. in

thickness. These glands form a continuous layer backwards from the pharyngeal orifice for some distance. Towards the cavity of the tympanum they are less numerous, yet, according to Von Tröltsch, they are found on the tympanic orifice. Towards the pharyngeal orifice large mucous glands appear lying on the outer side of the cartilage.

FIG. 52.



Lateral Wall of the Nasal Cavities, showing the Pharyngeal Orifice of the Eustachian Tube. After Henle. The Middle Turbinated Bone is removed.

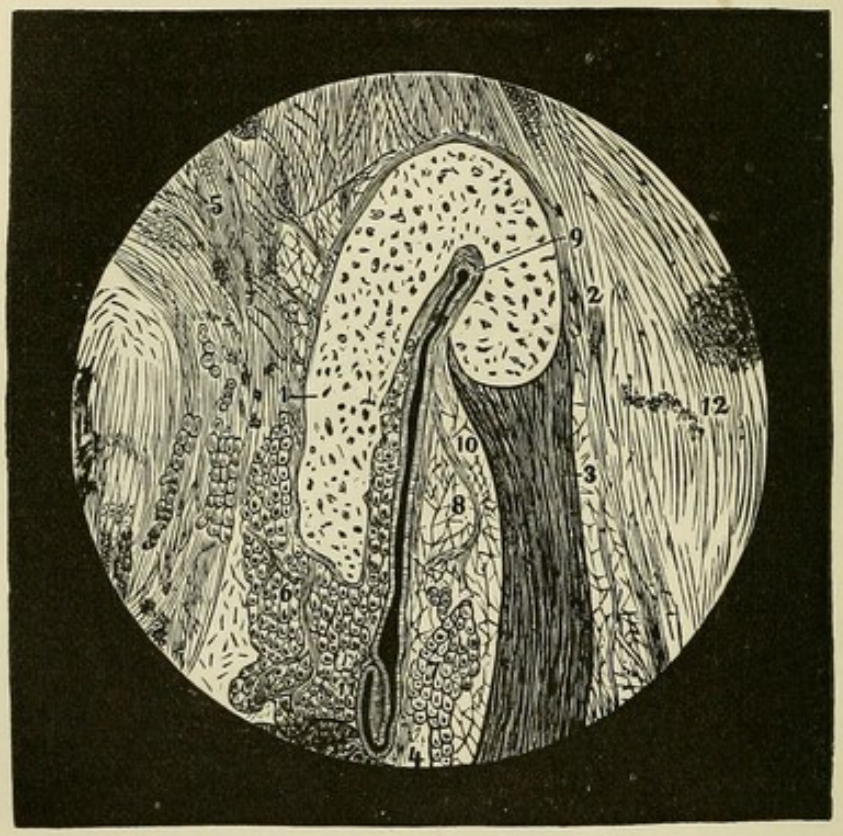
Mm. *Border of attachment of the middle turbinated bone. The upper membrane is split by a vertical section, and turned back on two sides, in order to show the openings of the upper ethmoidal cells.* F. S. *Frontal sinus.* S. S. *Sphenoidal sinus.* 1. *Openings of the lower ethmoidal cells.* 2. *Probe entering into the middle nasal space from the frontal sinus.* 3. *Constant opening between the antrum of the lower jaw and the nasal cavity.* 4. *Occasional opening between the same parts.* 5. *Pharyngeal orifice of the Eustachian tube.*

The lateral wall of the tube, which, with its upper border, bounds the convex surface of the enveloping ridge of the car-

tilage, 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.

Fig. 53.



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 fibro-cartilage.* 6 *and* 7. *Acinous glands.* 8. *Fat in the lateral wall.* 9. *Safety tube.* 10. *Accessory fissure.* 11. *Fold of mucous membrane.* 12. *Adjacent tissues.*

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 point where the lateral wall of the nasal cavity passes into the pharynx, at the same height with the posterior point of the inferior turbinated bone, lies the pharyngeal orifice of the tube. (Fig. 52.)

Since the inner wall of this canal projects into the caliber 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.

According to Rüdinger,* the minute differences in form of the Eustachian tube in animals is so characteristic, that from a section of the Eustachian tube, the animal from which it has been taken can be designated.

The known functions are to conduct away the secretions of the cavity of the tympanum, and to act as a ventilator of this part. What part it has to do with the conduction of sound to the ear, or what connection it has with the voice, has not as yet been determined. Rüdinger has observed fatty degeneration of the tubal cartilage of man, and it may be conceived that fatty degeneration of its muscles may occur in some subjects and become a serious impediment to the performance of its functions.

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. This anatomical fact explains the intolerance which this membrane displays towards the injection of fluids from the pharyngeal orifice. The tube of the infant differs much from that of the adult. It is shorter, wider, and more nearly horizontal.

Rüdinger divides the fissure of the tube into two portions. There is a semi-cylindrical space under the hook of the cartilage which he calls the *safety* tube, and the fissure connecting with it the accessory fissure.

Both divisions are produced by the shape of the cartilage,

* Stricker's Hand-book, p. 973.

and are separated from each other by projections of mucous membrane. The mucous membrane is firmly attached to the tissues about it on the concavity of the hook; but at that point where the accessory fissures begin, fold-like projections are produced between this fissure and the safety tube. The projection of these folds prevents the safety tube from being closed. The closure is first possible at the point where the bend of the cartilage becomes narrower, and the mucous membrane is not closely united with it. This point is at about the middle of the tube, where the mucous membrane has a slightly undulating surface, as seen in Fig. 55.

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 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 belongs to the pharynx. Indeed, these parts are so 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

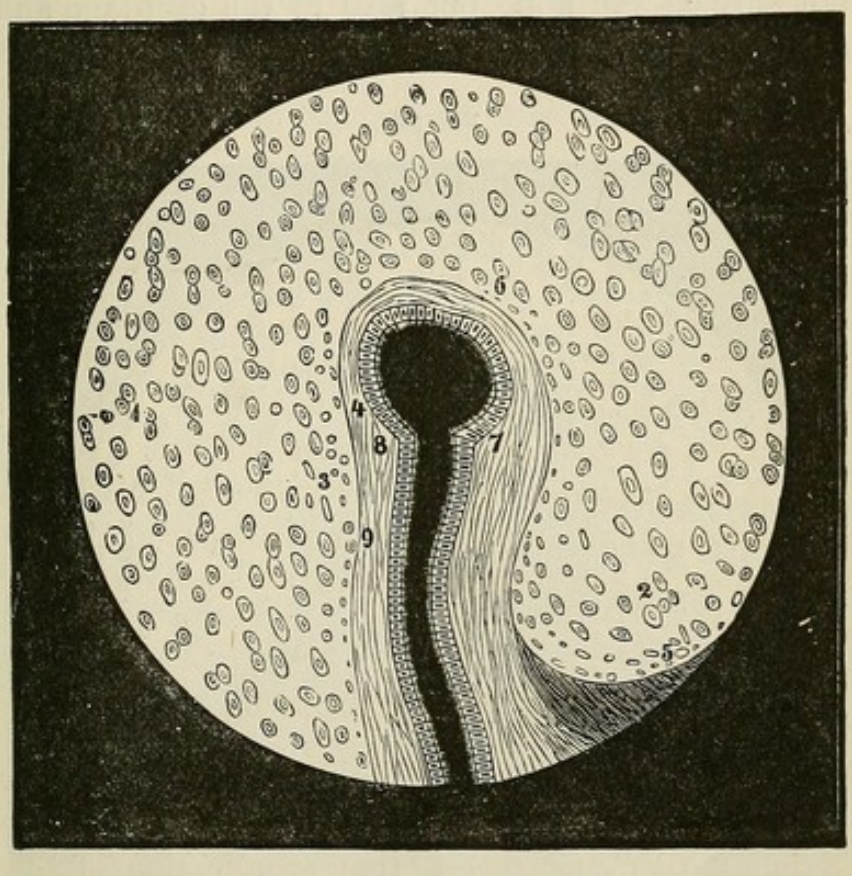
1. **The Abductor or Dilator of the Tube.**—This muscle is also known as the spheno-salpingo staphylinus muscle, the circumflexus palati, or tensor palati mollis. It is probably the most important muscle of the tube.

This muscle 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 caliber 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.

Fig. 54.



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.*

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 inti-

mately 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 by a few fibres from the cartilaginous portion of the tube.

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.

FIG. 55.



Section of the Middle Third of the Eustachian Tube. After Rüdinger.

1, 2. *Cartilage.* 3. *Dilator of the Tube.* 4. *Folds of mucous membrane under the cartilage hook.* 5. *Folds of mucous membrane in the accessory fissure.* 6. *Submucosa.*

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.* The salpingo-pharyngeus muscle also assists in this action.

3. **The Salpingo-pharyngeus.**—This is a thin muscular layer, that ascends from the lower end of the tube obliquely downwards and backwards, 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.

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 outward, 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, however.† 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. This fact throws light upon the etiology of cases of diseases of the middle ear, arising from inflammations of the respiratory organs, such as Pneumonia and Bronchitis.

BLOOD-VESSELS.

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

* Rüdinger, Beiträge zur vergleichenden Anatomie und Histologie der Ohrtrompete.

† Rüdinger, l. c., p. 7.

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.

Historical.—The history of the successive steps by which the Eustachian tube has taken its true and important position with relation to the study and treatment of aural disease is a very interesting one, and has been very succinctly given by *Dr. Ludwig Mayer*,* from whose writings the author has already quoted in the chapter on Foreign Bodies.

As has been said on page 19, Alcmeon and Aristotle knew of the Eustachian tube, but Eustachius was the first writer who gave an exact description of it. This is found in the edition of his anatomical works published in Venice in 1564. (*Bartholomæi Eustachii Opuscula Anatomica.*)

The passage in reference to the tube, as quoted by Mayer, is as follows:

Ergo a caverna ossis lapidei, in quam meatus auditorius, conchion appellatus finitur, via in narium cavitatem perforata est: ab illa enim meatus alter oritur rotundo canaliculo similis, et instar tenuioris calami amplus, qui oblique ad interius interiusque basis capitis latus procedens, in medio quatuor foraminum, totum istud os penetrat atque perfodit. nã posteriori ipsius sede arteria soporaria calvariã ingreditur: anteriori quartum nervorum cerebri jugum extra ipsam emergit: externum latus arteriae in durã cerebri membranã distributae aditum patefacit: internum denique fissura quaedam circumscribit, quae à cuneum referentis ac lapidei ossis extremis partibus, oblique infra et anteductis, fit. Caeterum hunc meatum, de quo sermo est, arbitrabitur for-

* Studien über die Anatomie des Canalis Eustachii. München, 1866.

tasse quispiam eo loco desinere ; res autem non ita se habet, sed alterius generis substantia auctum, inter duos faucium seu gulae musculos, à paucis hucusque bene cognitos secundum, paulo ante me moratae fissurae ductum ulterius procedit ; et juxta radicem internae partis apophysis ossis alis vespertilionum similis in alteram narium cavitatem terminatur ; et in crassam palati tunicam prope radicem gargareonis inseritur. Substantia sane ejus, qua extrema fissurae ossi temporum et cuneo simili communis tangit, cartilaginea est ac admodum crassa ; huic vero appositae partis substantia exacta cartilago non est, sed membranosum nescio quid habet, et tenuior evadit a hujus meatus intena extremitas narium cavitatis medium respiciês robusta est cartilago, quae plurimum extuberat, mucosaque ; narium tunica obducitur, ac fini ejusdem meatus quasi canitor praeferta esse videtur. figura teres non est, sed aliquantum depressa duos efficit angulos : latitudo cavitatis calamum, quo scribimus, fere adaequat, sed in fine duplo latior est, quam in principio, quae similiter mucosa sed tenui induitur tunica. Hoc callidissimum naturae artificium a me inventum contemni (ut opinor) non debet : siquidem tum philosophis, tum medicis non parum utilitatis afferre potest. nam antiquiores philosophi, quorum numero, ut Aristoteles refert primo de natura animalium undecimo fuit Alcmeon, capras non modo ore ac naribus, verum etiam auribus quoque spirare, forte ob eam causam arbitrati sunt, quod meatum quam descripsi non ignorarent atque adeo saepius experti fuissent spiritum, ubi ipsum quis cohibet, ad aurium cavitatem vi quadam impulsum recurrere, et instar fluctus, auditus organa percutere. Erit etiam medicis hujus meatus cognitio, ad rectum medicamentorum usum maxime utilis, quod scient post hac ab auribus, non augustis foraminibus, sed amplissima via posse materias etiam crassas, vel a natura expelli, vel medicamentorum ope, quae masticatoria appellantur, commode expurgari.

The last paragraph of this quotation shows, that Eustachius anticipated an earlier use of his discovery than was made by the profession.

The writers who followed Eustachius up to Valsalva's time, based their labors on what Eustachius had done. Mayer, in order to express his estimate as to their value, quotes Goethe, who says : "Denn eben wo Begriffe fehlen, da stellt ein Wort zur rechten Zeit sich ein." Where the ideas are wanting, words serve a very good turn.

Valsalva, however, described the muscles of the Eustachian tube very exactly, but a hundred and twenty-five years after Eustachius. He supposed that the function of the muscles was to keep the tube constantly open. It was not until 1850 that the anatomical descriptions began to be accurate. Then F. Arnold, in his *Handbuch der Anatomie des Menschen*, published at Freiburg in Bresgau, in 1851, gave a careful description of

the tube. Merkel, *Anatomie und Physiologie der menschlichen Stimme und des Sprech-Organs*, and Tortual, *Neuen Untersuchungen über den Bau des menschlichen Schlundes und Kehlkopfes*, 1861, afterwards described the canal. Von Tröltsch,* in an article published in his Archives, elaborated the subject much farther. The labors of Mayer and Rüdinger have brought our knowledge of the anatomical structure to the present stage.

It should never be forgotten that Joseph Toynbee was the first writer, in a paper presented to the Royal Society in 1851, to show that the faucial orifice was *controlled* by the muscles of the palate, and that the act of swallowing affected the caliber of the tube. Toynbee thought that the tube was completely closed in a state of repose, and although not strictly correct in this, his labors can hardly be overestimated.

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CHAPTER X.

INJURIES OF THE MEMBRANA TYMPANI.

THE diseases of the membrana tympani occur either as a result of an inflammation of the external auditory canal, or of the middle ear. I have not seen any cases of independent or primary myringitis, or inflammation of the drum membrane, such as are delineated with theoretical minuteness by some writers on otology. The anatomical structure of a membrane that has but one layer of tissue peculiar to itself, and that in its centre, but which is a direct uninterrupted continuation of the adjacent parts, precludes the idea of an inflammation that occurs primarily in this part. A glance at the nerve, lymph, and blood supply of the partition wall which is called the membrana tympani, shows that it has no independent nourishment, and strengthens the view that the inflammations that attack it, must be of a secondary character. I have therefore discarded the term myringitis, or inflammation of the drum membrane, except as the name of one of the symptoms of otitis externa or media, or to describe the inflammation produced by injury. There is probably no independent disease called myringitis, in the sense that we speak of a keratitis or a retinitis.

Dr. A. H. Buck* has recently reported a case of interlamellar cyst of the membrana tympani, which might be supposed to be an independent disease of this part; but the history shows that the patient was suffering, at the time of the formation of the cyst, from chronic eczema of the auditory canal, which causes the case to be one of extension of disease of the meatus to the drum-head.

The membrana tympani is, however, subject to injury from explosions, or sudden and violent movements of the atmos-

* Medical Record, vol. vii., p. 572.

phere, which cause the undulations to be condensed and forced inwards upon the drum-head. It may also be ruptured by the force of condensed air, as, for example, that which is found in passing through the lock of a caisson used in building bridges. The membrana tympani may also be ruptured by blows upon the side of the head or upon the ear, or from direct injury by the striking of a sharp instrument directly upon the membrane, and so forth.

The explosion of artillery is not apt to cause rupture of the drum-head. When we consider the number of persons who have been thus exposed to injury, it is somewhat surprising that no more have suffered from this cause. After diligent inquiry among army surgeons, I have heard of but very few cases of rupture of the membrana tympani occurring from this cause; and although I have seen many patients who became partially deaf, from the exposures incident to campaigning, during our late civil war, I have as yet seen but one case, where a rupture of the drum membrane occurred from the explosion of artillery. The long-continued exposure to heavy firing often, and perhaps always, causes a temporary ringing in the ears, probably from concussion of the labyrinth, and sometimes hemorrhage from the vessels of the membrana tympani, but very rarely is a rupture produced. The effects of the concussion do not always pass away, and some soldiers acquire a chronic inflammation of the internal and middle ears from this cause, just as do boiler-makers, who work amid deafening noises. Ruptures from concussion do occur, however. I once saw a woman at the New York Eye and Ear Infirmary, who had suffered such an accident from the firing of a pistol near her ear; and Dr. Hackley observed a similar result in an actor who was obliged to fire a pistol over his shoulder during a play. 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 caliber of the tube, is also a source of protection. Those persons who suffer a rupture of the drum-head from external concussions, probably have some catarrhal affec-

tion 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 our civil war, infantry soldiers in the trenches were in the habit of lying down, while the artillery behind fired over their heads; and yet, as I have found by inquiry, rupture of the membrana tympani was scarcely heard of.

Gruber's experiments on the cadaver show that the resisting power of the membrane is very great. Dr. Schmidekam assisted Professor Gruber* in these experiments, which proved, according to the former author, that the resisting power of the membrane was greater in man than in the other animals. It required a column of quicksilver of 143cm. high to rupture the membrana tympani of an ear that had lain in alcohol for a few weeks. The stapes and incus had been removed. The rupture was straight and parallel to the lower three-fourths of the anterior line of attachment of the malleus. In another case a drum-head, which exhibited the remains of a former inflammatory process, in the form of a false membrane, was not ruptured until a column of quicksilver 168cm. high, was used. Here again the rupture occurred on the anterior segment.

Gruber also examined the resisting power of the drum-head by the following experiment: He introduced a catheter with a bulbous extremity into the Eustachian tube of a fresh subject, having a healthy membrana tympani, and fastened the catheter in the tube by means of a stout thread stuck through it. He then allowed a stream of air from a compression pump—air that had been condensed four or five fold—to pass suddenly into the tube, or after closing the tube by tying a cord about it, he stopped the external auditory canal by means of a gutta-percha plug, with a small tube in it, through which he allowed the compressed air to pass. Gruber was never able to break the membrane in this experiment. The gutta-percha plug with the tube was driven out of the canal, but the membrane was never ruptured.

* Lehrbuch, p. 332.

Professor Gruber saw a great many patients who were engaged in the battles of Schleswig-Holstein and Bohemia in 1864 and 1866, and although he examined nearly all the aural patients of the Garrison Hospital in Vienna, he saw but one where the explosion of projectiles had caused a rupture of the drum-head. In this case the soldier was knocked senseless by the explosion of a grenade, which killed two near him. When he recovered his senses he was suffering from tinnitus aurium in the left ear, and was deaf on this side. Pain occurred, and in three weeks after, when he was seen by Dr. Gruber, he was found to have a roundish opening about one and a half lines in diameter, in the anterior and inferior segment of the drum-head. The tubes were pervious, and there was no evidence that he had previously suffered from aural disease. This, however, was the only case among hundreds of soldiers that fought at Königgrätz, who had suffered the injury which has been detailed.

Dr. Andrew H. Smith, one of my colleagues at the Manhattan Eye and Ear Hospital, was the medical officer in charge of the men engaged in laying the foundations for the bridge from New York to Brooklyn over the East River, and had many opportunities of observing the effects of compressed air upon the membrana tympani. Through Dr. Smith's courtesy, I saw some cases that illustrate this subject; and I here give from Dr. Smith's notes, one of rupture of the membrana tympani which occurred while the patient was passing through "the lock."

Dr. Smith describes the case of rupture of the membrane as follows :

"John H., on May 17th, the pressure being about 35 pounds to the square inch above the normal; the patient was attacked while in the lock going down for the first time, by a severe pain in the right ear, followed by a slight discharge from the meatus. No sensation was felt as of anything giving way in the ear. He completed his watch, and then reported to me. On examination, the drum-head was found to be ruptured at its upper edge. The opening was nearly circular and rather less than a line in diameter. The patient preferred not to go on with the work, and he was not seen by me again."

Dr. Smith believes that most of the men who suffered from aural trouble after having been in the caisson, had previously some 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 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 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 drum-head. 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."

I saw three or four of these cases of congestion of the tympanic cavity, they having been sent to me by Dr. Smith, and was enabled to see 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.†

* This is the term used by the men to signify the operation of holding the nose and blowing until the air is felt to enter the middle ear. This operation has to be constantly repeated while the air pressure is increasing in the lock, in order to relieve the pain resulting from the pressure upon the membrana tympani. In some persons the act of swallowing answers equally well.

† Dr. Smith's paper on "The effects of High Atmospheric Pressure, including the Caisson Disease," received the prize of the Alumni Association of the College of Physicians and Surgeons for 1873, and will soon be published. My extracts are taken from the manuscript loaned to me by the author.

A gentleman who once consulted me in reference to what I deemed to be an incurable chronic catarrh of the middle ear, which had resulted in thickening and sinking of the drum-head, afterwards came to me 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,* 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 now at St. Louis in 1869–1870.

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 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

* Transactions of the American Otological Society, 1870.

passage to the pharynx." 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.

Dr. A. Magnus,* of Königsburg, investigated very carefully the behavior of the ear in condensed air, in 1863, while a railway bridge was building in his city. He proved that the injury to the ear was caused by pressure upon the membrana tympani, because when he plugged the auditory canal hermetically, no unpleasant sensations were felt, but when he removed the stopper the air streamed with a powerful current into the canal, and pain occurred very soon. The ear that was stopped remained without pain, and the Valsalvian experiment soon relieved the pain in the uncovered one. Magnus also proved by an examination of ears when the pressure was being exerted, that the membrana tympani was actually pressed inward. The triangular spot was obliterated when the pressure was greatest and the pain severe. A patient without any membrana tympani, who was subjected to the condensed air, had no pain. Indeed, there was not a trace of an unpleasant sensation.

The membrana tympani undoubtedly owes much of its resisting power, as Mr. 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. My friend Dr. Robert F. Weir,‡ Surgeon to the New York Eye and Ear Infirmary, has seen four such cases. In one the

* Archiv für Ohrenheilkunde, Bd. I., p. 270.

† The effects of compressed air upon the hearing power will be again alluded to in the chapter on Chronic Non-suppurative Inflammation.

‡ Verbal communication.

drum-head was ruptured by a blow upon the head with the hand. In another, fragments of rock from a blast struck the head and ruptured the membrane. In the third case the injury was caused by a snow-ball striking the ear; and in the fourth a hair-pin was accidentally forced through the part. In the first three, of Dr. Weir's cases, the rupture was slit-shaped, parallel and posterior to the handle of the malleus.

I have now under my observation a gentleman of about fifty years of age, whose membrana tympani is said to have been ruptured when he was a small boy, by blows upon the side of his head, given by one of his teachers. The membrane is nearly entirely gone, and there is at times a purulent discharge from the tympanic cavity. Teachers and parents who have the bad habit of striking children unexpectedly to their little charges, should be warned of the danger of a box on the ear to the integrity of the organ.

The membrana tympani is sometimes ruptured in attempts to remove foreign bodies, such as inspissated cerumen, and so on, by means of a probe, as has been seen in one of the preceding chapters. The text-books of Toynbee and Von Tröltsch record several interesting cases of injury to the drum-head by mechanical violence. The latter author relates one in which a young man, while going up a ladder, accidentally struck his ear against a blade of straw, which passed through the membrane and caused the severest pain, so that he nearly fainted. In one of Toynbee's* cases the rupture was caused by an unexpected blow upon the ear of a boy by a tutor. In another case the ear was hit by a bolster while the boys were engaged in a playful contest. In both of these cases the rent was found to be on the lower part of the membrane.

Toynbee also relates a case which is of interest on account of the nervous symptoms produced by it. A young man of seventeen, while shooting, in endeavoring to force his way through a hedge, got a twig into the right auditory canal. It produced sudden and severe pain, followed by bleeding. Mr. Toynbee saw the patient a week afterward. The pain speedily subsided; but for days after the accident there was "a feeling

* Text-book, p. 28.

on the same side of the tongue as if something cold had been rubbed over it; the taste on that side also was impaired." The sensibility of the tongue to touch was, however, unimpaired.

The chorda tympani nerve was probably injured in this case; for the same sensations are sometimes caused when a bit of cotton or woolen is brought in contact with the cavity of the tympanum and with the nerve.

The function of the chorda tympani is probably chiefly in connection with that of taste, and not of hearing.

*Professor Flint** relates a case which sustains this view. A soldier received a gunshot wound, the ball passing through the head, entering just above the ala of the nose, on the left side, and emerging behind the mastoid process of the right temporal bone. The wound healed, with the usual symptoms of complete facial paralysis on the right side. The buccinator and orbicularis oculi were completely paralyzed. The hearing was perfect. The sense of taste was entirely abolished in the anterior portion of the tongue on the right side. These facts were verified by Professor Dalton of this city.

Experiments upon dogs and cats, and other animals, also show, according to Flint, that the chorda tympani influences taste; for sections of the root of the fifth pair, or of the chorda tympani, is followed by loss of taste in the anterior portion of the tongue.

The chorda tympani is given off from the facial, as it passes vertically downwards at the back of the tympanum, about a quarter of an inch before its exit from the stylo-mastoid foramen. It ascends from below upwards in a distinct canal, parallel with the aquæduct of Fallopius, and enters the cavity of the tympanum through an opening between the base of the pyramid and the attachment of the membrana tympani. It becomes covered by mucous membrane, and passes forward through the tympanic cavity between the handle of the malleus and the vertical crus of the incus (see Fig. 44, on p. 194), and then passes out of the cavity, through the canal of Hugier, at the inner side of the Glaserian fissure. It then passes downward, between the two pterygoid muscles, and meets the gustatory nerve at an acute angle, and communicating with this it passes to the submaxillary gland; after joining the submaxillary ganglion it terminates in the lingualis muscle.

Its anatomy seems to indicate that it has very little to do with the function of hearing. It merely passes through the tympanum, without supplying any of its tissues, as has already been described in the chapter on the anatomy of the middle ear.

Claude Bernard also performed experiments upon the chorda tympani of cats and Albino rats, by cutting out the facial nerve at its exit from the stylo-mastoid foramen. In from six to ten days the terminal twigs of the lingualis nerve, and the nerve fibres coming from the chorda tympani were found to

* The Physiology of Man, The Nervous System, p. 157.

have undergone fatty degeneration. Degenerated nerve fibres were also found in the tip of the tongue, but not in the papillæ. There were also degenerated nerve fibre in the submucous tissue.*

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, if not always, some pre-existing catarrh of the Eustachian tube and tympanic cavity. I have seen several such cases, but in all of them I have been able to trace disease of the middle ear 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.†

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 spontaneous origin.

A traumatic rupture of the membrana tympani, especially one arising from the perforation of the membrane by a sharp instrument, is much more apt to cicatrize promptly, without suppuration, than one that has been perforated in the course of inflammation of the middle ear.

The force of large waves upon the side of the head in sea-

* Monatsschrift für Ohrenheilkunde, No. 1, 1873, from Comptes Rendus, Hebdom. des Seances de l'Academie des Sciences, T. lxxv., No. 27. Paris, 1872.

† 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, Wiener Med. Wochenschrift, Nos. 35, 36, 1872.

bathing, is not an uncommon cause of rupture of the membrana tympani. I have seen such cases, and one where both membranes were ruptured. A wave is sometimes allowed to strike upon the membrane with great violence, and if it do not break it, it will at least excite an inflammatory action. Physicians who practice at the sea-side, should warn their patients of this danger from surf-bathing. Long Branch and Newport, furnish every year a certain contingent of aural patients from this cause.

A little care in not allowing the waves to strike the side of the head in full force, or plugging the meatus lightly with cotton, will be found to be a sufficient protection from the severity of the waves. If water be allowed to stay in the auditory canal for some time, it becomes a source of congestion; but such causes of diseases of the middle ear are more appropriately considered in a subsequent chapter.

Dr. C. H. Burnet,* of Philadelphia, has lately 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 39 years old, and consulted Dr. Burnet 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. Burnet. A watch that should have been heard 40 feet was only heard 5cm. The tuning-fork placed on the vertex was heard very distinctly in the injured ear.

On examination, Dr. Burnet found the meatus uninjured. A small piece of mud was 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

* Transactions of the American Otological Society, 1872.

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 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.

The explosion of a bag of gas near the ear, may also cause a rupture of the membrana tympani. *Dr. J. Orne Green*,* of Boston, reports such a case. 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 towards 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 $1\frac{1}{2}$ lines long, nearly perpendicular, through which purulent matter could be forced by Valsalva's method of inflation. H. D. $\frac{6}{48}$.

Dr. Green states that this patient had previously suffered from impaired hearing and mucous rales in his ears. Many of the cases of rupture of the drum-head on record, if the antecedents had been inquired into, would undoubtedly exhibit the same condition of things.

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. He was treated by Dr. Henry L. Shaw of Boston. In both of these cases the rupture healed perfectly, and the hearing power was partially restored. In Dr. Green's case it became $\frac{8}{48}$.

Dr. Green saw two other cases in which the patients suffered from the concussion of the same accident. It caused a loud buzzing in the ear and confusion in the head. The

* Transactions of the American Otological Society, 1872.

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.*

Fracture of the base of the brain involving the temporal bone, very often produces rupture of the membrana tympani and consequent hemorrhage from the ears; but a consideration of such cases belongs to the province of general surgery.

Prognosis.—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 concussion of the labyrinth, or a fracture or dislocation of the ossicula, 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, 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, however, and become chronic, when the treatment should be the same as that of any other similar affection arising spontaneously.

Treatment.—We can do very little indeed, in the way of treatment, if no inflammatory symptoms, such as pain or swelling, occur. Above all, we should not disturb the ear immediately after the occurrence of the injury, as is sometimes mis-

* Dr. Green records several other cases of injury of the side of the head which produced a rupture of the membrana tympani, but as they do not differ from others that are noticed in this chapter, I beg to refer my readers who may wish to carry this subject farther, to his interesting paper

takenly done, by syringing it. There is a very prevalent disposition in the profession, to syringe the ear in every case of aural disease that presents itself; but no ear should be syringed without a good and sufficient reason. When inflammatory symptoms occur, they should be treated by leeches, the warm douche, and by the other means that will be detailed in the chapter on Acute Inflammation of the Middle Ear. Meanwhile the ear should be protected from the cold air, by a bit of cotton placed in the meatus, and the patient should be kept under careful but not meddlesome observation.

FRACTURE OF THE HANDLE OF THE MALLEUS.

This rare accident has been described by Menière, Von Tröltsch, and Weir.* The history of the case of the second-named author is as follows: A man accidentally thrust a pen-handle which he held in his hand into his ear, in consequence of knocking his elbow against a door. The severe pain caused him to faint. After he recovered, he found that he heard badly from the injured ear, and he suffered from tinnitus of that side. Von Tröltsch saw the case a year after, and from the peculiar slanting position of the handle of the malleus, and from the fact that it was uncommonly thick under the short process, he diagnosticated a united fracture of the manubrium.

Hyrtl, is quoted by Von Tröltsch, as having described such a united fracture in the malleus of a prairie dog. This fracture was also situated just under the neck of the malleus. The membrana tympani of this animal is, according to Hyrtl, very superficially situated.

Dr. Weir's case is one of ununited fracture.† A man, aged 32, came to Dr. Weir's clinique, at the New York Eye and Ear Infirmary, on May 11, 1867, and gave the following history: Four months previously he fell into an open areaway, a distance of about fifteen feet. He became unconscious, and remained so for nearly sixteen hours. He had been informed that his right ear bled for about an hour.

* Von Tröltsch on the Ear, 2d American Edition, p. 151.

† Transactions American Otological Society.

Upon returning to consciousness he felt a severe pain from the right ear, across the forehead to the other ear. The pain lasted for nearly a month, and gradually diminished; but the great tinnitus, which date from the time of the injury, continue unabated. There was no history of any foreign body having entered the ear. The watch was heard upon the affected side when pressed firmly upon the ear.

The drum membrane was normal in color; but there was an irregularity in the handle of the malleus. The bone was found to be fractured a short distance below the short process, presenting the appearance shown in the engraving. The broken ends of the bone were completely and transversely displaced.

FIG. 56.

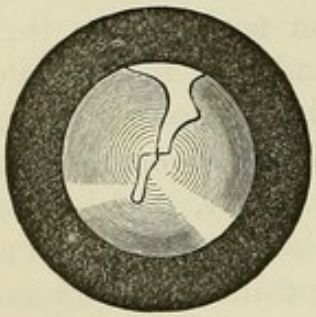
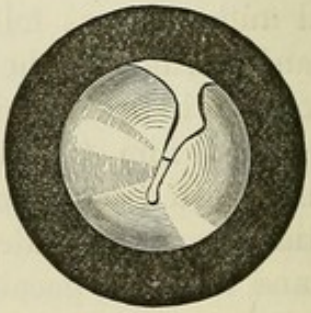


FIG. 57.



When Dr. Weir caused the patient to perform the Valsalvian experiment, the fragments came into apposition, and the line of the bone became regular; but the posterior portion of the membrana tympani projected unduly forward from want of support. In a few moments the displacement recurred, with corresponding sinking of the posterior of the drum membrane. Dr. Weir's colleagues—Drs. Hackley and Simrock—thought that a faint whitish line, posterior to the malleus, might be a cicatrix from a laceration of the drum-head. The patient did not return to the Infirmary.

CHAPTER XI.

ACUTE CATARRHAL INFLAMMATION OF THE MIDDLE EAR.

THE nomenclature that I have adopted in lecturing upon the affections of the middle ear, and the one which I regard as most in accordance with the anatomy and pathology of this part of the organ of hearing, may be tabulated as follows:

I.—Acute catarrhal inflammation.
II.—Subacute catarrhal inflammation.
III.—Chronic non-suppurative inflammation, divided into two forms—catarrhal and proliferous.
IV.—Acute suppurative inflammation.
V.—Chronic suppurative inflammation.
VI.—The consequences of chronic suppuration:

1. Polypi.
2. Exostoses.
3. Mastoid disease.
4. Caries and necrosis.
5. Cerebral abscess.
6. Pyæmia.
7. Paralysis.

By such a classification as this, especially that relating to the suppurative affections, correct notions are formed as to the nature of such diseases as polypi and mastoid disease, which is otherwise difficult. Polypi and exostoses have hitherto been classified under the diseases of the external auditory canal. They are certainly, in most cases, situated in this part; but this is their chief claim to such a classification. In by far the greater number of cases they are the direct result of inflammation of the middle ear.

If we were to form our estimate of the frequency of acute catarrhal inflammation of the middle ear from the number of

cases that occur in the statistics of writers on diseases of the ear, we should come to a very erroneous conclusion as to the number of people who suffer from this affection. It is indeed a very common one. It is difficult to find an adult who has not at one time or another suffered from "ear-ache." Ear-ache is the popular name for acute catarrh of the middle ear. My own statistics show that of 994 cases of aural disease seen in private practice, only 55, or a little more than five in a hundred, belonged to the class now under consideration. The tables of other writers show about the same relative frequency. That this disproportion does not arise from an actual rarity of the affection, I think a little thought will show. Such painful affections very often never reach a practitioner, and are treated at home, a fact which accounts for their infrequency in statistical tables.

Every physician will at once recall the fact, that it is often incidentally mentioned, when perhaps he is visiting a family suffering from other diseases, that Johnny or Mary have had a severe ear-ache all night, and that there has been great difficulty in quieting the fearful pain. Very often, indeed, the fact will be added, that the pain is not yet subdued, and that the family have quite exhausted the means at their disposal for relieving it; and yet, taught by tradition and experience, they do not expect anything from the physician, whose aid becomes so efficacious for the pain of colic or of peritonitis. It is to be feared that many physicians stand helplessly by, and allow an acute catarrh of the middle ear to run on to suppuration of the drum-head, or, worse still, to periostitis of the mastoid or to meningitis, without an attempt at interference.

A little later, in the discussion of this affection, we shall discover, I think, that the means at our disposal for its relief are ample, and that they have what may almost be termed a brilliant effect, when properly used; but I wish in the outset to impress upon the minds of my readers the fact that the commonly neglected ear-ache of the household is identical with the disease known as acute catarrhal inflammation of the middle ear. It will then be evident that we are dealing with an extremely practical subject, and one on which every family practitioner is, or should be, very much interested.

The symptoms of this affection are so characteristic that in the adult, they point unmistakably in the most cases to its seat. I say in the adult, for in young children who have not yet learned to speak, the diagnosis sometimes becomes very difficult, and it is not always possible.

Symptoms.—The symptoms of acute catarrh may be enumerated in the following order:

Subjective.

1. Pain, referred to the depth of the ear.
2. A sense of fulness in the same part.
3. Noises in the ear.

Objective.

1. Vascular injection.
2. Bulging outwards of the membrana tympani.
3. Impairment of hearing.
4. Catarrh of the pharynx and Eustachian tubes.
5. Fever.

The 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 causes 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 trouble. Sometimes, however, patients with good habits of observation notice that the pharynx felt thickened and full, and that the throat was sore, a short time before the pain in the ear began. I am inclined to believe that the most patients are aware of what, for the want of a better name, may be termed a thickness of hearing, a fullness 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 the most cases, unless at once arrested, into acute suppuration of the middle ear; a disease which, strangely enough, some practitioners seem to invite, by the

remark which they make, "It is a common gathering of the ear, from which we shall get no relief until suppuration is established." I intend to combat this idea in the discussion of the treatment. It is certainly an erroneous and mischievous view of a serious disease.

The sensations 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 may last for some days after the pain has passed away.

As I have said, the 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 in the ear, 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. Besides this, the physiological process of teething, is often credited with a great deal of pain, which more properly belongs to the ear. With a certain style of what may be called easy going practitioners, 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.

The instillation of warm water into the auditory canal will usually temporarily relieve an infantile ear-ache; and in this procedure we have a means of diagnosis which is always at hand. I have seen children who were crying with pain from inflammation of the middle ear, go to sleep in a few moments after the instillation of warm water into the meatus. Sometimes, however, this procedure will fail to give relief, and we must depend upon the objective symptoms, of which I shall soon speak, found in the color of the membrana tympani.

Adults sometimes mistake the pain from inflammation of

the lining membrane of the middle ear, for what is termed neuralgia. I have seen cases where an anti-neuralgic treatment by means of quinine and opium, had been tried in vain for a disease which was really a true inflammation of 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 5th and 7th nerves.

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 of their normal 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.

I think there is always some 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 the infants. 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 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. I have known many instances where the acuteness of hearing was found on accurate examination to be markedly increased in cases of chronic aural catarrh, in which an acute inflammation had supervened. It may be increased also in acute cases occurring in persons whose ears have been previously healthy; that is to say, sounds may seem very loud to them.

I will not attempt any explanation of the phenomenon, but be content with noting the fact.

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, I have most frequently observed in the posterior and inferior quadrant, but also in Shrapnell's membrane, and usually in the posterior portion of the 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—I believe I have seen but two in my experience—the imperforate membrana tympani will be found to pulsate synchronously with the pulsations 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 when this occurs, from the pressure of the blood column or of mucus behind it. 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.

Febrile symptoms are almost always present in cases of the disease under discussion. The temperature is usually quite considerably increased, so that the general aspect of the patient, suffering from great local pain, impairment of hearing, and a dry, heated skin, is one of intense suffering. Yet this is the disease which many physicians allow to run its course, without any of the antiphlogistic treatment that they would at once resort to, were any other organ of the body similarly attacked.

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 ear-ache. 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. 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 consequence. 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, I have found no pathognomic evidences of syphilis in the character of the pain or the appearance of the membrana tympani in such cases.

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 we have seen that 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 I first showed in an article in the Archives of Ophthalmology and Otology.* My experience has since been confirmed by many other observers.

In the description of the treatment of the pharynx and nares in the course of chronic aural inflammation, the subject of the use of the nasal douche will be more fully discussed.

* Archives of Ophthalmology and Otology, vol. i., No. 1.

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 and opium. A nervous pain in the ear, a true otalgia, is a rare disease. In fifteen hundred cases, I have seen but one such affection, and 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 pre-eminently 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 ear-ache. Some of these agents are of a 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 Harlem oil, Cologne water, ether, and all stimulating applications. Poultices are remedies often used; but while they generally quiet 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, unless other means cannot be employed, or when the latter prove ineffectual. In some cases, however, the urgency of the pain will demand that poultices be employed. 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.

I would place local blood-letting as the chief and first remedy in acute aural catarrh. This blood-letting should be performed by means of leeches applied to the tragus, and not to the mastoid process. Wilde, and Von Tröltsch, have taught the profession that this is the best point for the application of leeches in inflammation of the ears, and the reasons 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 six 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. I have seen almost magical effects from their use. One of the most striking of the cases in my note-book is the following: I 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. I found the symptoms of acute aural catarrh, in a reddened but intact drum membrane, congested pharynx, and so forth. When I entered the room he seemed to be in mortal agony. He said that he had not slept for forty-eight hours, and his anxious countenance verified his assertion. I at once sent out for some leeches, and caused one to be applied to each ear, and before they had dropped from the tragus he 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.

Leeches are, however, a troublesome remedy, and in country districts they are not always to be had. In their absence I place the use of warm water as next in efficiency. This should be poured continuously into the ear, and not used by means of a syringe, as I have known patients to employ the water when told to pour warm water into the ear. Clarke's aural douche (see illustration on page 124) is the best means of which I know for applying warm water to the ear. Sometimes the warm water is unpleasant, instead of grateful, to the patient, and then the vapor of water or the smoke from a cigar or pipe may be conducted into the ear. Children may sometimes be relieved from a commencing 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, or Hourteloupe's artificial leech may be applied.

Poultices, as I have said, are only to be used as a last resort. Then they should be made small enough to be put in the canal, with only a slight covering of the auricle, but a denser one over the mastoid; and their use should be given up as soon as the inflammation has abated.

If the patient or his friends are told to apply the 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 do no good. I have quite often found, that a neglect to state just where the leeches should be applied, has caused all the efforts to relieve pain to be of no value.

Rohland's styptic cotton—a preparation of cotton in a solution of alum—prepared by Dr. Rohland of this city, will be found a very efficient means of arresting the hemorrhage from a leech bite. The bleeding should, however, usually be encouraged, by the use of warm compresses, for an hour after the leech has dropped from the ear.

Paracentesis of the drum membrane is a very efficient remedy at times, 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, of Halle, taught us the value of this means of treatment in acute cases, and I have found it of great value. I would even pass a cataract needle 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. I have done so with striking effect in some cases. Yet leeches and warm water, if promptly 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 is used in the operation of discision of a soft cataract, is the one I employ. The point of opening should be determined by the seat of the greatest amount of bulging, which I have found to be in Shrapnell's membrane, and in the posterior and inferior quadrant of the membrane. The operation causes so little pain,

that this element does not enter into the consideration of the surgeon. I have found the light of a candle about the best and most convenient source of illumination, when the operation is to be done in a sick room, and the patient is in bed. An instrument with an angular handle has some advantages when the operation is to be done for chronic inflammation, and we desire to make a larger opening; but for acute cases a thorough puncture, through which the blood, mucus, or pus can be drawn, is usually an opening large enough to relieve pain. I have more frequently performed the operation in cases where the severity of the pain has passed, and yet I have also performed it with the happiest of immediate results when the patient was at the height of distress.

If we find on examination that the mastoid region is red, hot, tender, and swelled, it will be necessary to make an incision through its tissues down to the periosteum; but it is only very rarely that this is the case in acute aural catarrh. Such a state of things is more apt to be found in subacute suppuration, or as a result of chronic suppuration, under which heads the subject will be fully discussed.

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 may be enveloped in a warm-water poultice.

The Eustachian catheter, and Politzer's method of inflating the middle ear, should be used as soon as the acute symptoms have subsided, say in twenty-four hours. If employed with gentleness, there need be no fear of aggravating the subdued inflammation into a relapse.

The hearing should be accurately tested by means of the watch and tuning-fork, in order to see, after the pain has subsided, if any impairment has occurred. If only one ear be affected, careless patients will believe that the hearing is perfectly good, after the pain and fulness have passed away; but the physician should be sure of this for himself. In half-treated acute catarrh are laid the foundations for that insidious and obstinate disease, chronic non-suppurative inflammation of the middle ear.

While this energetic local treatment is carried on, the attention of the physician should be turned to the general system. It will often be necessary to give a full dose of opium or morphine at bed-time. It is somewhat remarkable, however, that opium has very little effect, when used without local depletion, to quiet the pain from aural inflammation. Very large doses will be taken in vain, unless the local means that have been described are also employed.

The patient should be kept in the house, and in a well-warmed room, during the stage of pain and fever. Pediluvia and diaphoretics are hardly necessary in case the pain is once subdued. The diet should be nourishing. The patient should be enjoined to keep his skin in good order by means of frequent bathing, in order to prevent relapses. The improper habits of life, or the exposures to cold, that have induced this attack, should be carefully sought out, in order that future ones may be avoided.

The practitioner who, while treating a grave constitutional disease, finds this local inflammation breaking out, should by no means allow the severity or danger of the constitutional symptoms to prevent him from the proper treatment of the acute aural catarrh. The local and constitutional treatment can well go on together; while the neglect of the ear at the proper time may lead to irreparable damage not only to the health and prosperity of the patient, but it may destroy his life.

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. It is to be hoped that the neglect of treatment of the ear will not prevail in the next generation to the extent that it does in ours.

The practitioner who looks through the generally excellent

works on the diseases of children, will be painfully impressed with the fact, that very little attention is given to the common complications of infantile diseases with acute catarrh and suppuration in the ear.

The course of a case of acute aural catarrh, promptly treated in the manner that has been outlined, usually ends in complete recovery, with integrity of the structure and functions 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. My published cases show that fifty of the fifty-nine cases that were recorded recovered; while it is probable that some of the remaining nine did also, although I have no notes to show this.

Two died. In one of the cases there were constitutional symptoms, as I was informed, of fever, and the acute aural catarrh may be said to have been incidental to typhoid fever. The other case of death was a case of mastoid disease, and the patient died of disease of the brain. It will be referred to in the chapter on the affections of the mastoid.

SUB-ACUTE CATARRH OF THE MIDDLE EAR.

There is a variety of catarrh of the middle ear which is very common in young persons and in children, that hardly demands a separate chapter for its proper consideration, but 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. I have ventured to term this affection sub-acute 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. While this view may not be strictly incorrect—for the affection that I am about to describe, may last for months, and run into the strictly chronic form—it has, in my opinion, more of the characteristics of acute catarrh in its nature, and in its readiness to yield to treatment, than of chronic inflammation.

Symptoms.—The subjective symptoms of sub-acute 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, and may not, be impaired. I have seen many such cases 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. 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 experiments of Magnus, which have been described in the tenth chapter, show that any excessive pressure which pushes the drum-head inwards lessens, or if the pressure be great enough, obliterates, the light spot. 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 towards the speaker, is heard.

This impairment of hearing 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 believe that children do not 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 readily when addressed, should be at once carefully examined as to its hearing power, and not scolded for absent-mindedness.

Treatment.—It is apt 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 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, will perhaps in time allow Nature to relieve these cases; but the impairment of hearing, which is the most striking and most troublesome symptom, will be the last one relieved, and it may not be relieved at all, and the patient grow up to be permanently hard of hearing. We have at our hands, however, in Politzer's mode of inflating the ears—a method of treatment that has been fully described on page 98—a means of instantly improving the hearing, and thus of removing the most embarrassing symptom 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 I prefer this method, which is Mr. James Hinton's adaptation of Politzer's principle.

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 caliber of the tube and the tympanic cavity by mucus. Structural changes, such as thickening of the mucous membrane, bands of adhesions, have not occurred. Hence I would not class these cases among those of chronic catarrhal inflammation.

I append three cases, two of which have been before published;* but I have been able to follow them up, and note that the recovery was perfect. I again publish them, with an additional one of the same character. The cases are very common, and it is not therefore for their rarity that they are inserted, but that they may perhaps teach how much may be done to instantly relieve this form of disease. The practitioner who ignores the ear will certainly pass by, among these cases, many which, if properly examined and treated, would add very much to his reputation, and increase his power of doing good.

CASES.

Case I.—F. S. B., aged 16, N. Y., Sept. 1, 1865. Has been deaf at times for a number of years, and for the last summer persistently so. His general condition is fair; is well developed. The tonsils had been so much hypertrophied as to impede respiration; but they were removed previous to his coming under my observation. The pharynx secretes excessively, as well as the nasal mucous membrane. There are numerous granulations scattered over the pharynx. The membranæ tympani are pinkish, brilliant in appearance. The light spot is elongated. The watch is heard about six inches from each auricle.

Politzer's method was practised three or four times, when the hearing distance extended to sixteen inches on the right side, and ten on the left. A gargle containing iodine and brandy was ordered to be used twice a day. He was also to practise Politzer's method twice a week, in connection with the iodine inhaler. The patient continued to improve, and at the present writing, April 20, 1866, the treatment has been abandoned, the hearing power being nearly, if not quite normal. The patient goes to school every day. He was seen by me for some weeks once a week, while his father, who is a distinguished physician of this city, carried out the treatment at home, which consisted in the use of the gargle, inflating the middle ear by Politzer's method once in three or four days, with attention to the general health. 1872. The patient is now a young man in college, and has no trouble on account of his hearing.

* American Journal of the Medical Sciences, vol. vii., p. 64.

CASE II.—Girl, aged 16, at Eye and Ear Clinic in University Medical College, March 28, 1866. Has not heard ordinary conversation for years, and has been very much embarrassed in swallowing and breathing, on account of enlarged tonsils; general condition is fair; the voice is extremely nasal; only hears when addressed in a loud tone of voice; the watch is heard two inches on the right side, one inch on the left; membranæ tympani present nothing striking in appearance, except that they are quite brilliant; the tonsils are excessively hypertrophied. The use of Politzer's method immediately improved the hearing somewhat, which improvement lasted, according to the patient's statement, about a day. When next seen, the tonsils were excised with the forceps and scissors, a long outgrowth being dragged down from behind the soft palate on the right side, which must have pressed upon the orifice of the Eustachian tube, and then the iodized air was driven into the tube. The hearing distance became two feet on the right side, and about six inches on the left. An iodine gargle was ordered, with cod-liver oil, a half tablespoonful to be taken three times a day. The patient is now under treatment, and still (April 26, 1866) continues to improve, hearing very well, with no trouble in respiration. 1872. I have seen this patient several times since, on account of naso-pharyngeal catarrh, and her recovery of hearing proves to be permanent.

CASE III.—Master —— (sent to me by Prof. Fordyce Barker, Jan. 21, 1873), æt. 14. This boy has had "a cold," and has been very hard of hearing for some weeks. He is in excellent general health. The membranæ tympani present nothing particularly abnormal. The pharynx and nostrils are secreting excessively. Hearing distance—right ear, $\frac{2}{48}$; left ear, the watch is only heard when laid on the auricle. He was seen every other day for three weeks, when the Eustachian catheter and Politzer's method were used, while a gargle of chlorate of potash was employed at home. At the first sitting his hearing distance was brought up to $\frac{10}{48}$ R. E., $\frac{2}{48}$ left, so that conversation was heard with much more ease, and when his hearing power became $\frac{30}{48}$ on each side, and was still improving, he was allowed to return to his school.

The use of the catheter when the patients will submit to it, and nearly all except 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 makes, some air will enter the tube. It is highly probable that infants sometimes suffer from sub-acute catarrh, which if not relieved by local treatment passes on to a chronic process, which end 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 a nasal 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.

OTITIS MEDIA HEMORRHAGICA.

I have seen and reported * two cases of acute aural catarrh which had an unusual course and termination—that is to say, the course was very acute and terminated rapidly in perforation of the membrana tympani without suppuration, but with quite an abundant hemorrhage through the drum-head. It is well established that hemorrhage 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 I am about to describe certainly do not come under the classification of hemorrhage from blood-vessels made atheromatous by renal disease. They are, I think, to be considered as cases of acute inflammation of the lining membrane of the middle ear, in which the morbid process has an unusually 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 that 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. I think these cases are analogous to those which I am about to record, and that they serve to explain them.

Case I.—The first case that directed my attention to hemorrhage through the membrana tympani, as a consequence of acute inflammation of the middle ear, was that of a young lady, of rather delicate organization, who was under the care of Drs. Agnew and Loring. The case was seen in consultation with the

* Transactions of the American Otological Society, 1872.

latter-named gentleman, who gave me the history. The patient was deaf from what seemed to be hypertrophy of the membrane lining the drum cavity; the membrana tympani was thickened, sunken, and immovable; she was treated in the usual manner, *i. e.*, the catheter and Politzer's method were employed, and the attempt made by them to force the drum-head outward. On the day or day before I saw the patient, and about twenty-four hours after the catheter and Politzer's method were used, she was seized with violent pain referred to the depth of the ear; to relieve this, paregoric was dropped into the ear. Dr. Loring and I saw the patient in the evening; the pain had then somewhat abated. On examination, I found, after carefully removing the fluid that had been dropped in, that the membrana tympani was ruptured, and that blood was issuing from the *pulsating* opening. The patient recovered after an erysipelatous inflammation of the auditory canal and side of the face. I did not see her again, but Dr. Agnew examined the membrane in a few days, and could find no rupture, and no trace of it.

I might, perhaps, be slightly in doubt as to the occurrence of a rupture and hemorrhage from the membrane in this case, had I not seen one subsequently which was very similar, and where, as in this case, *no suppuration* occurred after the rupture, and consequently no scar remained. The presence of the paregoric rendered it somewhat difficult to determine whether the fluid in the rupture was blood or not; but I took this fully into consideration, and determined that it was.

Case II.—This occurred in a gentleman in good health, of forty-seven years of age. He smoked excessively, but in other respects his habits were good. He had chronic pharyngeal catarrh, but it troubled him very little. He did not remember that he had ever had ear-ache as a child or adult. I saw him on November 7, 1871. His history was as follows: About ten o'clock to-day, he suddenly experienced a severe pain in his right ear. The pain was so acute that the patient was obliged to leave his business and go home. The treatment consisted in the instillation of sweet oil and tincture of opium. There was no relief, however, until about six P. M., when "a loud report occurred in his head," and quite a free hemorrhage occurred. The patient thought more than a teaspoonful of blood escaped. I saw him a few moments after the hemorrhage had occurred. The pain had entirely subsided; the membrana tympani was perforated in the anterior and inferior quadrant, and a small quantity of dark-colored blood was about and in the opening, while the membrane was pulsating as in the former case, or rather the blood column was pulsating in the cavity of the tympanum. This patient fully recovered without any suppuration whatever. The opening healed, and the hearing, which was reduced to such an amount as to be expressed by the fraction $\frac{1}{36}$, was restored to a normal standard. The treatment consisted in the careful use of an injection of tepid water, just after the occurrence of the rupture, with the subsequent use of the Eustachian catheter, through which air was introduced, and Politzer's method of inflating the drum-head.

The history of these two cases, as well as of those cases of paracentesis of the membrana tympani where blood only

escaped, indicates that *otitis media hemorrhagica* is a much more tractable form of middle-ear inflammation than true catarrhal, or suppurative inflammation. They serve to strengthen the indications for an early perforation of the drum-head when accumulations occur in the tympanic cavity.

AURAL HEMORRHAGE IN THE COURSE OF BRIGHT'S DISEASE.

There will, perhaps, be no better opportunity than the present of alluding to those hemorrhages from the tympanic vessels that occasionally occur in Bright's disease. Schwartze reported such a case* in 1869.

The patient was a non-commissioned officer, of twenty-five years of age, who suffered from albuminuria, with retinal hemorrhages. There was also enlargement of the liver and spleen, and infiltration of the lungs. On the 16th January, 1868, he suddenly complained of pain in his right ear, which had been previously sound. When Dr. Schwartze saw the patient some hours after, the membrana tympani was of a bluish-red color and devoid of concavity. Some leeches were applied, but they did very little good. The next day the membrane was of a dark-red color, so that an extravasation of blood into the cavity of the tympanum was plainly evident. On the 19th there was an abundant serous discharge, and when the ear was cleansed by a syringe, a small blood coagulum was removed. Anteriorly and below there was a perforation in the membrana tympani about as large as the head of a pin. In the afternoon a whitish mass came out of the ear, in the water that was instilled every ten minutes. This mass, which looked like a fibrous coagulum, was one and a half inches long, and two lines broad, and one-half a line thick. On the 20th another similar mass came out, and on the 22d the patient died. The discharge from the ear had then become purulent.

The microscopic examination of the mass removed, when it was not quite fresh, showed an extremely fine granular material, mixed with numerous scales of epithelium. The post-mortem examination was made on the 23d January. There was great hypertrophy and dilatation of the left ventricle. Both kidneys were atrophied. The lungs and spleen enlarged. Pneumonia of both lungs. Retinitis apoplectica, with retinal detachment on both sides.

EARS.—Hemorrhagic inflammation of the membrane lining the right cavity of the tympanum; cavity of the tympanum filled with bloody purulent fluid. Membrana tympani greatly reddened and swelled, covered by a thin layer of pus, and perforated as before stated. The mucous membrane of the Eustachian tube was also injected, but not so markedly as the tympanic cavity. No affection of the labyrinth.

In the left ear, of which the patient did not complain during life, the cav-

* Archiv für Ohrenheilkunde, Bd. IV., p. 12.

ity of the tympanum was also filled with a bloody serous fluid; but there was no inflammation of the lining membrane. There were small ecchymoses on the mucous membrane of the naso-pharyngeal space. The mucous membrane of the tube was injected, and mostly so at the faucial orifice of the tube.

In the same year that Schwartze published his case, my friend Dr. Gouverneur M. Smith read a paper before the Academy of Medicine,* in which he called attention to the fact that impairment of hearing was at times one of the symptoms of Bright's disease, and a symptom that could not be explained by referring it to uræmia. The author once treated a case of obstinate suppuration in the middle ear, in a man of 61 years of age, who, although suffering from Bright's disease, of which he died, complained chiefly of neuralgic pains referred to his suppurating ear, for three or four months prior to his death. I have now no doubt that the renal disease, by its effect upon the tympanic vessels, was the cause of the acute suppuration in the ear, and that if I had seen the case when the rupture of the drum-head occurred, that I would have found it hemorrhagic in its nature.

The subject is clearly of enough importance, to lead us to be on our guard for renal disease in cases of hemorrhage into the tympanic cavity, or even in cases of severe pain in the ear, occurring in persons who seem to have any disposition to kidney disease.

* On the Etiology of Bright's Disease, with Remarks on the Prophylaxis. Transactions of the New York Academy of Medicine, vol. iii.

NOTE.—Since the publication of the author's cases of Otitis Media Hemorrhagica, Dr Mathewson of Brooklyn, and Dr. Hackley of New York, have also observed and reported at a meeting of the New York Ophthalmological Society, cases of acute inflammation of the middle ear, in which hemorrhage occurred through the membrana tympani before any pus appeared. Their course was quite similar to that of those related on pages 255 and 256. Dr. Hackley's case occurred in a young woman who had just passed through the menstrual period, and the menses reappeared after the aural hemorrhage ceased.

CHAPTER XII.

CHRONIC NON-SUPPURATIVE INFLAMMATION OF THE MIDDLE EAR.

Both in the ranks of the laity and the profession, the treatment of aural diseases has of old been stigmatized as unsuccessful and unsatisfactory. Carefully made observations of the results of rational and scientific practice, in a large number of cases, have shown that this reproach can only with justice, if at all, be applied to two classes of the affections of the ear. Nearly all the others are singularly tractable when their course is properly regulated. By these two classes, I mean chronic non-suppurative inflammation of the middle ear, and the affections of the labyrinth, or internal ear. In recent times the generic term, chronic catarrhal inflammation of the middle ear, is usually employed to designate the former variety of disease.

I shall soon find fault with the indiscriminate use of this name, but for the present we may allow it to stand, as giving a pretty clear idea of the affections arranged under it. Statistics show that, of every thousand cases of aural disease, that present themselves in private practice, a little more than one-half are chronic non-suppurative inflammations of the middle ear.* The disease is called chronic because, when it first comes to professional notice, it has usually already existed for months and years, and because, if unchecked, it advances with destructive progress as long as life lasts. Although the disease often does its work of impairing or destroying the function of hearing, with but few of the subjective evidences of

* New York Medical Journal, August, 1869. Transactions Medical Society State of New York, 1871.

what is called inflammation—there may be no heat, redness, or pain—we find many of the other marks of diseased action, in swelling, thickening, adhesions, 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. It is the same disease which Sir William Wilde understood, but which, as it seems to me, he inappropriately called chronic myringitis, or inflammation of the drum-head. But the drum-head is only one of other parts that is affected in this disease, and may, perhaps, be scarcely at all injured, while the most important changes in structure and function have occurred in other parts of the middle ear. In common speech—and I do not mean by this, among the laity, but in the profession—many of the forms of chronic catarrh of the middle ear have been, from time immemorial, classified as nervous. The great author whom I have just quoted, did much to combat this error—an error which not only kept back the growth of the science of otology, because it retarded the conception of a successful plan of treatment, but which also assisted to deepen the reproach which for centuries has rendered aural disease the *bête noir* of medical practice.

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 value 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 "*Krankheitsbild*"—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 as a rule to the notice of the practitioner of modern otology only when the disease is far advanced.

The following table shows this:

Cases of Chronic Non-suppurative Inflammation.—Whole number, 525.

No. of cases of	80 years' standing	1
"	over 40 years' standing	6
"	over 20 " "	40
"	between 10 and 20 years' standing	133
"	" 5 and 10 "	141
"	" 3 and 5 "	75
"	" 1 and 3 "	74
"	one year	42
"	less than one year	13
	Whole number	525

These are the cases of this disease that I have recorded, in private practice. It will be seen that 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.

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, as I have seen by frequent examples, may lose very much of their hearing power before they are at all aware of it. Then, again, the lower 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.

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 at a very late stage of their trouble. Be all this as it may, we now have tolerably accurate means of diagnosticating, and fairly successful means of treating those affections, and it is in the light of these recent advances that we are now able to speak.

First, as to the nomenclature. I have never been fully satisfied with the nomenclature of Von Tröltsch, vast improvement as it was on those classifications which had preceded it. Some of them were crude, others fanciful and altogether too refined. Von Tröltsch classified all non-suppurative disease as catarrhal, and then separated those in which the catarrhal symptom—excess of secretion—was not very marked, by placing them under the head of sclerosis or hardening or rigidity of the mucous membrane. 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, I felt that aural catarrh was a meagre and incorrect name with which to describe such a state of things. The very name "catarrh," as applied to 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 has made a division in his text-book, and describes an *otitis media hypertrophica*, or plastic inflammation; but I think his own 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.

The nomenclature of the author is founded on his own clinical experience, and upon the reports of the pathology of this class of cases that have been made by Toynbee and others.

Chronic non-suppurative inflammations of the middle ear may be divided into two great classes,

Catarrhal,
Proliferous.

I choose the translation of the German word *Wucherung* as furnishing the best adjective to describe the changes in the middle ear, of which I am to speak; and in what I have to say I shall attempt to be guided by these divisions.

Some authors and practitioners would admit another classification, based upon the parts involved, and speak of chronic myringitis, or chronic inflammation of the membrana tympani, and of chronic catarrh of the Eustachian tube. Whatever we may believe of acute inflammation of these parts, I can scarcely accept 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 leads, as I believe, 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 so much for what they do to the tube, but 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, I do not see how we can with propriety 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. No time need be spent upon this question, which may, perhaps, seem to some a comparatively unimportant one, had not incorrect notions in the past led to an incorrect style of treatment. 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 substituted for the catheter, when its true place, valuable and indispensable as it is, except in the case of very young children, is as an adjuvant to that instrument.

SUBJECTIVE SYMPTOMS OF CHRONIC CATARRHAL INFLAMMATION.

I think we may assume, from the history of cases, that this form of disease is either a consequent 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. 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 perfect ear, it is only under peculiar circumstances, certainly not in ordinary conversation, in front of the patient, will a person 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, and I believe, 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 of which these patients speak, 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 cerebral disease. When vertigo occurs in aural disease, it is a consequence of increased pressure upon the labyrinth through the fenestra ovalis. 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. There are many cases in my note-book which illustrate this, but none more striking than the following:

A physician consulted me last winter on account of impairment of hearing in one ear, accompanied by a tendency to topple over on that side, which he said was a consequence of being thrown from his sleigh some months before, when he suffered a concussion of the brain. He was quite disposed to regard the tendency to fall over as a cerebral lesion, but the use of the Eustachian catheter, and Politzer's method of inflating the ear, not only improved the hearing, but took away the unpleasant sensation. Physician as he was, he was at first disposed to smile at the idea of using local means to ameliorate this brain-symptom; but he has continued to be perfectly relieved from his cerebral malady up to this time, nearly a year since he consulted me.

I have often heard patients describe the feeling of fulness in the ears as a sensation as if 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. Very many times, after I have examined a patient suffering from chronic disease of the middle ear, I have been

asked to look again to see whether I could not find some hardened wax; and on one occasion a poor fellow, who I suppose was, to a certain extent, insane, grew very angry and called me hard names, because I would not remove wax which he knew was in his ear.

Von Tröltsch* 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 a rapid and complete recovery from the mental affection, after the cerumen was removed. It is the opinion of Schwartze,† of Halle, a very careful and competent observer, 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 who suffer from aural disease distinguish its tinnitus from these illusions or hallucinations.

Dr. Koppe confirms this view, and shows that in some cases hallucinations disappear after treatment of the ear.

I have elsewhere reported‡ a case of the suicide of a professor in one of our educational institutions, who consulted me 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 that I was correct in my 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. During this last summer, a gentleman, a public-school teacher, consulted my associate, Dr. Charles S. Bull, in regard to a suppuration of the ear, which caused considerable impairment of hearing and great tinnitus. He was exceedingly depressed

* Text-book, second American edition, p. 531.

† Loc. cit., p. 532.

‡ New York Medical Journal, August, 1869.

and annoyed by the tinnitus. It is said that he committed suicide on account of the depression caused by this state of his ears. There can be no doubt but that this symptom is one of the most distressing that can befall a patient, and that in some cases it is the provoking cause of suicide. Again and again I have satisfied myself that the great depression, which is the rule in persons whose hearing is impaired, was due entirely to the aural disease.

Dr. O. D. Pomeroy,* of this city, 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 this proportion was not as large as stated by Schwartze and Koppe.

Dr. C. E. Wright† publishes 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.

Von 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, and I am enabled to verify this opinion. Over and over again, have patients with chronic disease of the middle ear, not suffering from pain but from tinnitus, voluntarily informed me that these noises, together with the impairment of the hearing, had a great effect upon their mental powers. On the other hand, I have seen cases where most successful men, such, for instance, as distinguished general officers in the army, and distinguished writers, have suffered from boyhood with chronic inflammation of the middle ear and tinnitus aurium.

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, etc.

* Transactions of the American Otological Society, Fourth Year, p. 46.

† Indiana Journal of Medicine, November, 1871.

Wilde is undoubtedly correct in stating that the descriptions which patients give of the noises depend to a certain degree upon their fancy, their graphic power of explanations, and not unfrequently upon their rank of 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.

Only one thing more need be added as to the nature of this symptom. The ordinary tinnitus should 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.

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 usually 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 usually 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 many other symptoms than these which have just been enumerated—feelings of fulness, confusion of intellect, vertigo, tinnitus, and sore-throat—of which patients with chronic catarrh of the middle ear often complain; but they are not usually 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 head-aches, dyspepsia, neuralgia, etc., 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 I term 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 of course 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, I think 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 ear-aches, 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, of which an account will be given a little later on in the discussion of this subject, 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.

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. Naso-pharyngeal inflammation.

If we exclude the latter, we have also the objective symptoms of chronic proliferous inflammation.

The tuning-fork is one of the most useful 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 should be in some doubt as to whether we were dealing with a peripheric or central disease.

FIG. 58.



Tuning-fork.

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 felt on the affected side, or, if one be diseased, on the side of the ear most affected, and on which the ticking of a watch or the sound of conversation is not as well heard. This subject has been quite fully discussed in Chapter II., and

I beg to refer the reader to that for the different views as to the explanation of the value of the tuning-fork.* The use of the tuning-fork, as usually employed, must, however, be considered to some extent as a subjective test; for when it is used, we must depend on the patient's statement as to the side on which he hears the vibrations the better. By means of a double diagnostic tube, however, such as was used by Lucae in his experiments, we may make the test more exact.

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, however, 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 this 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. There are, however, some cases in which a watch is not heard well, while ordinary conversation is distinctly appreciated. 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.

There is a fact in regard to the hearing power of many patients suffering from chronic non-suppurative inflammation, that does not seem to have been as yet satisfactorily explained. It is the fact, that these persons hear better in noisy places than their neighbors who have normal hearing power. For example, such patients when in a long American railway carriage, will not only hear with ease, the person sitting on the same seat with them, but also the conversation of persons who are at such a distance that a person with normal ears, cannot distinguish a word they say. I have often been informed by

* The tuning-forks usually employed are those of the note C such as is here represented. It is better to strike them on a yielding body, such as the knee of the examiner, than upon a hard body. That of the note B is also used.

† Archiv für Ohrenheilkunde, Bd. V., p. 100.

reliable patients, that on actual test they could hear in such places better than persons with good hearing power. The tick of a watch, is, however, heard no further under such circumstances. The author once knew a mail agent, on one of our railways, who, although very hard of hearing, was never supposed to be so, by those who only talked with him amid the noise of the train. I think the explanation of this capability of hearing better in the midst of noises, will be found to depend upon an intensification or condensation of the sound waves, by the rapid vibrations of the wheels of the carriages, and the other means by which the sound is increased and a place made noisy. Certain it is, that some patients suffering from this form of disease of the ear not only hear better in noisy places than in quiet ones, but also better than persons with sound ears. These phenomena cannot be explained away by any assertion that they depend upon inexact observation. I have proved them to be facts by causing repeated experiments to be made.

CHANGES IN THE MEMBRANA TYMPANI.

I do not regard the appearance of the drum-head 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 labyrinth wall of the cavity of the tympanum. I think, however, that we very rarely find an absolute sinking inwards 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 pretty fair 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?

The introduction of Von Tröltsch's method of examining the membrana tympani has done more than anything else to stimulate the study of its character. The ordinary anatomical text-books give no true idea of this beautiful and important part. Such authorities on aural disease as Kramer, Wilde, and Toynbee, give descriptions of it that are far from exact. To Von Tröltsch and Politzer, are we indebted for such perfect descriptions that we now have a complete guide to the changes that may occur upon it.

In order to determine what may fairly be considered a normal membrana tympani, I have examined a number of what may be considered healthy ears. 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. Such persons are very rare in any community, and consequently I have only as yet examined seventeen membranes belonging to this class. From these cases, and the observation of others, I determine that 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 shows through, 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.

Von Tröltsch* seems to have been disposed to regard these calcareous formations as connected with high degrees of impairment of hearing, but I have not found this to be necessarily the case. Politzer† 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.

Moos has proved by one case which he observed, that a calcareous degeneration may occur in the course of a non-suppurative process. This case was that of a woman more than seventy years of age, who had chronic catarrh of the middle ear.

Calcareous degenerations, as shown by the microscopic examinations of Politzer, usually occur in the fibrous layer. Where the deposit is 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 has shown, in his work on this membrane, 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 from its surface, and the factors which cause this reflection have been fully detailed on page 189.

* Politzer, The Membrana Tympani, p. 58.

† L. c.

Politzer* 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 I cannot endorse this view. 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, I think we may draw quite positive and valuable conclusions as to the traction exerted by the malleus, and as to the inclination of the membrane. I do not deny that we may find an irregular or small light spot on a person with normal hearing power; but I believe that such a state of things is rare, and that 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 94 ears affected with chronic non-purulent inflammation of the middle ear, seen at the Manhattan Eye and Ear Hospital, and recorded by Dr. D. Webster, it is recorded that—

In 59	the light spot	was	present.
35	"	"	absent.
9	"	"	normal.
44	"	"	smaller.
2	"	"	larger.
4	"	"	divided (*i. e.*, 2 or more light spots existed).

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 inwards.

CHANGES IN 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

* The Membrana Tympani, translated by Mathewson and Newton, p. 8.

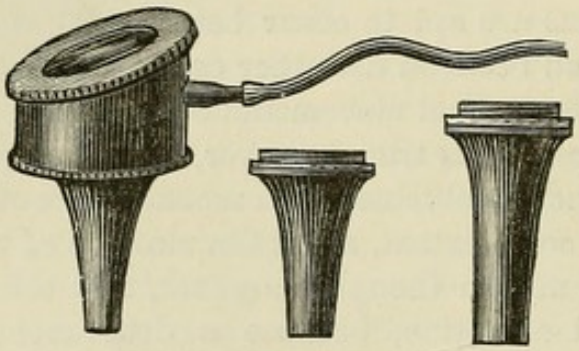
Valsalvian experiment for testing the permeability of the Eustachian tubes, and, on examination during this act, we find that the membranes moved outward and then inward. This change takes place, in a healthy membrane, chiefly at the apex of the light spot, or extremity of the malleus; but it may occur 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, however, 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, however, that the middle ear is 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, as I believe, almost useless therapeutically, and dangerous to the integrity of the tension of the membrana tympani. I very often see patients who have learned this method of treatment, and, having believed that no harm could ensue from a very frequent performance of the experiment,

have been in the habit of inflating the membrana tympani several times a day. A membrane that has been thus treated becomes very flaccid, and flaps to and fro, at every swallowing motion, like the sign-board of a country-inn on a windy day.

Siegle's otoscope, a representation of which is here given, enables us to form pretty accurate notions of the mobility of the membrane. The air may be exhausted by means of the

FIG. 59.



Siegle's Speculum.

lips, while the membrane is carefully watched for its movement, or a syringe may be used by an assistant for the same purpose, while the surgeon examines the movements of the drum-head. Care should be taken that the *speculum*, as it should be called, fit accurately in the auditory canal, so that a real exhaustion of the air may occur. Of course, the otoscope must be used to examine the drum-head through the glass of the speculum.

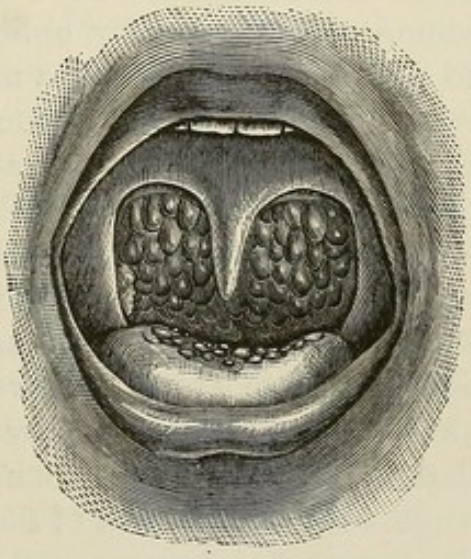
CHANGES IN THE EUSTACHIAN TUBE.

Having considered the appearance of the drum-head in cases of chronic non-suppurative inflammation of the middle ear, 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 evidences 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 any 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

FIG. 60.



Pharyngitis granulosa.

This engraving was made from a drawing, by Mr. G. C. Wright, of the pharynx of a young lady, who had suffered for many years from a chronic suppurative inflammation of the middle ear; but it is a fair type of some of the worst cases of granular pharyngitis, as seen in chronic catarrhal inflammation.

is a stoppage of the secretions, and subsequently hypertrophy of the structure. This affection is called by some authors chronic follicular pharyngitis, and its more advanced stages glandular hypertrophy; but I prefer the simple nomenclature of 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. If the tonsils are not enlarged, they often exhibit, by a jagged appearance, the evidence of former disease.

The rhinoscope often exhibits the same condition of the mucous membrane about the mouths of the Eustachian tube. Dr. O. D. Pomeroy* characterizes these appearances as follows, viz.:

"I.—Mucus in the mouth of the tube, with or without greenish or grayish mucus clinging or adherent to the post-nasal septum, and occasionally filling the nares.

"II.—Increased redness in and about the mouth of the tube, or paleness of the mucous lining of the part.

"III.—An œdematous condition of the parts near and in the mouth of the tube, resulting in more or less of swelling.

"The swelling in the region of the tube, the result of hyperæmia or œdema, may—1. So far obliterate the mouth of the tube as to cause it to appear as a minute dimple, or obliterate it entirely; or—2 Produce so much swelling of the collar-like surrounding of the tube as to greatly exaggerate it. 3. Increase the elevation which separates the mouth of the tube from the fossa of Rosenmüller. 4. Enlarge the posterior extremities of the middle and inferior turbinated bones, and produce a malposition in posterior nares, and give it a rough and uneven outline. 5. Cause a ring-like swelling around the tube, rough, red, and of a macerated appearance.

"IV.—Granulations similar to those found in the pharynx in granular pharyngitis near the mouth of the tube.

"V.—Polypi in the posterior nares, and more frequently on the turbinated bones.

"VI.—An apparent diminution in the mobility of the lips of the tube during contraction of its muscles.

"VII.—Whitish striæ, indicating cicatricial degeneration of the proper substance of the mucous membrane in the region of the Eustachian tube."

Very many of the patients who suffer from pharyngeal

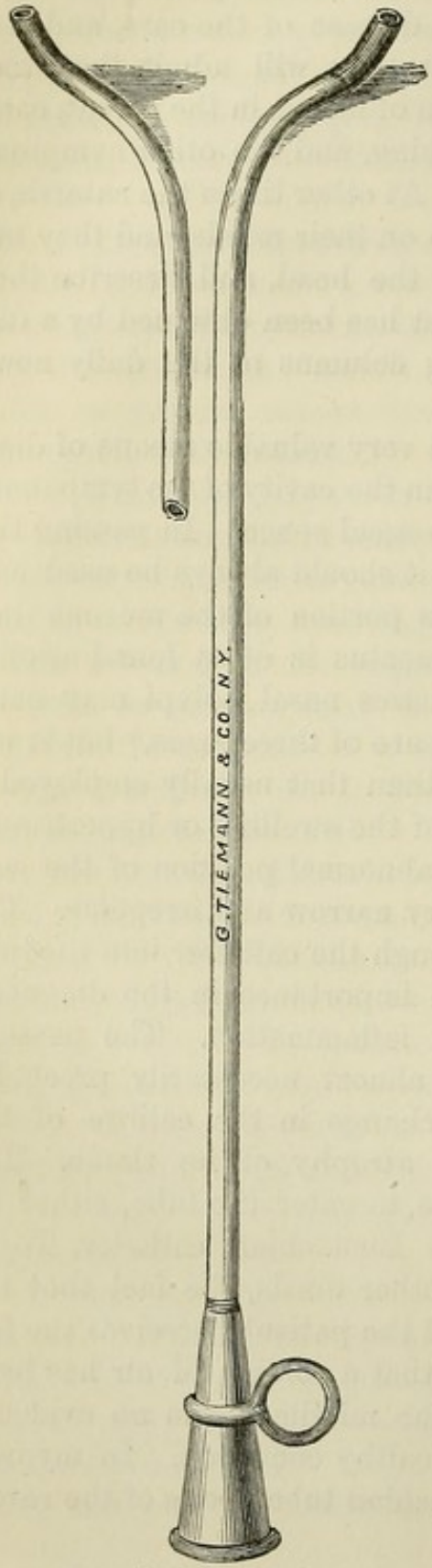
* Letter to writer.

and naso-pharyngeal inflammation, scarcely speak 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 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. The catheters usually employed are of three sizes,* but it will be found that one still smaller than that usually employed is needed, not on account always of the swelling or hypertrophy of the membrane, but of some abnormal position of the septum which renders the canal very narrow and irregular. The way 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 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. In my own experience, closure of the Eustachian tube is one of the rarest

* Two of the catheters are figured in actual size on page 94.

Fig. 61.



Noyes' Eustachian Catheter.

of conditions. I mean, by closure, 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 in size very much. 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. For such cases the catheter has usually been made longer, and introduced through the opposite nostril; but Dr. Noyes,* of this city, thinks that this method is not reliable, because by it the air simply passes "across the axis of the Eustachian tube, and if it pass up the tube at all, it can only do so after being reflected from the outer wall of the trumpet orifice."

Dr. Noyes has therefore modified the catheter usually employed, by giving the beak a double curve.

The engraving shows the exact size and shape of the instrument invented by Dr.

* Transactions of the American Otological Society, 1870.

Noyes. The following are his directions for using it. "When introducing the catheter, it is needful to keep the front close to the septum, as well as to the floor of the nostril. Arrived at the posterior edge of the septum, the beak should wind closely around it, curving obliquely across, and turning upward, so as to point toward the Eustachian orifice."

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, however, become reddened by the mere application of instruments to the external meatus, 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 a valuable assistance in determining the patency of the tube and the size of the cavity of the tympanum.* Kramer claims to determine, by the use of the diagnostic tube, the character of "exudation" and the width of the tube. If there is a piercing (*durchgehendes*), near, rattling, vesicular sound, he then diagnosticates 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. I only quote these from the last edition of Kramer's book, to show to what lengths a man may go in riding a hobby; for Kramer's hobby is the diagnosis of the affections of the middle ear, by the sounds heard through the diagnostic tube, caused by blowing through his catheters.

The true value, however, 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.

PATHOLOGY.

After the clinical investigations of Kramer and Wilde, the first great advance that was made in otology were the dissec-

* See engraving on page 97.

tions 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 truth. 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,* and others, we have verified on the dead bodies diseases that have been diagnosticated in the living one, or, I should rather say, we have learned, from the inspection of the ears of the cadaver, what is probably the condition of ears in life.

The pathological appearances in chronic catarrhal inflammation are—

1. Collections of mucus 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.
3. Hypertrophy of the bony walls of the tube.
4. Obstruction of the tube and cavity of the tympanum by dense fibrous tissue.

* A Descriptive Catalogue of Preparations Illustrative of the Diseases of the Ear. London, 1857. Archiv für Ohrenheilkunde, Bd. I.–V. Monatsschrift für Ohrenheilkunde. Guy's Hospital Reports. Gruber's Lehrbuch. Transactions American Otological Society. Moos' Klinik der Ohrenkrankheiten.

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 adhesions in the mastoid cells.

9. False membrane on the tendon of the tensor tympani muscle.

10. Partial obliteration of the cavity of the tympanum from adhesions of the membrana tympani to the labyrinth wall.

11. Hyperostosis of the petrous bone, and anchylosis of both stapes.

12. Atrophy and fatty degeneration of the tensor tympani.

These are actual appearances, of individual cases taken from Toynbee's catalogue and from the writings of the other authorities whom I have mentioned; some of them are perhaps consequences of suppurative inflammation, although I have been careful to exclude all cases in which there was loss of the membrana tympani, or other positive evidence of a suppurative process.

Gruber's* account of the pathology of otitis media hypertrophica is, that, "from some cause or other, there is first a great hyperæmia with distention of the membrane, and in part the new formation of blood-vessels, and increase of the intercellular fluid. The connective-tissue corpuscles are increased. The tissue of the inflamed mucous membrane is less moist than in the catarrhal form. The new formations or new elementary formations go on to a higher development. The most various adhesions may occur, or a soft connective substance appears which is either evenly spread over the whole portion that was originally inflamed, and thus leads to hypertrophy of the mucous membrane, or it may go on to granular formation. Many of these new formations may also undergo regressive metamorphosis—they may undergo molecular disintegration, become fatty, and be absorbed."

* Lehrbuch der Ohrenheilkunde, S. 516. Wien, 1870.

CAUSES.

I have endeavored, in recording the histories of about fifteen hundred cases of aural disease observed in private practice, to give the probable remote and proximate causes. These are only to be obtained by a strictly-observed system of cross-questioning, 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.

Judging as well as I am able, from my experience in public as well as private practice, I am disposed to consider the following as among the most probable causes of chronic non-suppurating inflammation of the middle ear:

Remote.—1. A feeble state of the system, due, for example, to inherited or acquired syphilis, phthisis pulmonalis, etc.

2. Defective hygienic management, *e. g.*, neglect of bathing, want of exercise in the open air, lack of proper food, etc.

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 ear-aches, and of chronic sore-throats, is usually distinct enough in chronic *catarrhal* inflammation, 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, I think, that the most of them were due to neglect, or improper management; for example, the heads of some children are oftentimes 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 an 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 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, temperance, and so forth, it leaves behind a residuum of hypersecretion or proliferation, which, as has been said, is the foundation for repeated attacks, and, finally, of permanent thickening.

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. Schwartze believes that the pathological change in these syphilitic cases is a periostitis, and this view seems to be correct.

Just how it is, that pregnant women are so often affected by a proliferous inflammation of the middle ear, I am unable to say; but it is a fact, that many women have told me, that they traced their impairment of hearing to their first pregnancy, and that they became worse at the birth of each child. I am now in the habit of warning such patients that great attention should be paid to their throat 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 I have usually observed during such cases.

The causes given by patients themselves, taken from my note-book, are as follows: "Stuffy sensations in the head;" "going in the water very frequently;" "severe colds in the head;" "when a child, the ears would stop up, and, would not hear well for a few days." The first manifestation was "a roaring noise heard at night;" "chronic sore-throat;" "great

deal of ear-ache;" "all the colds from which I suffer are in the head;" "excessive grief;" "a sound like that of locusts was the first indication of trouble;" "by accident I discovered that I could not hear from one ear;" "I have always had a great deal of sore-throat;" "diphtheria;" "typhoid fever." One patient gave a graphic account of a gradual loss of hearing from proliferous inflammation, in the following words: "Ten years ago I observed that I could not hear the church-bells, and in four or five years it began to be difficult for me to hear conversation." Another ludicrously attributed his chronic catarrh to exercise upon a gymnastic pole. Another was quite sure that it resulted from great mental anxiety. These are fair specimens of the causes assigned by the patients or their friends for cases of the variety of aural disease now under consideration. Some of them are far from being true causes, although the most of them may be admitted as having at least placed the system in such a condition that catarrhal disease or proliferation of tissue was likely to result. It is undoubtedly true, that any great mental depression may cause an attack of pharyngitis in a person disposed to it, and that such a long-continued state of mind will make such an affection incurable.

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 inflammation 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.

CHAPTER XIII.

CHRONIC NON-SUPPURATIVE INFLAMMATION OF THE MIDDLE EAR—CONTINUED.

TREATMENT.

AT the beginning of the preceding chapter a table was given, showing at about what time in the history of their disease the patients from whose cases it was made up consulted the writer. It may be safely asserted, that the most of these persons never underwent any serious or rational local treatment until that time; so that we may assume that the greater number of persons in the United States who suffer from the form of disease under consideration, are in the habit of waiting for a period of from five to twenty years before they attempt to get relief.

We must certainly diminish the number of these cases before we can hope for brilliant results. The neglect of aural therapeutics by the last and the preceding generation now recoils upon us. Patients come very late for advice about their ears, because they have been taught, not by the laity, but by wise and skilful physicians, that it is not prudent to meddle with the ear; that they will outgrow its diseases, as soon as their constitution is invigorated; if young girls, that, when the menstrual function comes on, they will be all right, and so forth, while, during this time of delay, adhesions between the membrana tympani and the ossicula, and the walls of the cavity of the tympanum, have been forming, and hypertrophy of the mucous membrane and atrophy of the tendons of the intra-auricular muscles—in short, all the changes that we have noted previously—have occurred.

In one respect the treatment of the catarrhal 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 need to pay very little to it. Perhaps we may classify the treatment as follows:

1. Constitutional and hygienic.
2. Local blood-letting.
3. Applications to the naso-pharyngeal space (only applicable to the catarrhal form of the disease).
4. Applications to the Eustachian tube.
5. Applications to the cavity of the tympanum.
6. Cutting operations upon the membrana tympani and the ossicula.

In the text-books of Wilde and Toynbee (books that have deservedly had a wide circulation in this country, and have done much to call attention to the ear) constitutional treatment figures very largely in the treatment. The use of mercury and iodide of potassium is strongly insisted upon. We, of the present time, have grown very 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 probably 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. Ample experience has shown that we can do nothing for these cases by such a treatment, and I may say, that it has been abandoned in the infirmaries and hospitals, where large numbers of cases of aural disease are seen. The constitutional 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.

The causes of these forms of disease suggest a kind of constitutional treatment however, 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, sleeping apparel, and the like. Hence the Turkish bath,* sponge-bathing, walking, riding, boat-rowing, the general application of electricity, iron, and so forth, become prescriptions which the otologist will be called upon to give very frequently, if he properly appreciates cause and effect. It is only against specific drugs, where there is no specific diathesis, against a routine system of prescribing a constitutional remedy in the vague *hope*, that it may do good, that I have been speaking.

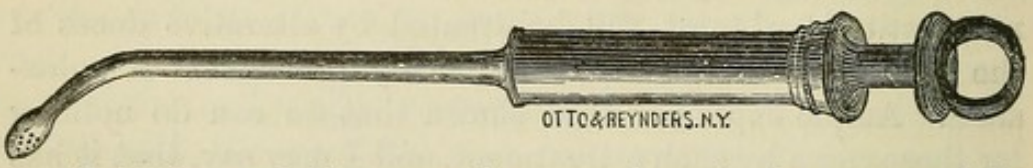
The use of leeches in some cases of chronic catarrhal inflammations that have sub-acute tendencies, is occasionally of value, although they give no such marked relief as that which is experienced in acute inflammation. When there are marked symptoms of congestion, such as fulness and slight pain, a leech may be applied on the tragus once a week, for four or five weeks.

TREATMENT OF THE PHARYNX

The treatment of the pharynx may be classified as follows :

1. Injections of the naso-pharyngeal space.
2. Gargling.
3. Cauterizations.

FIG. 62.



Injections of the naso-pharyngeal cavity by means of the naso-pharyngeal syringe, I have found very valuable in the treatment of chronic catarrhal inflammation. The solutions I use are common salt, permanganate of potash, gr. $\frac{1}{8}$ ad $\frac{\ddot{z}}{3}$ j, a saturated solution of chlorate of potash, tar-water, etc. Great masses of muco-purulent material are often dislodged by this treatment, even in cases where ordinary inspection does not show that any has collected. The nasal douche is very frequently used for the purpose of cleansing the naso-pharyngeal

* The Turkish bath is one of the best means of keeping the circulation so equable that catarrhs do not readily occur. It is not a good plan, however, to allow the head to be wet, during the shampooing process that follows the hot-air bath, neither should patients disposed to aural disease, take the cold plunge which is often given at the termination of the whole process.

space, but it is a means of treatment that is attended with considerable danger to the ear, even when all proper precautions are taken.

The posterior nares syringe is made of hard rubber. It is a very efficient and safe means of cleansing the pharynx and nostrils. In cases of acute inflammation of the pharynx attended with considerable swelling, it should be used with care, or it will abrade and irritate the mucous membrane of the posterior pharyngeal wall. This abrasion may then lead to an extension of the inflammation along the tube, to the tympanic cavity. In chronic cases I have never seen or heard of any harm being done by the posterior nares syringe.

Dr. Warner, of Ohio, uses an air-bag as the means of forcing the fluid through the curved tube, and gives the instrument, instead of the nasal douche, into the hands of the patient. It is, however, a rather dangerous plan to trust an operative or mechanical treatment, such as introducing an instrument behind the uvula, to a patient, where it is possible to avoid it.

THE NASAL DOUCHE.

The author has published several cases that illustrate the dangerous consequences that may result to the ear from the use of the nasal douche. The appliance is, however, so convenient of application, and it is thought to be so thorough in its work of cleansing the nostrils and pharynx, that the profession are very loth to abandon it. I am of the opinion, however, that its use should be discountenanced by the profession. Various criticisms have been made upon the published cases of injury to the ear from the use of the douche, but I believe that they have been fully met, and that most of the otologists on this side of the water, are agreed that the nasal douche, even when employed with all proper precautions, has produced serious aural symptoms in quite a large number of cases. The harmful results are probably due to the entrance of a large quantity of fluid, in a flood, as it were, into the cavity of the tympanum along the Eustachian tube, and necessarily in a direction contrary to the motion of its ciliated epithelium.

The use of the nasal douche was first suggested by Professor Theodore Weber, of Halle, Germany, and is based upon a physiological fact that was first promulgated by *Dr. E. H.*

Weber, of Leipsic, in 1847. This fact is, that when one side of the nasal cavity is entirely filled with fluid by hydrostatic pressure, while the patient is breathing through the mouth, the soft palate completely shuts off the superior naso-pharyngeal space from the mouth, and does not permit any of the fluid to pass downwards. The fluid then passes into the opposite nasal cavity, and escapes through the nostril. *Prof. Theodore Weber* suggested the use of a cup to the bottom of which was attached a bit of rubber tubing, for the purpose of taking advantage of this physiological principle. Such an apparatus is figured on page 124, and is now very much used under the name of Clarke's aural douche for the purpose of cleansing the meatus and stilling pain in the ear. *Dr. J. L. W. Thudichum* brought this apparatus to the notice of the English-speaking profession,* and made it more convenient, so that in America it has acquired the name of Dr. Thudichum. It should, however, be called Weber's douche.

As early as 1869, I had found that the nasal douche was sometimes a troublesome and dangerous appliance, and I added a note to indicate this, in my translation of Von Tröltsch on the Ear (second edition, page 369); but I was not fully convinced that it would readily cause acute aural inflammation, until the following case occurred in my practice. The case has been amplified from the first record that appeared,† in order to avoid the reiteration of explanations, that the criticisms upon the case in the Monatsschrift für Ohrenheilkunde, and by Professor Elsberg of this city, compelled me to make.

Case of Otitis Media Purulenta, and Pyæmia, from the Use of the Nasal Douche.—On the 12th of December, 1868, I was consulted by a clergyman, forty-nine years of age, in regard to a sub-acute catarrh of the middle ear, affecting both sides of the head. The history of the patient was as follows: Some years before, he was attacked with what seemed to be hay fever, or a form of coryza attacking certain persons during the summer. This coryza became a chronic catarrhal inflammation of the naso-pharyngeal space, attended by the usual symptoms—a sense of stuffiness of the nostrils, frequent expectoration of glairy mucus, sneezing, and so forth. For the past two months the patient has been in the daily habit of using Weber's nasal douche, for the purpose of cleansing the nostrils and of introducing remedial agents into them. He had once before

* On Polypus in the Nose and Ozœna. London, 1869. Lancet, Nov. 24, 1864.

† Archives of Ophthalmology and Otology, Bd. I.

tried this means of treatment, but it had caused so much unpleasant feelings in the ears that he was obliged to desist from employing it. A warmer solution was always used in the douche, and it was employed under the direction of a physician who was probably well aware of Dr. Thudichum's directions, and took all the precautions which he advises in his pamphlet. This fact is mentioned, because the advocates of the douche claim that it never does harm when properly employed. Dr. Thudichum advises that a solution of salt and water, or milk and water, but never pure water, should be used, as did Professor Weber some time before. The patient was also instructed to breathe through the mouth, and Dr. Thudichum observed that very often patients became confused, struggled, breathed through the nose, and defeated the plan. It is during this excitement, that the accident of entrance of fluid into the ear seems usually to occur. For about two weeks these unpleasant sensations on using the douche have been again experienced. The patient complains of being deaf, and of having a full sensation in both ears, almost amounting to pain. The membrana tympani of each side is found to be reddened. An ordinary ticking watch, heard by a person with normal hearing power about six feet, is only heard when placed in contact with the auricle of each side. A leech was applied to each ear on the tragus, the Eustachian tubes were rendered pervious by means of the catheter and Politzer's method. In a few days the membrana tympani assumed a normal appearance, and the hearing was restored by means of this treatment. The patient then desired that an attempt should be made to relieve the trouble in the naso-pharyngeal region. The uvula and tonsils were relaxed, the whole mucous membrane of the upper pharyngeal space secreted excessively, and the patient had contracted a habit of constantly endeavoring to clear his nostrils. Fluids passed through the left nostril, but none through the right. The Eustachian catheter, however, passed without difficulty. The nostrils were cleansed by means of a nebulizer, salt and water being used in it, after which the parts were swabbed out with a solution of arg. nit. gr. x. ad $\frac{\text{ʒ}}{}$j. The patient improved under this treatment until Jan. 28, when he was for some time exposed to the air of a winter's day, with the head uncovered (at the consecration of a bishop), when the symptoms, which had been to a certain extent relieved, returned.

Jan. 31, a gelatinous mass was found plugging up the inferior meatus of the right nostril, seeming to be attached to the floor of the canal. Portions of this were removed by torsion, at intervals of about three days, until Saturday, Feb. 6, when what seemed to be the remainder of this growth was removed. The patient left the office, saying that his nostril was much clearer, and went to Yonkers, a city about fifteen miles by rail from New York. There he again used the nasal douche, and again experienced a decidedly unpleasant sensation in his ears, which, however, did not amount to pain. On Sunday morning and evening the patient performed his clerical duties, but with a great sense of languor and uneasiness. On Sunday night, Feb. 7th, at about eleven o'clock, he was awakened by a severe pain in the mastoid region of the right ear, which kept him from sleep. I saw him Monday morning, at about eight o'clock, and noted the following symptoms: The countenance was anxious and flushed, the skin hot, pulse about ninety-six, right mastoid region red and sensitive, right membrana tympani reddened, watch only heard when pressed upon the auricle. The patient was asked as to the condition of the left ear; but he said there

was no trouble there. An examination of the tragus and mastoid process failed to exhibit any symptoms of inflammation in that ear. Two leeches were ordered to be applied to the mastoid process, and the patient was to take aq. acetat. amm. At five P.M., the pain in the ear had entirely ceased after the application of the leeches. The patient was breathing hurriedly, however, his pulse was weak and frequent—about ninety-six—and he complained of pain and tenderness in the abdominal region. Morph. sulph. gr. $\frac{1}{8}$, was ordered to be taken *pro re nata*, and a poultice was applied over the abdomen. Tuesday, Feb. 7. The patient took two powders of morphine, and passed quite a comfortable night. This morning he complains of pain in the forehead, but has none in any other part of the body. The surface of the body is dry and hot. Ordered aq. acetat. ammon. and nutritious diet. Feb. 8. Last night the patient was attacked by a severe pain and swelling of the left foot, and at about half-past seven A.M. he had a severe chill, lasting about fifteen minutes, not followed by sweating. At about this time a discharge appeared from the left ear. There has been no pain experienced in this part. He has not slept well, and his general appearance is bad. Countenance anxious. Breathing labored. Pulse about 96. The left ankle and dorsal region of foot are red, greatly swollen, and tender. Left membrana tympani ulcerated and discharging freely.

Dr. Foster Swift, of this city, was called in consultation, and the following treatment agreed upon: The foot was wrapped in an alkaline lotion. Vichy water was given *ad libitum*, with beef-tea and wine; morphine *pro re nata*. Feb. 9. Patient does not seem so well. Respiration is hurried. The intellect is somewhat clouded. Pulse about the same. Face of a sallow hue. The stimulants are increased, so that he now takes half an ounce of brandy in milk punch every four hours, day and night. Quin. sulph. gr. ii., every four hours. The left ear is syringed with lukewarm water, zinc. sulph. applied, and Politzer's method used to inflate the drums. The patient is so deaf that he only hears when spoken to near the ear.

The patient was treated in this manner, until Feb. 22d, the brandy punch being steadily increased until he was taking two ounces every four hours, with beef-tea, eggs, etc. His pulse was never over 100, usually about 96; the skin had a saffron hue, and patient lay in a doze, except when the pain from his foot kept him awake nearly the whole time.

Dr. George A. Peters, Surgeon to the New York Hospital, was called in consultation a few days ago, in addition to Dr. Swift and myself, and to-day two openings were made in the foot, one near the internal, and one near the external malleolus. Pus was evacuated. The dorsal region of the foot was very much swollen, but no fluctuation was detected. The patient's general condition is now better; his countenance less anxious; the respiration is not so hurried. The urine was several times carefully examined during the treatment. No abnormal condition was found, beyond an acid reaction early in the course of the disease. The heart was also examined, and no organic changes were found. Several openings were made in the foot from time to time; but the patient slowly improved from this time until March 16th, when he was able to sit up. The membrana tympani healed, and the hearing distance became about one foot on the right side, and four to six inches on the left. Conversation is heard with ease. Politzer's method has been practised

every two days. Quinine and iron have been taken in addition to the stimulants. The foot is still swelled, but all the openings but two have healed. April 4. The patient has been going about the house for a week. Hearing power is still further improved. A little erysipelatous soreness of the foot occurred last night. The naso-pharyngeal catarrh is completely gone. April 7. Patient rode out to-day, and gets about the house, employing himself in intellectual labor. Tissues of the foot still swelled and rigid ; motions of the ankle-joint unimpaired.

1873. I am in the habit of seeing this patient quite often. He is now in excellent health, but a very little lame from the inflammation of the foot.

My friend, Professor Elsberg, of this city, published a paper* in which he claimed that an analysis of the cases that had been published, of harm to the ear from the use of the douche, showed that the cause was uncertain. Dr. Elsberg has had a large experience in treating diseases of the pharynx, and although he has prescribed and employed the douche in more than 1600 cases, he has seen none of the results that I have observed. I can only explain this by the presumption, that when an accident to the ear occurs, the patients are more apt to consult a person who is in the constant habit of treating aural disease than to go on with the treatment of the nasal catarrh. Besides, as it is believed by many otologists, it is possible that the douche sets up a chronic inflammation of the tympanic cavity, without any acute stage, and thus the true cause of an insidious chronic catarrh is passed over and supposed to be an advance of the naso-pharyngeal inflammation. Of course it is not believed by the author that the use of the nasal douche will *necessarily* cause aural disease, but that it is a dangerous means of treatment, which should be carefully watched by the practitioner.

I append, from a paper previously published, an analysis of cases in which serious results have occurred.† Were it expedient to further extend the discussion of this subject, I could add several more, for I am constantly hearing of them from my professional friends, and seeing them in my own practice. While preparing this chapter for the press, I am treating daily a patient suffering from suppuration of the middle ear, that was caused by the use of the douche.‡

* Archives of Ophthalmology and Otology, vol. ii., p. 77.

† L. c., vol. iii., No. 1.

‡ The famous Cheselden mentions the fact, that syringing the nose when the Eustachian tube is open, sometimes causes deafness.

ANALYSIS OF REPORTED CASES OF INJURY TO THE EAR FROM THE USE OF THE NASAL DOUCHE.

Patient.	Instructor* in Use of Douche.	Fluid Used.	Ear Disease Produced.
Case I. Rev. Dr. C.	A physician.	A warm solution of carbolic acid.	Acuta otitis media suppurativa. Pyæmia. Recovery.
" 2. Dr. Frank.†	Dr. Frank.	Cold water, which he advises in all cases.	Acute otitis media. Recovery.
" 3. Mr. D.	Dr. Roosa.	Warm solution of salt and water.	Perforation of both membranæ tympani. Recovery.
" 4. First of Dr. C. I. Pardee's‡ cases.	A physician.	Warm solution of salt and water.	Otitis media suppurativa. Necrosis of middle ear. Permanent deafness.
" 5. Second of Pardee's‡ cases. Medical student.	A physician.	Salt and water.	Acute otitis media. Recovery.
" 6. A Physician.	A physician.	Unstated.	Otitis media suppurativa chronica.
" 7. Patient at Manhattan Eye and Ear Hospital.	Unknown.	Unknown.	Otitis media acuta. Recovered.
" 8. Mrs. C. Dr. Mathewson's case.	A physician.	Warm fluids.	Otitis media acuta. Recovered.
" 9. Dr. Hackley's¶ case.	Unknown.	Warm salt water.	Otitis media suppurativa chronica, supervening on old perforations.
" 10. Dr. Piffard's§ case.	Unknown.	Warm fluids.	Otitis media acuta. Recovery.
" 11. Judge ——.	A physician.	Unknown.	"Deafness." Recovery.
" 12. Dr. Loring's‖ case.	A physician.	Warm fluid.	Otitis media suppurativa chronica.
" 13. Physician¶ Dr. Mathewson's second case.	A physician.	Unstated.	Otitis media acuta. Recovery.
" 14. Physician.¶ Dr. Mathewson's third case.	A physician.	Unstated.	Otitis media subacuta.
" 15. Physician.	A physician.	Warm salt water.	Fainting and otitis media catarrhalis.
" 16. Dr. O. D. Pomeroy's case.¶	Dr. Pomeroy.	Warm salt water.	Otitis media suppurativa.

* The instructor is given in order to meet the point made by the advocates of the douche, that no harm occurs when it is properly employed.

† Archiv für Ohrenheilkunde, Bd. V., p. 202.

‡ The Medical Gazette, vol. vi., No. 23. Medical Record, Feb. 1, 1870.

§ Reported by Dr. Pardee, l. c. ‖ Verbal report to writer.

¶ Reported in Archives for Ophthalmology and Otology, vol. iii., No. 2.

Dr. Pardee, in his paper in the Medical Gazette, claims that the douche is an inefficient, as well as dangerous instrument. He does not think that the conformation of the nasal passages allows of their being cleansed by such a flood of water as comes from the douche.

GRUBER'S METHOD.

Gruber adopts a method of cleansing and medicating the naso-pharyngeal space, for which he claims superiority over the naso-pharyngeal syringe and the nasal douche. Dr. Gruber also claims that his method of treatment was promulgated a year before the nasal douche was introduced to the profession—that is, in 1863, at a meeting of the medical profession in Vienna. But Gruber spoke of his method only with reference to aural disease, while Weber's nasal douche was recommended as a means of treating the nares. Gruber's method consists in the use of a two-ounce hard rubber aural syringe, the nozzle of which is well rounded off, in the following way: The syringe is filled with the fluid to be injected and placed in one nostril. The fluid is then forced with more or less vigor into the nostril, the other being closed with the finger, if the operator desires to inject the Eustachian tubes, but left open if the intention be to simply inject the naso-pharyngeal space. "In the force with which I empty the syringe, in the more or less perfect closure of the other nasal meatus, are found the factors which more or less favor the entrance of fluids through the tubes. The latter effect may also be increased, after the syringe is removed, by causing the patient to perform the Valsalvian experiment." *

Gruber believes that it is the root of the tongue, as well as the soft palate, that by instinctive contraction and lifting upwards shuts off the superior from the inferior pharyngeal space, and prevents fluids injected by the nasal douche or by his method from passing downward. This statement is proved by the fact that when the soft palate is destroyed by ulceration, the fluid may be made to pass out of the other nostril, as well as if the palate were sound.

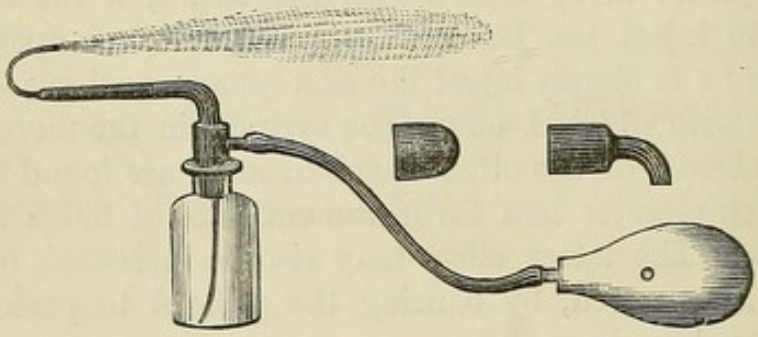
Gruber deprecates much instruction to the patient as to how he shall breathe or hold his palate during the injection of the fluid, but he prefers to leave him to his own instincts. A fluid should be used which will do no harm if some of it pass into the stomach.

* Monatsschrift für Ohrenheilkunde, Jahrgang VI., No. 4.

Dr. Gruber fully corroborates my views that the harmful effects of the nasal douche are due to the entrance of the fluid into the middle ear, and he shows that however proper it may be to *intentionally*, inject fluid in small quantities into a diseased cavity of the tympanum, it is manifestly incorrect to force it into an ear that was previously healthy, with no restriction as to quantity, as is done in the use of the nasal douche.

"The current from the nasal douche is continuous, even when the cavity of the tympanum is already full; the fluid in the pharynx attempts more and more to enter into the middle ear, and when the pressure is very great, rupture of the membrana tympani may occur. I have often seen ecchymoses on the membrana tympani, that were caused by the nasal douche." *

FIG. 63.



Nebulizer for Pharynx.

I am very glad to have the views which I first brought before the profession, thus endorsed by so high authority as Professor Gruber. It is to be hoped that the method of anterior syringing, and the use of the posterior nares syringe, may finally supplant the nasal douche.

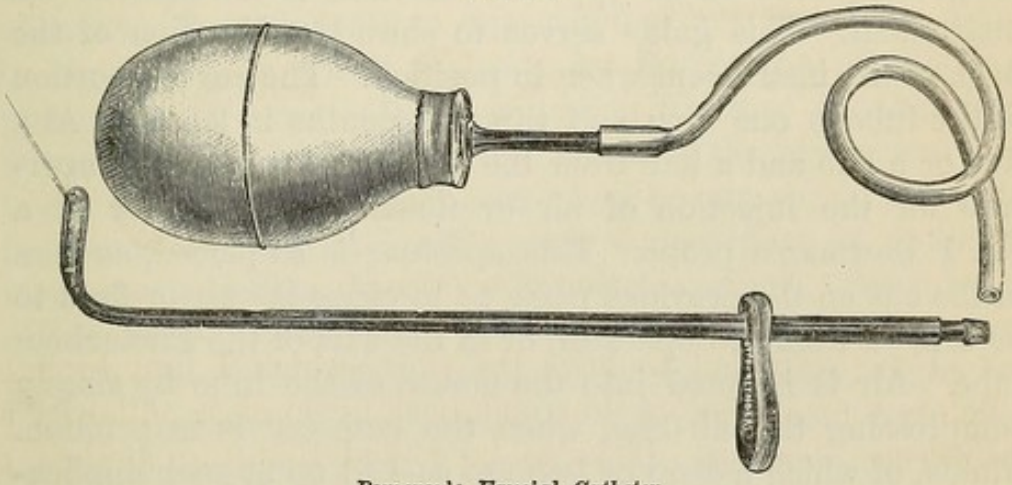
The solution that may be used with benefit as gargles are, of course, very numerous. The gargle that I most frequently prescribe is a saturated solution of chlorate of potash. Where there is much granular pharyngitis, a gargle containing iodine, will probably be more efficacious. I am in the habit of advising patients suffering from chronic disease of the middle ear, suppurative or non-suppurative, to use a gargle of cold

* Gruber, l. c., No. 8.

water, by Von Tröltsch's method, as long as they live. The gymnastic exercise of the muscles of the Eustachian tube, is by no means an unimportant means of treatment.

Gargling is a very efficient means of cleansing the pharynx, if it be performed in the manner advised by Von 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.

FIG. 64.



Pomeroy's Faucial Catheter.

Cauterization of the mouths of the Eustachian tubes, and of the posterior pharyngeal wall, is of great value in the treatment of catarrh of the middle ear. Nitrate of silver in solutions of from 20 to 100 grains to the ounce of water, is the agent chiefly to be employed. It should always be used by a nebulizing apparatus, in preference to a probang, although where the granulations are well defined, the individual elevations may be pencilled with the solutions.

These applications are not very unpleasant, and they are

certainly very efficient in diminishing secretion, and in changing the character of tissue. The use of the solid stick is very unpleasant to the patient, and is, I think, to be avoided. Dr. O. D. Pomeroy, of this city, who has done much to introduce the nitrate of silver treatment of the pharynx in aural disease, uses a peculiar instrument for making applications to the mouth of the tube, and for inflating the cavity of the tympanum.* Although Dr. Pomeroy names his apparatus a faucial catheter, I am inclined to think that its chief value is as a means of making applications to the mouth of the tube, and not of inflating the *middle ear*.

The instrument consists of a hard rubber tube, seven and a half inches in length. Its breadth at its proximal extremity is one-fourth of an inch, but it lessens towards the beak, which is a little more than one-eighth of an inch in thickness. The proximal extremity has a lip for the adjustment of a rubber tube. At about an inch and a half from this is a perpendicular guide, placed in an opposite direction to the beak of the instrument. This guide serves to show the direction of the beak of the instrument when in position. The curved portion of the tube is one inch and three-sixteenths in length. At a line or a line and a half from the end of the beak, is an aperture for the injection of air or fluids of the caliber of a No. 1 Bowman's probe. This aperture is so placed, as seen in the cut on the previous page, as to cause the air or fluid to be thrown from the operator, or in the axis of the Eustachian tube. Air is injected into the mouth of the tube by simply compressing the air-bag, when the catheter is in position. Fluids, of which a drop or two are sucked up at each application into the beak of the instrument, are forced into the tube, in the form of a fine spray.

Dr. Pomeroy thinks that the use of this instrument is ordinarily simpler than the employment of Politzer's method; but in this view I cannot coincide—and as a catheter, I hardly think it will take the place of an instrument introduced through the nose. The verdict of the profession has hitherto been for the method of Cleland, as against that of Guyot, and none of the

* Transactions of American Otological Society, 1872.

faucial instruments have, as yet, reversed this judgment. The faucial catheter of Dr. Cutter,* ingenious as it is, will hardly supersede the catheter in ordinary use, which is, as has been demonstrated, an efficient instrument, and one that in ninety-nine cases out of a hundred is readily introduced, and with no "guess-work," as has been said, but with an exact knowledge of its position.

Solutions of sulphate of zinc, of alum, sesquichloride of iron, and so on, in weak solutions, may be used with advantage by the patient himself during the treatment of naso-pharyngeal inflammation. They are most efficient when used in one of the nebulizers that are now so largely employed in the treatment of the throat.—(See Fig. 63.)

THE TREATMENT OF THE EUSTACHIAN TUBE.

Among the means employed in the treatment of the Eustachian tube, the use of the Eustachian catheter stands pre-eminent. 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, as it seems to me, 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 the catheter; but I become more and more convinced after ten years of pretty steady experience in its use, that 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,
Vapors,
Fluids,
Bougies,
Electricity.

* American Journal of the Medical Sciences, April, 1872.

I have placed common atmospheric air first, because I regard it as the most important of the agents to be employed. It is, however, not so efficient in chronic as in sub-acute 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.

Among the vapors employed, I attach most importance to the vapor of water—steam—an old remedy, but one which had most undeservedly fallen into disuse in this country, until it was again employed by myself.

*Dr C. I. Pardee** has published a paper, in which he has carefully noted the results of six cases of the most obdurate variety of non-suppurative disease of the middle-ear, and in all of these there was marked improvement, both in the hearing distance and in respect to the tinnitus aurium, by the use of steam through the catheter. Dr. Pardee deduced from his cases the practical lesson, that in the treatment of the disease of the tympanic cavity, its condition of moisture or dryness should be considered, and that when dryness exists, our therapeutic efforts should tend to re-establish the normal secretion.

I am in full accord with Dr. Pardee's proposition, and I do not therefore use the vapor of water in the strictly catarrhal cases, but in the proliferous inflammation, where adhesions exist, with rigidity and hypertrophy of the mucous membrane.

The apparatus required for the injection of steam into the cavity of the tympanum, consists of the following appliances:

1. An apparatus for generating the vapor.

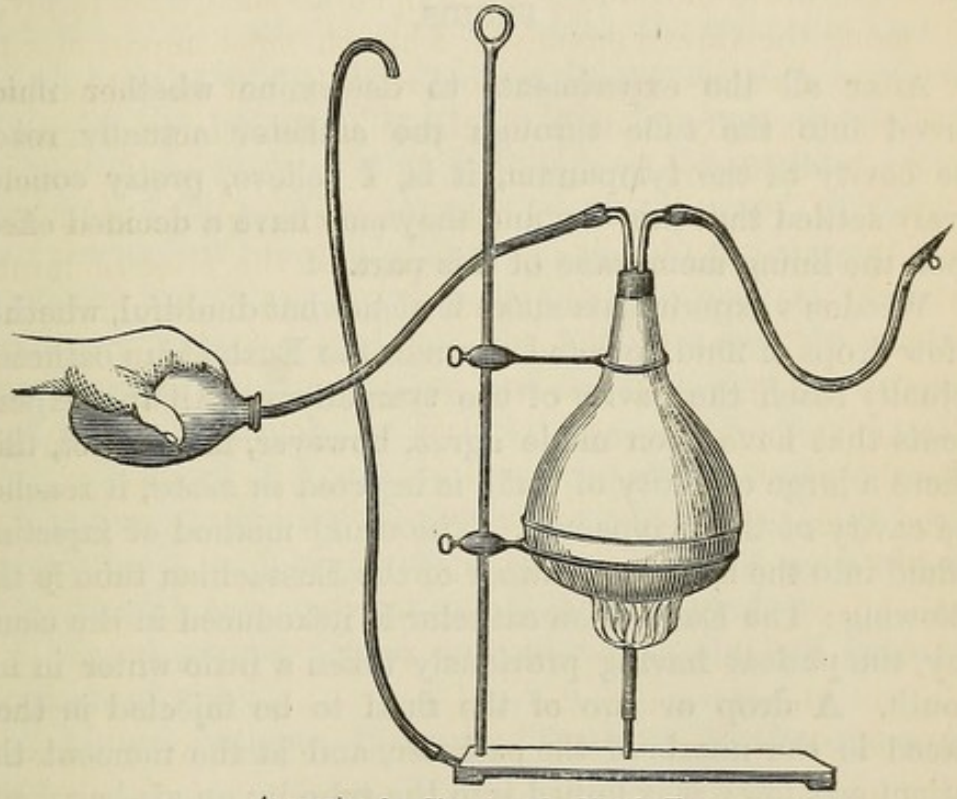
A nickel-plated copper flask is the best for this purpose, although a glass flask used over a sand-bath will do very well. The only objection to the glass flask is, that the flame may leap beyond the level of the water in the flask, and break it, as has often occurred to me. Two glass tubes are placed in the cork, and a very minute opening for the escape of steam.

* Transactions of the American Otological Society, 1870.

A piece of flexible rubber tubing is placed over each of the glass tubes. In the free end of one of the tubes is a nozzle adapted to the Eustachian catheter; in the other a tip adapted to an ordinary air-bag.

2. A hard-rubber Eustachian catheter. A metallic instrument cannot be used, on account of its becoming too hot to be borne. Many practitioners keep the catheter in place by a

Fig. 65.



Apparatus for Steaming the Middle Ear.

holder; but I always employ my fingers for that purpose. Dr. Pardee gives the following account of the method of forcing the steam into the catheter, a method which I have found important to be observed in detail. The steam may be generated by a gas-burner, as depicted in the cut, or by an alcohol lamp. I prefer the former.

"The catheter should be placed in the mouth of the Eustachian tube, and retained in position by the catheter-holder; then the small nozzle of the steam apparatus being in the outer end of the catheter, steam can be forced to the middle ear by sharp pressure on the air-bag. If the pressure on the

air-bag is slow, the prolonged contact of the steam is likely to be unpleasantly felt by the patient, and there is some danger that it may escape into the pharynx and provoke inflammation there. On the other hand, if it be applied by sudden, sharp pressure, and the nozzle removed from the catheter after each puff, no inconvenience is ever felt, and there is no possible danger of exciting inflammatory action in the pharynx."

FLUIDS.

After all the experiments to determine whether fluids forced into the tube through the catheter actually reach the cavity of the tympanum, it is, I believe, pretty conclusively settled that they do, and they may have a decided effect upon the lining membrane of this part.

Wreden's experiments make it somewhat doubtful, whether a few drops of fluid, injected through the Eustachian catheter, actually reach the cavity of the tympanum. All the experiments that have been made agree, however, in one fact, that where a large quantity of fluid is injected *en masse*, it reaches the cavity of the tympanum. The usual method of injecting a fluid into the mouth or caliber of the Eustachian tube is the following: The Eustachian catheter is introduced in the usual way, the patient having previously taken a little water in his mouth. A drop or two of the fluid to be injected is then placed in the nozzle of the catheter, and at the moment the patient swallows, it is forced into the tube by an air-bag.

Dr. F. E. Weber, of Berlin, has invented an instrument for spraying the tube and the tympanic cavity. He calls his apparatus the "pharmaco-koniantron." It consists essentially of a long and flexible Eustachian catheter, which is passed into the tube as far as the junction of the cartilaginous with the osseous portion. It is perforated laterally about 1¼mm. from its beak, and it is introduced through an ordinary metallic catheter. The fluid is forced through the lateral opening in the form of spray, by means of an air-bag attached laterally to the tube of a small syringe. The fluid to be used is first driven by the syringe into the nozzle of the catheter, and then forced forward by the air-bag.

As has been intimated, Dr. Wreden* does not believe, that drops of fluid injected in the manner that has been described through a *tubal* catheter, reach the cavity of the tympanum, but that they pass only to the osseous part of the tube. He does not deny that injections *en masse* will reach the cavity of the tympanum, but he thinks such injections dangerous.

Wreden advises the use of the tympanic catheter—that is, a catheter that passes beyond the isthmus of the tube, as a vehicle for introducing drops of fluid into the middle ear. After the tubal catheter, through which the tympanic one is passed, is in position and fastened by means of a forehead band, and the permeability of the tube has been ascertained by the use of a probe 1.4mm. in thickness, the operator drops five drops of the solution to be used upon a watch crystal or other convenient receptacle, draws it up into the catheter and inserts the instrument as far as the *tympanic orifice of the tube.* The drops are then forced into the middle ear by the mouth. Sensations of fulness in the ear, and an increase of the impairment of hearing, usually occur, but they pass off in from 6 to 12 hours. In about 48 hours the beneficial effect should be seen.

Wreden uses the following named agents through the tympanic catheter, and he insists that the *maximal doses should not be exceeded*, lest acute inflammation be excited.

1. Fused caustic potash, one-quarter to one-half grain to the ounce of water.

2. Liquor potassæ, three to five drops to the ounce of water.

3. Concentrated acetic acid, two to three grains to the ounce of water.

4. Pure iodine, one-eighth to one-quarter of a grain to the ounce of a half-per cent. solution of iodine.

5. Corrosive sublimate of mercury, one-twelfth to one-eighth of a grain to the ounce of water.

6. Nitrate of silver, one-quarter to one grain to the ounce of water.

7. Sulphate of copper, one-quarter to one grain to the ounce.

* Separat-abdruck aus der St. Petersburger medicinischen Zeitschrift N. F. Bd. I. 1871.

8. Sulphate of zinc, one to two grains to the ounce.

9. Iodide of potassium, two to five grains to the ounce.

10. Sulphate of atropine, one-half to one grain to the drachm of water.

11. Hydrate of chloral, one to two grains to the ounce of water.

Wreden uses these agents through the tympanic catheter, chiefly in the proliferous form of inflammation of the middle ear. These injections are made every third or fourth day, for from fifteen to twenty days, and although it is not claimed that the results are brilliant, they are well worthy of a trial where all the ordinary means by a tubal catheter have failed.

In chronic catarrhal inflammation the agents named last on the list are also used, but the caustic applications are only applied to the cases of proliferous inflammation—the cases classed under the head of sclerosis by Van Tröltsch.

Kramer was perhaps the first to use the tympanic catheter to any great extent, and his instrument is essentially the one that Wreden employs. It is a hard-rubber catheter, made long enough to reach the tympanic orifice, and is passed into the tube through an ordinary tubal catheter.

Bishop, of London, invented a nebulizer for the faucial mouth of the Eustachian tube; but it was a very inconvenient instrument, and never came into general use.

Dr. C. E. Hackley's instrument will be found a more efficient means of spraying the tube. Dr. Hackley's apparatus consists of an air-bag, an Eustachian catheter, with a hard-rubber nozzle to fit in its mouth, a piece of rubber tubing, and a hypodermic syringe.*

"The nozzle of the air-bag is inserted into one end of the rubber tube, the tip to fit in the catheter being placed in the other end. The hypodermic syringe is filled with the liquid to be employed, then its point passed through the tube and out through the caliber of the hard-rubber tip for the catheter, as shown in the cut."

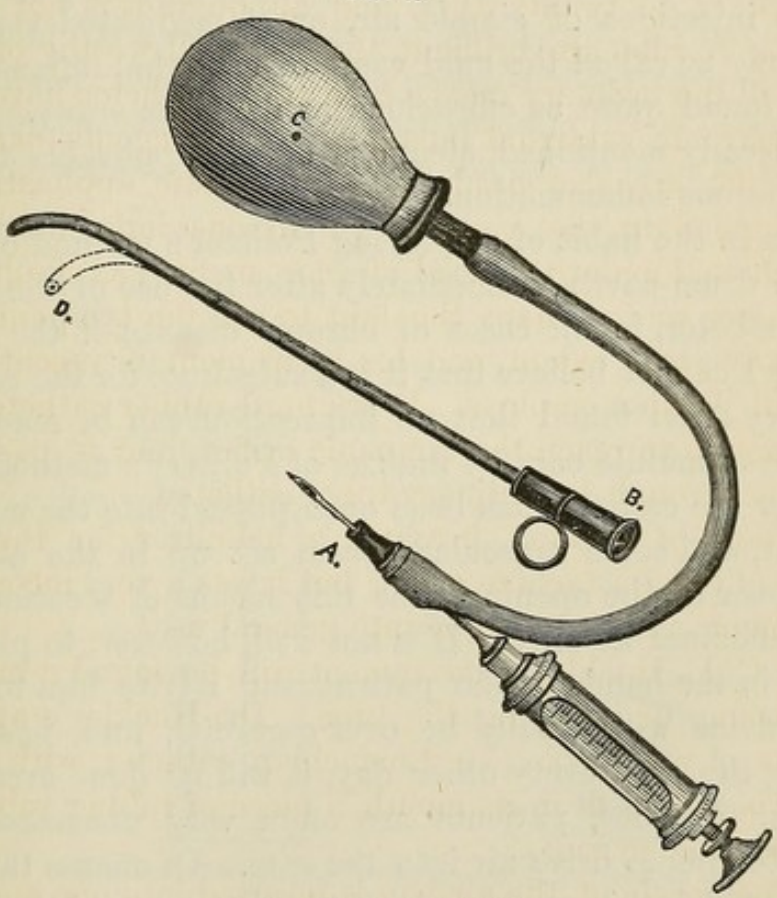
"The mouth of the Eustachian catheter B being fitted over the hard-rubber tip A, and held there, if sudden pressure is

* Medical Record, No. 134.

made on the air-bag, while the piston of the syringe is forced home, the liquid will be thrown through the catheter in the form of spray.

"In using this apparatus for the treatment of diseases of the ear, the catheter should be carefully introduced through the nose, and placed in position. Then, while the diagnostic tube is placed in the ear, the hard-rubber tip should be inserted in the catheter, and *air alone* forced through to deter-

FIG. 66.



Hackley's Eustachian Nebulizer.

mine whether the catheter be properly in position. If found to be so, the piston may be pressed on at the same time that air is forced through. During this experiment the catheter may be held in position by clamps for that purpose, or may be held by the fore and middle fingers of the left hand, while the thumb of the same hand presses on the piston, the other hand being used to work the air-bag."

It is well to have a small round opening made in the air-

bag, as at C; while the air is being forced out this may be closed by the finger, which then being removed, the air-bag quickly fills again.

It may be said in general terms that the use of spray of astringent fluids to the Eustachian tube, is chiefly of value in those 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 inflammation, will be found quite as efficacious as fluids or spray. As has been already mentioned, steam is chiefly applicable to cases of proliferous inflammation.

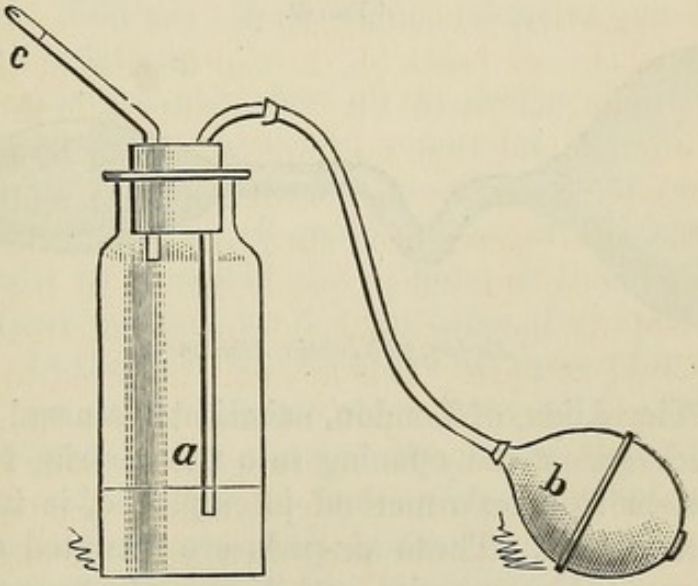
I am in the habit of employing Politzer's method of inflating the drum-cavity, immediately after the use of the Eustachian catheter, in all cases of chronic disease of the middle ear, but I cannot believe that it is a substitute for the catheter. It is very often found that no impression can be made upon the tube or middle ears by the use of Politzer's method alone, but after the catheter has been once 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 at once. It is not well, however, to place the air-bag in the hands of the patient and advise him to use it. Such advice will usually be over-regarded, and, instead of inflating the ears every other day, it will be done every hour perhaps. Besides, patients are often very unsuccessful in their attempts to drive air into the ears. Of course there are cases in which this system of self-treatment must be adopted, or none at all can be undertaken; but physicians who treat aural disease soon learn that, if they wish to achieve the best results, the treatment must be carried on by the medical adviser himself, and not be delegated to lay authority.

Some years since, I began to inject vapors into the ear by means of a simple apparatus* which is represented on the next page. The apparatus consists of a hollow bulb of

* American Journal of the Medical Sciences, vol. liii., p. 62.

hard rubber, 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 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 I chiefly employ. Dr. J. S. Prout, of Brooklyn, taught me 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. Great caution should be used in employ-

FIG. 67.

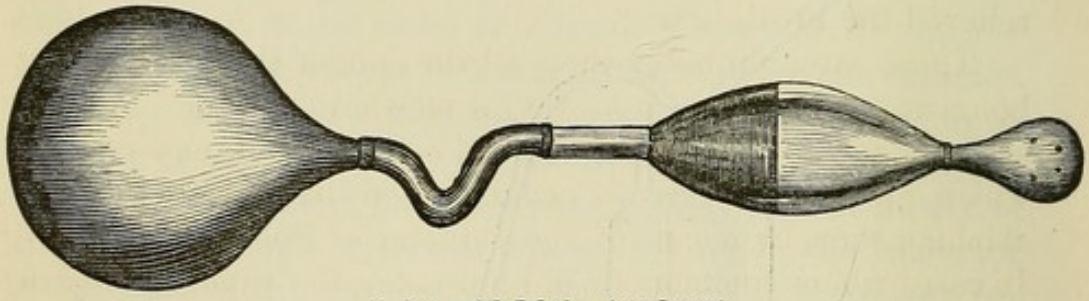


Apparatus for Injecting Vapors into the Nasal Passages.

ing the chloroform ; that is, but a few drops should be used, or the most intense pain will be caused. I have seen patients jump from the chair in surprise and pain, after one careful 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. The use of chloroform vapor is certainly a very valuable diagnostic means, although I am not so certain of its therapeutic value. The hollow bulb was recommended as an inhaler by Dr.

Buttles of this city; but the attachment to Politzer's apparatus was first made by myself. The vapor of iodine is very useful in many cases of naso-pharyngeal catarrh, and may be used by means of the inhaler that has been described, or by means of the simple apparatus that is represented on the previous page. It is very much employed by my colleague, Dr. Andrew H. Smith, at the Manhattan Eye and Ear Hospital. It consists of a simple glass bottle, whose cork is pierced with two holes, in each of which is a bent tube; one of these, *a*, reaches nearly to the bottom, the other simply passes through the cork. The latter tube has india-rubber nose-piece, such as is used in the ordinary nursing bottles. The other is connected to an air-bag, *b*, by which the vapor of the tincture of iodine is forced into the nostrils for three or four minutes.

Fig. 68.



Air-bag, with Inhaler Attachment.

Dr. Peter Allen, of London, substitutes a nasal pad, which is pressed *against* the opening into the nostrils, for the tube which, when Politzer's method is employed, is inserted *into* one nasal meatus. These air-pads are mounted on a strong piece of covered cotton wire, and they can be brought together or separated in such a manner as to stop up the nasal orifices. There is a hole in each pad, which communicates with two short bits of india-rubber tubing joining into a single tube. I have not found the use of the pads as convenient or efficient as the tip inserted *into* the nostril; but as some practitioners have thought that they were more convenient than the simple tube, placed in the nasal meatus, I have given this description of Dr. Allen's apparatus.* It can be had at the instrument-makers in New York.

* On Aural Catarrh, London, 1871, p. 79.

BOUGIES.

Bougies, for the purpose of dilating the Eustachian tube, are highly spoken of by some writers. Bonnafont and Kramer were perhaps the first to use them. *Guye*,* of Amsterdam, also employed them, and published three cases of emphysema produced by their use. In the first case there was emphysema along the neck, as far as the sternum. In three days it passed away. In the second there was suddenly considerable dyspnœa. The uvula was found to be the cause of the trouble. It was very much distended with air. An incision in it was made at once, and the patient again breathed quietly. In the third case a fold of mucous membrane in the fauces became so much swollen immediately after the use of the bougie, that breathing became difficult. Here, again, snipping the fold soon relieved the breathing.

These cases probably show all the danger there is in using bougies. They are, however, somewhat painful. Among some 1500 private patients, I have recorded but one case in which, after a fair trial, air could not be driven into the Eustachian tube by means of the catheter or Politzer's method. In cases where common air did not enter, the vapor of chloroform did. In this fact, will be found my reason for not resorting to the use of the bougie more frequently. Their use is chiefly to stimulate the mucous membrane lining the Eustachian tube, and thus 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. I find in injections of vapors or fluids the stimulant thus sought 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. Dr. Noyes reports a case† in which a fine whalebone olive-tipped bougie passed into both Eustachian tubes through the catheter, produced suppurative inflammation of the middle ear.

In the discussion which ensued on this case, Dr. Weir

* Archiv für Ohrenheilkunde, Bd. II., p. 6.

† Transactions of the American Otological Society, Third Year, p. 55.

said that he had tested the merits of the bougie practice for five years, and felt that in cases where obstruction of the Eustachian tube did not yield readily to Politzer's bag, the pump, or the catheter, the bougie was of very material assistance. In a large experience he had met with two accidents, purulent inflammation of the middle ear, and temporary emphysema of the eyelids, face, and neck. These accidents occurred from neglect of certain rules which he now carries out. Dr. Weir uses catgut bougies on which are marked the length of the catheter, the distance to the isthmus or narrowest part of the tube, 74 millimetres, then the distance from the point to the tympanic cavity, 11 millimetres, and finally the width of the cavity, 13 millimetres. The bougies ranged from Nos. 2 to 5 of the French Scale.

Dr. Weir's directions as to the employment of the bougies are so thorough and careful that I transcribe them.

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 then a few moments and then withdrawn, and air gently blown in through the catheter. If the air did not readily enter the tympanic cavity, all forcible attempts to force it were 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." Dr. Weir has found the most obstructions in the first portion of the tube, though in several instances he had overcome total obstructions at the tympanic orifice. "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."

ELECTRICITY.

This is an agent whose real value has been much underestimated in many departments of medicine, but which I am inclined to believe has been overrated in the treatment of aural disease. The effects of electricity on the acoustic nerve

will be fully discussed in the third part of this volume, while 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. *Drs. Beard* and *Rockwell* * think that "the best results are obtained in those cases passing from the sub-acute to the chronic stage, and that then they are brought about by the mechanical action of the Faradic current, on the adhesions within the middle ear." These are just the cases that are amenable to treatment by the catheter, Politzer's method, and applications to the pharynx.

Before closing the subject of the employment of the Eustachian catheter in aural disease, an allusion should at least be made to the singular dread of the instrument, now happily dissipated, which obtained in the minds of the profession in England and the United States. This dread seems to have depended upon two cases of death from the use of the catheter which occurred in the practice of a certain Dr. Turnbull, then of London, but who occasionally visited America, for the purpose of treating aural disease, until his death, which occurred a short time since, as I have been informed. These famous cases were reported in the London Lancet. In the same journal,† there is a letter from a correspondent accusing this Dr. Turnbull of advertising in the "Times" in an unprofessional manner—that is, by stating that he could cure "any case of deafness, not arising from organic disease, by the use of a peculiar remedy."

In order that the length and breadth of this matter of the death of patients from the use of the catheter, may be fully presented to the profession and not continue to be darkly hinted at, I quote from the Lancet‡ the account of the inquest upon these celebrated cases.

"On Monday evening an investigation took place at the Carpenters' Arms, Hoxton, before Mr. Baker, relative to the death of Mr. Wm. Whitbread,

* A Practical Treatise on the Medical and Surgical Uses of Electricity, p. 566.

† Vol. II., 1839.

‡ Vol. II., p. 558.

aged 66, which was supposed to have been occasioned by an operation lately performed on him by Dr. Turnbull of Russell Square. It appeared that the deceased, who was in the enjoyment of good health up to that time, had an operation performed upon him on Thursday week by the above physician, which consisted in injecting air through the nostrils for the relief of excessive deafness, under which he had been for some time laboring. Almost immediately after he was attacked with a violent swelling in the throat, and though the utmost attention had been paid to him, he expired on Thursday last."

"Mr. Wickham, a medical gentleman in the neighborhood, deposed, that on making a post-mortem examination of the body, he found that the inflammation in the throat was not sufficient to have occasioned the death of the deceased; death was produced by extensive inflammation of the brain, which, in his opinion, was occasioned by natural causes, and that neither the operation nor the inflammation of the throat had anything to do with it."

"The jury, on this evidence, returned a verdict of 'Natural death by the visitation of God.'"

"On Friday morning, at eight o'clock, an investigation, which occupied the greater portion of the day, was entered into before Mr. Wakeley, M. P., and a highly respectable jury of tradesmen, at the Plough Tavern, Museum Street, to prosecute the inquiry into the circumstances connected with the death of Joseph Hall, aged 18, who died whilst undergoing an operation for the cure of deafness, at the house of Dr. Turnbull, Russell Square, on the morning of Saturday last. The circumstances connected with the case had created an intense interest, and during the proceedings the inquest room was attended by many of the leading members of the medical profession."

"George Kimber merely stated that he and deceased were in the employ of Mr. Jackson, ornamental composition maker, of Rathbone place. He saw him last alive on Saturday morning, about seven o'clock, at which time he was getting ready to go to Dr. Turnbull's to be operated upon for deafness, to which he was subject; he was in all other respects quite well and healthy."

"Charles Spadbron, of Gravesend, deposed that he saw the deceased about ten o'clock on Saturday morning at Russell Square. He appeared in good health. There were other patients present at the time. Mr. Lynn, the gentleman who assists Dr. Turnbull, was pressed to operate. The deceased filled the instrument himself, and discharged the air by turning the cock. (The instrument was here produced, and the witness showed how it was filled. The bottom of the cylinder was held fast between the feet and the piston, worked up and down by the handle until the pump became filled with air.) The operation was repeated four times on deceased, but the tube through which the air passed was removed by Mr. Lynn from the right to the left nostril. On the tube being taken from deceased's nostril the fourth time, he fell back in the chair, apparently lifeless, and never spoke afterward."

"In answer to the coroner, the witness stated that he had had the operation performed on himself four times at a sitting; it produced a swimming in the head, and a portion of the air appeared to escape by the mouth, and the rest down the throat."

"Mr. James Reid of Bloomsbury Square, surgeon, deposed to having, by order

of the coroner, made a post-mortem examination of the body in presence of Messrs. Liston, Quain, Savage, and Lyon. Mr. Reid went into a long general anatomical statement, but the only points strictly bearing on the case were the following: That he found a thin layer of blood on the left side of the membrane, and globules of air under it, and in the small veins of the brain. That the left tympanum, or internal ear, had its lining membrane swollen, of red appearance, and there was a slight effusion of blood in it. From the known plethoric habit of the deceased, and from the fact of his having exerted himself at filling the air-pump before he was operated upon, he should say the cause of his death was apoplexy."

"Mr. Savage, lecturer on anatomy at Westminster Hospital, was next examined, and differed from the last witness, and stated that there was extravasated blood on both sides of the membrane, and that the tympanum of the right ear was affected as well as the left. He did not consider that deceased died of apoplexy, but that the injection of cold air, through the Eustachian tubes, was the primary cause of deceased's death."

"Mr. Liston, surgeon to University College Hospital, stated that he was present at the post-mortem examination, at the request of the coroner, and the probability was, that deceased died in a continued fainting fit. He could not easily disconnect the forcible injection of cold air into the tympanum from the effect that followed it. In the region of the tympanum were a number of small nerves, connected with the most important one in the body, which, receiving an impression, would cause spasms, or other fatal affections of the heart. Nothing precisely satisfactory could be come to on account of the decomposed state of the body."

"The coroner complained that though the subject of the inquiry had died on Saturday morning, no notice of his death had been sent by Dr. Turnbull or Mr. Lyon to the summoning officer of the district. He wished those gentlemen to give some explanation of their conduct."

"Dr. Turnbull and Mr. Lyon severally entered into an explanation."

"The coroner then addressed the jury at considerable length. And in accordance with the spirit of his observations, the jury returned a verdict of 'Accidental death,' with a caution to Dr. Turnbull never again to intrust the instrument of operation in unprofessional hands."—(*Times.*)

There are numerous explanations for these cases; but the account of the post-mortem is not exact enough to allow us to say which of them are correct. The first-named patient may have died from the emphysema produced by a wounding of the tissue by the point of the instrument. An examination of the tissues of the throat, immediately after the accident, would have determined this point; but there is no account of such an examination having been made. The experiments of Voltolini* show that all traces of an emphy-

* Monatsschrift für Ohrenheilkunde, Jahrgang VII., No. 1.

sema would pass off within ten hours after death, so that the post-mortem examination would give no information on this point.

The surgeon who determined that death was produced by inflammation of the brain, unfortunately gives no account of the evidences which led to the formation of this opinion. The second patient may have died in a fainting fit, or from emphysema.

The air-pump, is now scarcely used in the profession as a means of injecting air into the Eustachian tubes, because the air-bag is quite as efficacious, and because it is a much simpler apparatus. The management of an air-press should certainly never be left to the patient.

Voltolini, in the experiments to which allusion has been made, killed a rabbit in a few minutes by wounding the tissue of the pharynx, by a wire passed through a catheter, and then blowing forcibly into the opening. He thus produced great emphysema of the neck and chest. Voltolini believes that the cause of death of the rabbit, was a pressure upon the larynx by the emphysematous tissue, and not the pressure upon the lungs. Turnbull's patients may have both died from the same cause; but as we do not know the instrument used, or, in fact, any of the details, we can only surmise the real cause.

I need hardly say that the Eustachian catheter has never been even suspected of being the cause of death, since the time of these cases, although it is in daily use by physicians in all parts of the civilized world.

Before passing on to a consideration of the operative treatment for this class of aural affections, a word or two 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 that 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, they 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. The only reason that these limits of time are fixed is, that I have seldom seen anything accomplished in less than the shorter time, or after the longer term has expired. Very many patients leave us, at the outset, never to return. Some of them cannot leave their families to stay in a large city while their ears are being treated. This difficulty is being rapidly met. In every considerable town reputable and educated men, who have found that there is something more in aural practice than in syringing out the wax and then dropping in glycerine to restore it, are giving attention to otology, and the laity are beginning to reap the fruits of this cultivation of a hitherto barren field.

There is another class, however, whom such advice never influences. One of their family, 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 I have 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, 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.

CHAPTER XIV.

THE TREATMENT OF CHRONIC NON-SUPPURATIVE INFLAMMATION—CONCLUDED.

OPERATIONS UPON AND THROUGH THE MEMBRANA TYMPANI.

OPERATIONS upon and through the membrana tympani, have assumed a new importance within the past few years, in chronic, as well as acute aural disease. It is generally believed that still more will be accomplished for chronic aural inflammation by such procedures. There is, therefore, a justification for a full consideration of this subject, such as I shall endeavor to give in this chapter.

The reader of otological literature will be almost appalled by the amount of material on this subject. It begins with Cheselden's experiments on dogs, and ends as yet, with Weber's operation upon the tensor-tympani muscle. From the mass of authorities I have collected such a history of this subject as will, perhaps, enable the candid professional mind to come to a knowledge of the true value of these different proceedings, as far as they have as yet been developed.

I am indebted to a *brochure* by Dr. Hermann Schwartze, of Halle,* for the portion of this historical sketch that extends to our own day, although, wherever possible, I have consulted the original authorities and verified, and in some instances amplified, Schwartze's quotations.

1650.—Johannes Riolanus, of Paris, about 150 years before the time of Sir Astley Cooper, who is usually supposed to be the originator of the operation of perforation of the membrana tympani, inquired if it would not be possible to

* Studien Beobachtungen über die Küntsliche Perforation des Trommelfells, Archiv für Ohrenheilkunde, Bd. II., S. 24.

improve the hearing of the deaf, by destroying the membrana tympani. He was led to make this inquiry from the fact that he knew of a deaf person, whose hearing *was restored* by an accidental rupture of the membrana tympani, by means of an ear-spoon.

It is well to remember that, until very recently, there were no exact measures taken to estimate the amount of hearing, and that, consequently, such phrases as "the hearing was restored," "the hearing became perfect," as they occur in ancient books, only mean that the hearing was improved, sometimes very much, sometimes very little.

1722.—About a hundred years later, T. Cheselden, surgeon to St. Thomas's Hospital, London, well known as the inventor of the operation for artificial pupil, actually operated upon dogs, and I quote from his work on anatomy* the description of his cases. Speaking of the membrana tympani, he says: "I found it once half open on a man that I dissected, who had not been deaf, and I have seen a man smoke a whole pipe of tobacco out through his ears, which must go from the mouth, through the Eustachian tube, and through the tympanum, yet this man heard perfectly well. These cases occasioned me to break the tympanum in both ears of a dog, and it did not destroy his hearing, but for some time he received strong sounds with great horror."

Cheselden then goes on to say that an anatomist named St. Andre assured him that "a patient of his had the tympanum destroyed by an ulcer, and the auditory bones came out without destroying the hearing." I have only been able to obtain the second edition of Cheselden's works, but Schwartze quotes from the seventh, where the author states that he obtained permission to perform this operation, that was then esteemed such a formidable one, upon a prisoner. If the prisoner survived the operation, he was to have his freedom. Unfortunately for science and for the criminal, the proposed subject became ill, so that the operation was indefinitely postponed. Sir Astley Cooper† says that such an outcry was aroused by the inhumanity of the proposed oper-

* The Anatomy of the Human Body, London, 1732, p. 250.

† Philosophical Transactions, 1800, p. 152.

ation, that Cheselden never again obtained permission to perform it.

1748.—Dienert, of Paris, in a dissertation, recommended perforation of the membrana tympani for the purpose of evacuating blood or pus from the cavity of the tympanum. Itard says that Julius Busson proposed the operation six years before this.

1760.—The first man who actually performed the operation as a means of benefiting the hearing, was a person named Eli,* who seems to have been a charlatan.

Portal and Sabatier, two Paris surgeons, who lived at the same time as Eli, knew nothing of his operations. Portal proposed to puncture the membrana tympani, in the cases where it was greatly thickened. Sabatier, on the other hand, proposed to perform the operation upon a relaxed membrana tympani.

1788.—Wilde quotes a passage† from Dr. Peter Degravers, of Edinburgh, who lived in 1788, and who styled himself professor of anatomy and physiology, which shows that he had performed the operation. Degravers says: "I incised the membrana tympani of the right ear with a sharp, long, but small lancet. I left the patient in that state for some time, and afterward observed that it had united. I incised again the membrana tympani of the right ear, but crucially, and, on removing some of the parts of the membrane incised, I discovered some of the ossicula, which I brought out." Schwartze naively remarks, "There is no account of the results in this case."

1800.—In the beginning of this century, at about the same time, and independently of each other, Dr. Karl Himly, then of Brunswick, Germany, and Sir Astley Cooper, proposed the operation, especially in closure of the Eustachian tube. Himly had demonstrated to his students, in 1797, by experiments upon the human cadaver and living dogs, that the operation

* The following paragraph is quoted by Gairal, Lincke's Sammlung, Bd. V., p. 109, in proof of Eli's operation: "Est Lutetiæ homo quidam ELI dictus, qui surditatem curare audet, dummodo malum nona paralysi nervi septimi paris oriater, en vero eius methodum tympanum exscindit et suppositum immittit. Feci experimenta quædam, quæ satis bene ipsi cessarunt."

† Aural Surgery English edition, p. 15.

could be easily and safely performed; but he did not perform it on the living subject until 1806. He reports a brilliant result in one case only, in a person suffering from syphilitic ulcers of the pharynx, who had been deaf for years from closure of the Eustachian tube.

After Sir Everard Home had published his paper on the functions of the membrana tympani, a paper to which allusion has already been made in this volume, Sir Astley Cooper published a careful and exact account* of the case of a medical student at St. Thomas's Hospital, in London, who had lost his membrana tympani, but who, nevertheless, could hear quite well.

The student was twenty years of age, and applied to Sir Astley in the winter of 1797. He was attacked at ten years of age with suppuration in the left ear, and in about twelve months after with the same disease in the other ear. There was a profuse discharge for weeks from both ears, and in the discharge bones, or pieces of bones, were observable. The patient was totally deaf for three months; the hearing then began to return, and, in about ten months from the last attack, it was restored to the state in which it was when he consulted the great English surgeon. Sir Astley then gives an account of the means by which he decided that the drum-heads were perforated. The patient having filled his mouth with air, he closed his nostrils and contracted his cheeks: the air thus compressed was heard to rush through the meatus auditorius with a whistling noise, and the hair hanging from the temples became agitated by the current of air which issued from his ear. "To determine this with greater precision, I called for a lighted candle, which was applied in turn to each ear, and the flame was agitated in a similar manner." The examination of the case was continued in this thorough manner.

The gentleman, when in company, was capable of hearing what was said in the usual tone of conversation, and he could hear with the ear in which there was no trace of a membrana tympani, better than with the one in which there was merely a circular opening. When a note was struck upon the piano,

* Philosophical Transactions, l. c.

he could hear it but two-thirds of the distance at which the examiner could hear it.

Although this case was accessible to the profession from the year 1800, it is surprising to find the belief still widely prevalent among the laity and the profession, that the destruction of the membrana tympani involves almost complete loss of hearing. The advance in the simplicity of means of an accurate diagnosis in aural disease, is nowhere more distinctly seen than in a comparison of Cooper's method of determining whether the membrana tympani be intact or injured, with that of the surgeon of the present day, who, with the otoscope, is able to state just what the condition of the part is, with no aid from the patient, and in a very brief space of time.

This observation led the way to the operation of perforation of the membrana tympani * for the relief of impaired hearing. The only indication that the great English surgeon spoke of was closure of the Eustachian tube, which he believed arose from the following causes:

1. A common cold affecting the parts contiguous to the orifices of the tube, and thereby preventing the free passage of air into the tympanum.

2. Ulcers in the throat, from the scarlet fever, which in healing frequently close the Eustachian tubes.

3. A venereal ulcer in the fauces, by the cicatrix it produces, may cause a closure of the tube.

4. An extravasation of blood in the cavity of the tympanum.

The scientific character of Astley's observations is nowhere better shown than in these indications, which are exact, and in consideration of the state of knowledge as to the means of opening the Eustachian tube, correct. The last-named condition, however, cannot be said to depend upon closure of the tube, but is a simple case of hemorrhage into the tympanic cavity, which no affection of the tube would be likely to cause.

Mr. Cooper reports four cases:

Case I.—A woman, thirty-six years old, who had been affected for eight years. The deafness arose from enlarge-

* Sir Astley's paper descriptive of his operations was read June 21, 1801. See Philosophical Transactions of the Royal Society of London, 1801.

ment of the tonsil glands; a puncture of the drum-head was made, and while she stayed in the consulting-room for one half-hour, she could hear ordinary conversation.

Case II.—Ann D., age not stated, so deaf as not to hear words unless spoken close to the ear. She had been affected for six weeks. She could hear a watch when pressed upon her ear. After the puncture she could hear the watch several feet.

Case III.—J. R., aged seventeen. The hearing had been impaired since birth. There was an imperfect state of the fauces, so that he could not blow his nose. The Eustachian tubes had no openings into his throat. Puncture of the membrana tympani produced such a confusion that he nearly fainted, but in two minutes he recovered, and, two months after, his hearing continued perfect.

Case IV.—A person was sent to Mr. Cooper, who had received a blow upon the head, which had occasioned symptoms of concussion of the brain, and was attended with a discharge of blood from each ear. He recovered from all the effects of the blow but the deafness. Blood was found in the meatus by Mr. Cooper. After clearing this away and perceiving no benefit, suspecting that a quantity of blood was lodged in the tympanum, in a few days he punctured the membrana tympani. Blood mingled with the wax was discharged for ten days, during which time the hearing was gradually restored.

In closing his paper, Sir Astley states that little pain is felt in the operation, and that no dangerous consequences follow.* The Valsalvian experiment was the means by which he determined whether the Eustachian passage was open or not, for he says that, when the experiment succeeds, the tube is open. Besides this, the patient should be able to hear a watch placed between the teeth or on the temporal bones. Cooper published his four cases of good results, and, according to Schwartze and Frank, he was soon inundated by deaf

* Sir William Wilde states that, within a few months of his death, Sir Astley exhibited the greatest interest in this subject, and left his consulting-room full of patients for a long time, to send for a man in Bond Street, upon whom he had operated, in order to exhibit him to Mr. Wilde.—*Vide Dublin Journal*, vol. xxv., 1844.

persons from all parts of Europe. He then operated on fifty more cases, but the results were either slight, null, or they lasted for a short time only. Cooper then declined to see deaf patients, on account of the fact that he was doing very little good, and also because his fame as a surgeon was suffering from his reputation as an aurist. After the lapse of more than seventy years, the dispassionate, scientific character of Sir Astley Cooper's writings on this subject, stands in striking contrast to the charlatanism of some of those who followed him in this operation.

After Cooper's operations, a great interest was excited in France on this subject, and, according to the medical journals of the time, quoted by Schwartze, Riber of Bordeaux, Maunoir of Geneva, and others, operated, but with no permanent results.

In Germany, also, the same interest was created. Michaelis, a professor in Marburg, informs his friend Hunold, of Capel, that he had operated on one case successfully. Hunold then proceeded to puncture every membrana tympani to which he could get access. Finally, Hunold records that he has had the brilliant result of curing or improving seventy cases out of a hundred. Subsequently, it was shown by others, that these results were not only exaggerated, but, that they were not even at all in accordance with truth. Of Michaelis's sixty-three cases, in forty-two there was no result whatever; while in twenty-one, or one-third, there was greater or less improvement. But, of all these, in only one was there a permanent result six years after; *perhaps* the benefit was permanent in three other cases.

Schwartze says that after Hunold's marvellous accounts of his successful results from perforation of the membrana tympani, the operation became the fashion, and every one, who did not have the finest hearing, allowed the drum-heads of the ear to be pierced. Even the poor deaf-mutes had their drum-membranes perforated. Fashions in medicine are not confined to our own time.

To stem this tide of charlatanism, Karl Himly, professor in Göttingen, wrote a commentary upon the operation, and showed that it was only in exceptional cases that it was of any

value. These exceptional cases were such as those reported by Cooper, for the relief of which, since there were no means of opening the Eustachian tube, paracentesis of the membrana tympani was a beneficial operation; but the profession seem not to have studied Sir Astley Cooper's cases, but it was merely known that he perforated the membrana tympani with benefit to the hearing. Himly's paper excited so much attention that the operation was not heard of for a long time.

In England, as we have seen, Cooper abandoned the operation and otological practice. Stimulated by the opportunity for entering an operative field, Saunders opened an aural clinic in 1804, but soon closed it on account of the poor results of treatment. He speaks of one case of perforation in which a good result was obtained. After him came Curtis, who talks of the operation in very general terms, but without furnishing cases. Buchanan also promises to describe his cases, but he never did; and Schwartze thinks that Degravers, the Edinburgh professor, from whom I have quoted, and Stevenson, are not to be relied upon.

In France, Itard, Boyer, and Deleau wrote upon this subject. Itard was wise enough to perforate a drum-membrane of a deaf-mute whose tympanic cavity was filled with masses of tenacious mucus, and he succeeded in removing them after the operation by syringing. This was an anticipation of Mr. James Hinton's operation. In one hundred and seventy other cases, there was absolutely no result. He calls attention to the fact that permanent suppuration may occur even when the operation is very carefully performed.

1822.—Saissy, of Lyons, in his work on the ear, speaks guardedly of the operation, and of only one case where the result was entirely satisfactory. Dr. Nathan R. Smith, of Baltimore, translated Saissy's book, and invented an instrument for perforation of the drum-head, which he described in the appendix to his translation; but there is no account of the success of the operation in this country.

Schwartze gives very little credence to Deleau's account of his successful results. He claims to have improved eighteen out of twenty-five deaf persons and deaf-mutes, by the operation.

Hendriksz, of the University of Gröningen, in 1828, in an inaugural thesis on the subject, which Schwartze used in his historical sketch, states that in the institutions for the deaf and dumb, in Berlin, Vienna, and Gröningen, this operation was frequently performed. In Gröningen, eighty-one deaf-mutes were operated upon, of whom seventeen received for the moment a more or less decided improvement. We hear nothing then of the operation for twenty years, until Hubert Valleroux, in 1843, wrote an essay upon the danger attending it. He speaks of two cases of death from it.

Wilde,* in defence of the operation, when performed under proper indications, says that Dr. Butcher, of Dublin, reported two cases with a view of showing the ill-consequences resulting from the performance of the operation, and relates the cases of two young persons, a man and a woman, in both of whom it would appear that death ensued from puncturing the membrane. In the first instance, the only history of the case is that, prior to this period, she got a severe cold, with a swelling of the glands of the neck. No account is given of the cause or origin of her deafness, the condition of the membrana tympani, why the operation was performed, in what manner, by whom, or with what instrument. According to Wilde, all that we know is, that "catheterism of the Eustachian tube was performed, and said to fail; hence it was agreed that the membrane of the tympanum should be pierced, a small piece being drilled out of the membrane of the right side." No exact account of the operation and no names of the witnesses are given. Inflammation ensued, and *four months after* she died, when the petrous bone was found roughened and softened, and the membrana tympani entirely destroyed. This case, certainly, with such a history, can form no text for a homily against paracentesis of the drum-membrane.

The second case is equally indefinite. Wilde says all that is known of the case is, that he applied to a surgeon and had his tympanum pierced, "but why, or whether with a gimlet or a punch, a trocar or a probe, we are not informed. At first

* Text-Book, English edition, p. 297.

the hearing improved, and then relapsed. After some time head-symptoms set in, and the man died in six weeks." On the *post-mortem* examination, the brain and its membranes were found in an inflamed condition, and a small abscess in the anterior lobe of the brain, on the same side upon which the puncture was made. The cause of the deafness in this case was found to be a small tumor, about the size of a bean, lying on the acoustic nerve.

Paracentesis of the membrana tympani was certainly not indicated in this case, and the two together form no more of an argument against the operation, than the indefinitely-reported cases of death from the use of the Eustachian catheter do against the use of that instrument.

The treatises on diseases of the ear, of Kramer, Rau, Bonnafont, Toynbee, and Von Tröltsch, add very little to our knowledge of this subject.

It has thus been seen, that the first indication which was set down by the old authors, was closure of the Eustachian tube. Since the scientific use of catheters and bougies, this is no longer recognized as a correct indication for perforation of the drum-head. In the very rare cases in which there is an impermeable stricture from cicatrization, it would be, however, a proper operation.

Thickening of the membrana tympani was another prominent indication of the old authors—not of Cooper, however. We now know that a thickening of this membrane that is confined to the outer layers, may be removed by appropriate local applications, while one that has extended to the fibrous, or mucous layer, or both, is nearly always accompanied by thickening of the whole lining membrane of the cavity of the tympanum, so that this indication may also be dismissed.

A collection of blood, pus, or mucus, in the cavity of the tympanum, is, then, the only indication of the old writers which may fairly be said to be up to the present standard of knowledge. The collections are readily diagnosticated in all acute and sub-acute cases, and still remain good indications for perforation of the membrana tympani.

From this chaos of illy-defined indications and imitative experiment, there came out one fact in proper form. That

one fact was this: That it was pre-eminently proper to perforate the membrana tympani in order to remove mucus, blood, or pus, which could not find an exit through the Eustachian tube. Sir Astley Cooper's favorable cases showed this fact. Itard's deaf-mute was also another illustration of its truth; but, throughout all the history of these cases, we do not find, until we come down to Saunders,* and later to Hermann Schwartze, of Halle, that one writer had been able to select this single grain of wheat from the chaff. Schwartze saw what had been shown by the cases that were published, and in his first article† revived the operation of paracentesis, but chiefly applied it to acute disease, where these accumulations of mucus, blood, or pus, are likely to occur. The operation is now well established as a means of treatment in acute cases, and has already been described in the chapter on acute catarrh of the middle ear.

Schwartze has lately published one hundred cases in which he has performed a paracentesis of the membrana tympani. Before passing on to review the methods of writers who, since Schwartze's paper was published, have modified the simple operation and enlarged its field, so as to cause it to play a great part, as they claim, in curing chronic cases of catarrhal and proliferous inflammation, I will venture to criticise Schwartze's table of results. Of his one hundred cases, only two were in persons over fifty years of age, and only seventeen were over twenty. The remaining eighty-one were under that age, and forty-six were between one and ten years. In America, our cases of chronic non-suppurative inflammation occurring in young persons are usually quite tractable without paracentesis. We are chiefly anxious to enlarge our therapeutic means for the cases of persons who are more than sixteen years of age, and especially for those who are adults in middle life. Again, in thirty-four of the cases, the disease, whatever it was, had not existed for a year. There were only ten cases where the aural affection had lasted between five and ten years, and in six cases only, more than ten years.‡

These statements show that we have not, as yet, even in repeated paracentesis of the membrana tympani, found the

* See Introductory Chapter, p. 40.

† Archiv für Ohrenheilkunde, Bd. II., p. 36. ‡ Ibid., Bd. VI., p 195.

remedy for the class for which we in America are most anxious—old and neglected cases of chronic proliferous inflammation. Schwartze's contributions, in other words, principally affect acute and sub-acute disease. The line should have been a little more distinctly drawn between the cases of sub-acute and chronic inflammation, for which paracentesis was performed.

1845.—It was thought by many that, if a permanent opening could be kept in a drum-head, the great desideratum would be attained. Bougies were placed in an opening made with a small trephine, and, when it was found that this excited too much reaction, a gold tube, three lines long, and having a little ridge on both ends, was inserted, with a view of keeping up a permanent opening.* This was years before Politzer introduced his eyelet. In 1868, Politzer had a case in which he placed an eyelet in a cicatrix which he had incised. Although of service in this case, it has proved, however, to be beneficial only in very exceptional cases, where, perhaps, repeated paracentesis would do quite as well. Several cases of accident have occurred in its use. I saw one case in which the opening had closed and left the foreign body in the cavity of the tympanum. I saw the case but once. Dr. Noyes† reported another case, where, in attempting to insert the eyelet, it was lodged, not in the membrana tympani, but in the cavity of the tympanum. Eighteen days after, at the patient's solicitation, he was placed under chloroform and the eyelet removed by making quite an opening in the membrana tympani. The suppuration from this opening ceased, and the opening closed in sixteen days. The hearing distance was improved, from contact with the meatus, to three and one-half inches while there was an opening in the membrane; when the opening closed, the hearing went back to the first-named point. This accident of escape of the eyelet into the tympanum is thus one quite likely to happen, either at the time the membrane is pierced, or subsequently. The suppuration which occurs is more apt, however, to force the membrane into the auditory canal than into the meatus.

* Frank's Practische Anleitung, Erlangen, 1845, p. 310.

† Transactions of American Otological Society, third year, p. 57.

The published experience of those who have performed this operation do not commend it as a successful procedure, and I believe that it is now very seldom performed.

1867.—Wreden,* of St. Petersburg, went far beyond the propositions to make an opening in the membrana tympani, and excised a portion of the handle of the malleus. Inasmuch as the chief vascular supply of the membrana tympani was along the handle of the malleus, Wreden believed, and with correctness, that, by cutting this off, there would be less probability that the cicatrix would form. He says that, when he removed two-thirds of the membrana tympani and the handle of the malleus, he never saw the opening fully close. This operation never found much favor, for the reason that it proved to be dangerous to the hearing and even to the life of the patient. It often excited an otitis suppurativa of so severe a form, as to destroy the remainder of the hearing power. It may be doubted, too, judging from analogous cases occurring accidentally, whether even such an opening would not heal. The regenerative power of the membrana tympani is indeed marvellous. We need, however, spend very little time over this operation, for it has been practically abandoned by the imitators of Wreden, if not by the distinguished author himself.

Voltolini,† following the suggestion of Erhard, made the incision with the galvano-cautery, in the hope that the opening made in this way would be longer in closing. He made an incision through the centre of the posterior section of the membrane. There was a crackling sound, as if one passed a knife through a tense paper. This first operation was on a patient who had been deaf for three years, and had suffered from fever, after which he became blind from cataract and deaf from unknown causes, or at least unstated ones. Immediately after the deafness appeared, which is stated to have been complete, he was treated by the Eustachian catheter, but without effect.

Voltolini's first operation did not result in much if any benefit to the patient, but it proved that an opening made by

* Monatsschrift für Ohrenheilkunde, Bd. I.

† Ibid., Bd. I., p. 39.

the galvano-caustic apparatus could be kept open longer, than one made by the knife. Voltolini improved the hearing of a patient in whose membrane he had made an opening with the galvano-cautery to such an extent, that a watch which was not heard before the operation, except when laid upon the auricle, was heard more than an inch, and ordinary conversation so well that the patient, who was a shop-keeper, was able to carry on his business. The tinnitus aurium and sensations of pressure in the head were also removed. The painlessness of this method makes it one to be imitated, and where we find that the hearing is improved, as long as the opening remains in the membrana tympani, it would be well to use the galvano-cautery.

1863.—Gruber's operation, which he calls "myringodectomy," consists in forming a flap in the membrana tympani by means of a knife and forceps. The flap is cut off. Voltolini shows that this operation is both difficult and dangerous. It is difficult, on account of the surgeon being obliged to work with two instruments in a narrow canal. That it is dangerous, is shown by the histories of the cases which Gruber gives; *e. g.*, one patient had fever from the 9th to the 21st of November; and quite severe hemorrhage during and after the operation, so that the auditory canal was several times filled with blood. Voltolini also calls attention to the fact, that Gruber's method is but a modification of the old operations with perforators; but we may say, that all these operations are modifications of old ideas and suggestions. In one of Gruber's cases, the opening still existed five months after the operation was performed.

1868.—F. E. Weber, of Berlin,* recommended the division of the tensor tympani muscle, and the "abnormal adhesions that may occur in the region of this muscle." One of the chief indications is the relief of pressure upon the labyrinth from retraction of the tensor tympani. This muscle has its origin from the cartilaginous portion of the Eustachian tube, and runs along the edge of the bony canal, and is inserted by a well-defined tendon on the inner angle and inner surface of the handle of the malleus.

* Monatsschrift für Ohrenheilkunde, Jahrgang II., p. 51.

Weber thus advanced far beyond the idea of maintaining a permanent opening in the membrane, and carried into effect an old idea of dividing abnormal adhesions that may form between the ossicula.*

Dr. Weber published an article in January, 1872, in which he goes very fully into the object, effect, and manner of performing his operation. It is well known that the great Vienna anatomist, *Hyrtl*, was the first to suggest this operation, but Weber was the first to perform it. At the time of the publication of Weber's last article he had operated upon about fifty cases.

There were two conclusions which led Weber to the performance of this operation: 1st, The fact that had been demonstrated that the tensor tympani muscle kept not only the membrana tympani and the ossicula with their ligaments, but also the labyrinth, by means of the stapes, in a state of tension, and that, consequently, an increased tension or rigidity of the muscle prevented the proper conduction of sound and increased the pressure upon the labyrinth. 2d, He also reasoned that this increased tension would of itself excite and maintain catarrhal inflammation of the tympanic cavity, especially if there was at the same time an affection of the tube, and that it might cause a hinderance to the circulation in the labyrinth, with tinnitus aurium, etc. In short, Dr. Weber thought it possible that many varieties of non-suppurative affections of the middle ear might depend upon excessive contraction of this muscle.

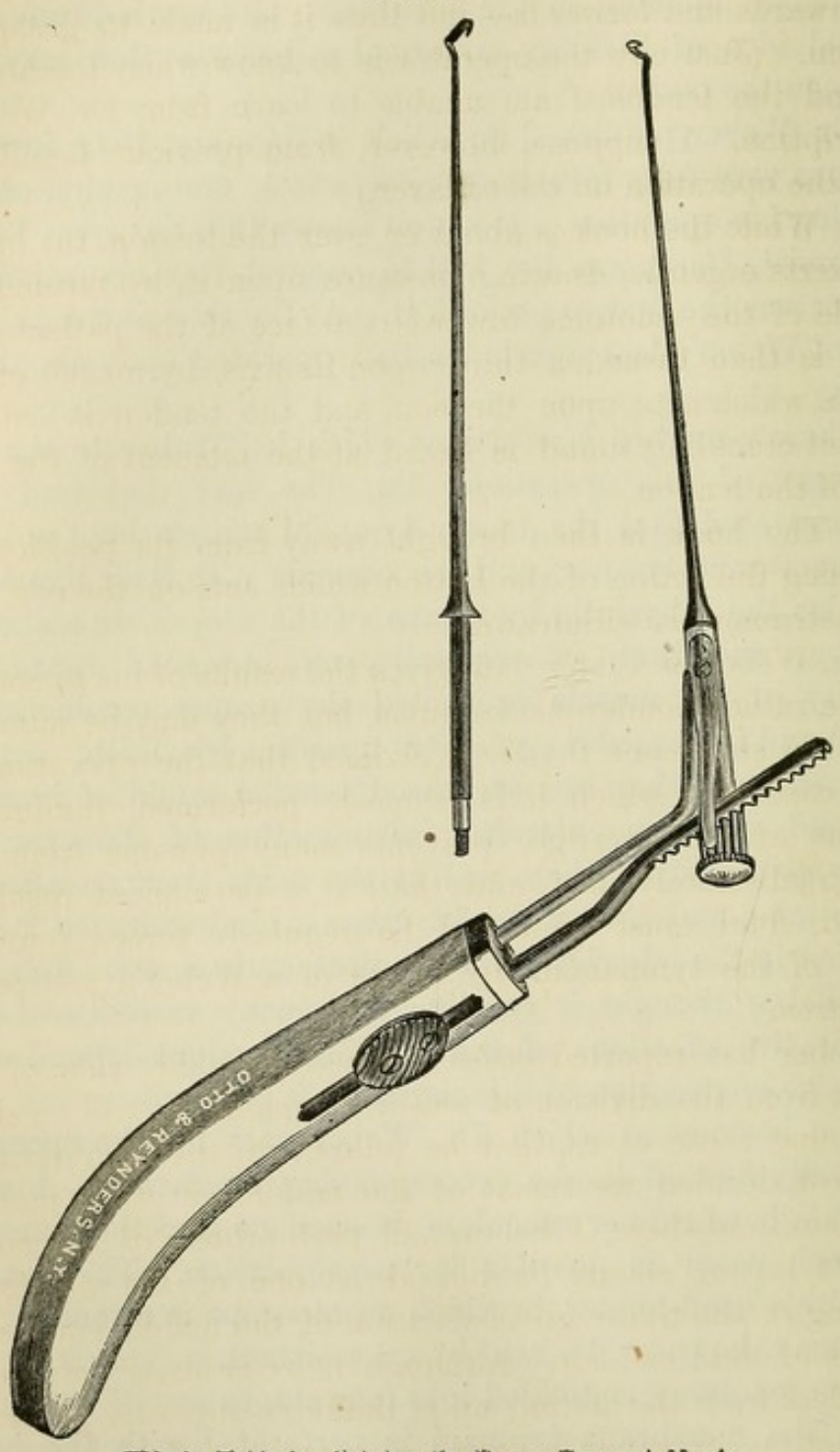
The instrument which Dr. Weber uses for the operation is exactly figured in the accompanying engraving. A short and thin hard rubber speculum is used so that there may be as much room as possible for manipulation. The head is fixed by a head-holder, to which an otoscope is attached; the head may, however, be held by an assistant.

The tenotomy is divided into four stages

1. The membrana tympani is perforated with the hook-shaped extremity of the tenotome, about 1—1½mm. in front

* L. c., Jahrgang IV., p. 143.

Fig. 69.



Weber's Knife for dividing the Tensor Tympani Muscle.

of the handle of the malleus, somewhat below and to one side of the short process.

2. The hook-shaped knife is pushed forward into the cavity

of the tympanum—the handle of the instrument being brought downwards and forwards—and thus it is made to grasp the tendon. (Just how the operator is to know when the hook is around the tendon, I am unable to learn from Dr. Weber's description. I suppose, however, from previous familiarity with the operation on the cadaver.)

3. While the hook is about or over the tendon, the operator exerts a gentle, drawing pressure upon it, by turning the handle of the tenotome towards the face of the patient; the hook is then turned a third upon its axis, by means of the button which acts upon the cog, and the tendon is cut. A distinct crackling sound is heard at the moment of the division of the tendon.

4. The hook is then brought away from its position by reversing the action of the button which acts on the cog, and the instrument is withdrawn.

Dr. Weber at a later date gives the results of his operation in nine rather ponderous formulas, but they may be summed up in the statement that it is claimed that the operation, in most cases for which it is properly performed, diminishes tinnitus aurium, vertigo, prevents many persons from becoming absolutely deaf, and that, if a permanent result is desired, fluid must afterward be regularly forced into the cavity of the tympanum, by means of a Weber's *pharmacokoniantron*.

Weber has reported cases which confirm his view of the benefit from the division of tensor tympani. It will be seen, by reading these cases, that he follows up the operation by the most decided treatment of the middle ear, thus placing this operation where, I believe, all perforations of the membrana tympani should be placed, as one of the means of assisting in the thorough medication of the middle ear by injections of fluid and air. Although there is usually a temporary effect from the letting up of the intra-auricular pressure, it cannot be compared to such an operation as iridectomy for glaucoma, when the use of the knife ends the treatment.

Gruber, in a lecture recently delivered, advocates the division of the tensor tympani muscle, on account of the fact demonstrated by Helmholz, that this muscle moves the whole chain of

the ossicula auditus, as well as the malleus, inward, a fact which causes us to believe that the intra-auricular pressure must be increased and morbid changes caused by any excessive contraction of this muscle. Gruber calls attention to the fact which he was the first to show, as he claims, that the muscle is inserted not only on the inner angle, but also on the anterior surface of the handle of the malleus, and he also alludes to what we have already noticed in the chapter on the anatomy of the middle ear, that the tensor tympani is intimately connected or united to the tensor palati muscle. This seems to indicate that the frequent affections of the soft palate must have some abnormal influence upon the tensor tympani. Gruber considers the indications for a division of the tensor tympani to be a retraction or contraction—a shortening of this muscle. These indications may be known by studying the changes on the folds or pockets of the membrana tympani.

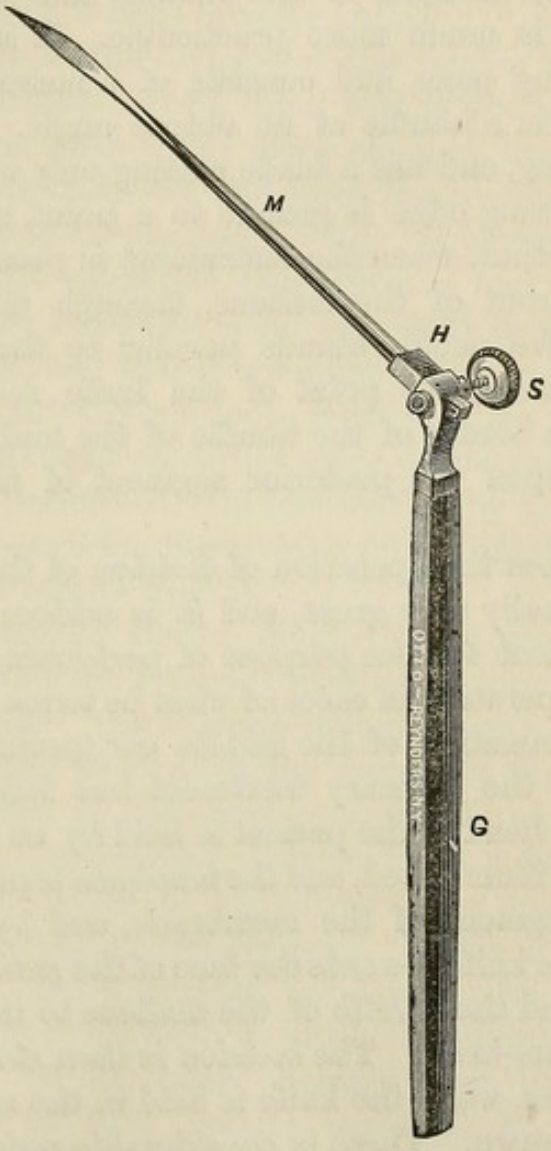
"If the membrane is drawn very much inward, and the lower end of the malleus goes with it, while the upper retains its position, and thus the posterior fold becomes more prominent, we have an indication of the abnormal sunken position of the drum-head." Gruber admits that this sinking of the drum-head may depend upon other causes than the retraction of the tensor tympani; but these may be readily distinguished. The excessive contraction of the muscle causes the handle of the malleus to appear broader, and the membrana tympani to look as if twisted, in a state of what in surgical language is called torsion. The anterior ligament of the malleus, which passes from the spina tympanica to the neck of the malleus, also becomes more prominent, in retraction of the tendon of the tensor tympani. The final mark of retraction of the muscle, according to Gruber, is the more or less rapid reposition of the membrane in its former position after the air-douche has been employed. It is certainly very easy for us to verify these indications, as given by Gruber, and it is to be hoped that the operation will have a fair trial in the class of cases

* Seperat-abdruck aus der Allgemeinen Wiener Medizinischen Zeitung, Jan., 1872.

of non-suppurative disease, for which we have as yet done so little.

Gruber advises that the tendon be usually divided as Weber recommends, in front of the handle of the malleus.

FIG 70.



Gruber's Knife for dividing the Tensor Tympani.

The accident that may *possibly* happen, if the membrane is opened posteriorly to the malleus, according to Gruber, is a perforation of the carotid artery, if the carotid canal be incomplete in its bony wall; but this kind of an accident seems to be almost impossible, with any care in the management of the

tenotome. As another argument for the anterior incision, it is stated, that the labyrinth cannot be entered if the opening be made in front of the malleus, while the knife might possibly go through the foramen ovalis, if the opening be made posteriorly. Gruber uses a much simpler instrument than Weber's for the division of the tendon, and one which, in my judgment, is much more practicable. It is represented on the preceding page, and consists of a narrow, needle-like knife, fastened in a handle at an obtuse angle. The knife is three inches long, and has a blade cutting only on the anterior edge. This cutting edge is ground to a point, and curved to such an extent that, when the instrument is passed one-half a millimetre in front of the malleus, through the membrana tympani, and the needle stands parallel to the long axis of the auditory canal, the point of the knife reaches only a little above the border of the handle of the malleus, but does not pass far upon the posterior segment of the membrana tympani.

The pain from the operation of division of the tensor tympani is not usually very great, and it is seldom necessary to etherize a patient for the purpose of performing it. Gruber performs the operation in cases of what he terms hypertrophic or plastic inflammation of the middle ear (proliferous inflammation), where the ordinary treatment has failed to benefit the case. The head of the patient is held by an assistant, the drum-head well illuminated, and the tenotome is passed through the anterior segment of the membrane, and by turning the outer end of the knife towards the face of the patient, the point is pushed around the handle of the malleus to the other segment of the drum-head. The incision is then elongated about three millimetres, while the knife is held in the same position, and then withdrawn. There is considerable resistance in the tissue when the tendon is divided, and a crackling sound is heard. The hemorrhage from the operation is usually very slight. The air-douche, by the catheter or Politzer's method, should be used after the cutting is finished, and the ear closed lightly with cotton, while the patient should be kept quietly in the house and avoid taking cold.

Those who doubt whether it is possible to divide the ten-

don without also cutting other parts, will have their doubts removed by performing the operation on the dead body according to the directions of Weber or Gruber, and then making an examination of the parts.

Dr. Orne Green recommends that Gruber's operation be done by making the incision *posterior* to the handle of the malleus, and with a little broader knife.*

The results of the division of the tendon are as yet not remarkably brilliant; but I think this is due to the fact, that cases are taken when many more changes than retraction of the tendon have occurred, and when the condition of the middle ear is beyond all therapeutic aid. It having been demonstrated that the operation is a safe one, and that it usually has a temporary beneficial effect, especially in diminishing the tinnitus aurium, and that it sometimes does substantial benefit, we may, I think, hope more from it in the future, when it will be undertaken at an earlier stage of disease of the middle ear. If thus performed, and followed up by treatment of the middle ear through the Eustachian tube, I think we may hope for substantial results from it.

1871.—Lucae, of Berlin, divided the posterior pocket or fold of the membrana tympani, in what he terms "dry catarrh of the middle ear" (proliferous inflammation), where there is a marked sinking inwards of the handle of the malleus, and great prominence of the short process, and when the Eustachian tube is permeable.† Lucae uses a bayonet-shaped needle, and the incision is made from below upwards, in order to avoid cutting the chorda tympani. If this nerve be divided, it is probably not a serious accident, judging from cases of injury to the drum-head in which the chorda tympani has been injured. Of 109 cases operated upon by this method, Lucae claims to have greatly benefited 46, and to have improved 39, while in 24 there was no benefit from the operation.

A question of priority has arisen between Dr. Lucae and

* Dr. Green has some preparations made by himself in Wedl's laboratory in Vienna, in which the fact that the tendon is exactly and cleanly divided in his operation is clearly shown.

† Seperat-abdruck aus der Berliner Klinischen Wochenschrift, 1872, No. 4.

Professor Politzer in regard to the performance of this operation, but the author will not venture to discuss this subject.

Politzer performs the same operation, in order to render the membrane more movable, under the name of the incision of the posterior fold of the membrana tympani. The incision is a longitudinal one, at right angles to the long axis of the fold, between the short process of the malleus and the peripheric end of the fold.*

Fig. 71.



Prout's Knife.

1870.—Voltolini advised the use of a probe, which is introduced daily in an opening made by the galvanic cautery, for some weeks after. I am not able to say whether Voltolini has found this method a certain means of maintaining an opening, but I am inclined to think not, from the fact that so little is heard from him on the subject.

Dr. Prout, of Brooklyn, divides adhesions between the membrana tympani and the promontory with a very small iridectomy-knife, having a long handle. His principle of operation is, to divide the adhesions according to their situation. I have seen him perform the operation in two cases.

In the first case † the membrana tympani was very much sunken, and an adhesion to the promontory had occurred, as shown by an opaque, yellow, immovable spot on the corresponding point of the membrane. In performing the operation, Dr. Prout used a knife such as is here represented.

"The blade is bent on the flat at an angle of forty-five degrees; it is triangular in shape, about one and a half lines long, and three-fourths of a line broad, sharp at the point and cutting at both edges. The shank is three inches long, of which the inch next the handle is not tempered, that it may be bent to any desired angle. The handle is eight-sided, that it may be

* Translation of Politzer's Lecture, by Dr. Burnett, Philadelphia Medical Times, vol. ii., No. 56.

† Myringectomy, followed by a decided improvement in the hearing power, in a case of adhesion between the membrana tympani and the promontory. Transactions of the Medical Society of the State of New York, 1872.

rotated between the thumb and finger in using it, and is two inches long."

The patient was 33 years of age, a teacher by occupation, and had been treated by Dr. Prout for some time previous to the operation, for advancing non-suppurative inflammation of the middle ear, but in spite of the use of the catheter, Politzer's method, and of the posterior nares syringe, the patient continued to grow steadily worse as to her hearing, and the tinnitus aurium became so unbearable as almost to unfit her for her daily duties.

On October 3, 1871, the patient was placed under the influence of ether, and Dr. Prout having illuminated the ear by means of the otoscope upon a forehead band, entered the knife in front of the adhesion, and cut around the promontory, with which the end of the handle of the malleus was in contact. By means of "a little cutting, picking, and teasing, a free opening was made of about one and one-half lines in diameter." An attempt was made to remove the piece of membrane adherent to the promontory; but the operator was not certain that he succeeded. As soon as the patient recovered from the ether, she said that she heard better. The warm douche was used to quiet the pain, which was not severe, however. The hearing power for the voice was much improved by the operation. The patient was able to hear reading and conversation at thirty feet in front of her, while before she could on one side only, and then at ten feet. There was a slight purulent discharge for about a week after the operation; but no very severe pain. One year after the operation the opening in the membrana remained of the original size; the cavity of the tympanum was dry; the watch was heard when pressed upon the auricle—before the operation it was not heard at all—ordinary conversation was readily heard at the distance of twenty feet.

Dr. Prout thus succeeded in maintaining what may fairly be called a permanent opening in the drum-head, and in giving great relief to the patient. His operation of dividing adhesions, wherever they may occur, is one on the same principle as that of cutting out a piece of iris in cases of posterior synechia, and certainly forms a basis for future experience.

The notes of Dr. Prout's second operation have not yet been published.

1869.—Mr. Hinton,* of London, believes that mucus dries up and becomes dense in the cavity of the tympanum, and thus becomes a cause of "confirmed deafness." He therefore incises the membrana tympani in order to remove this hardened mucus.

Mr. Hinton's operation consists of an incision in the membrana tympani, through which fluid is injected into the cavity of the tympanum and Eustachian tube. The incision is made with a lance-shaped knife, in the inferior and posterior quadrant of the drum-head, and is from two to three or even more lines in length. The syringing is done with some force, in order to drive out of the cavity, into the Eustachian tube and pharynx, dried or inspissated mucus, the collection of which, in many cases, according to both pathological and clinical experience, is the cause of the impairment of hearing and the tinnitus. I have seen Mr. Hinton perform this operation, and two cases upon which it had been performed some time before. In both these cases the patients were confident that there was an improvement in the hearing, and a lessening of the disturbing symptoms for some months after the operation.

The process of washing out the cavity of the tympanum, upon which Mr. Hinton lays great stress, is done by means of a syringe fitting hermetically into the external meatus. A solution of bicarbonate of soda is used. The syringing, which I did on one occasion at Mr. Hinton's clinique at Guy's Hospital, London, immediately after Mr. Hinton had performed the operation, sometimes causes vertigo, which passes away in a few moments.

Mr. Hinton once divided the chorda tympani nerve in performing the operation of incision of the membrane. "The patient felt a sudden shock running down the tongue, the corresponding side of which suffered an impairment alike of general and of special sensibility in its whole extent. The patient began to recover in two or three days." The most frequent ill

* On Mucous Accumulations within the Cavity of the Tympanum, from the Guy's Hospital Reports, 1869.

effect is an inflammation of the external auditory canal; when this is apprehended the ear should be syringed through the Eustachian tube instead of the meatus.

Mr. Hinton performs his operation in sub-acute or quite recent cases of accumulation of mucus in the cavity of the tympanum, as well as in those of long standing, such as have formed the subject of discussion in the preceding chapters. I confess to a little skepticism, however, as to the fact of inspissated mucus being the sole cause of the impairment of hearing in many of the chronic cases. The post-mortem examinations of ears, whose function was much impaired for a long time, that have as yet been made, do not reveal this as the only lesion in many cases; yet I think the operation is a good one, for it affords an opportunity of medicating the tissues of the middle ear.

My own experience in perforations of the membrana tympani has been chiefly in the manner of Schwartze and Hinton; that is to say, I have made simple paracenteses or openings into the membrane, and followed them up by treatment of the diseased membrane of the middle ear. Paracentesis seems to me a perfectly safe operation; it is comparatively painless, and is certainly an adjuvant in the treatment of chronic non-suppurative inflammation. My results are not as good as Prof. Schwartze's, perhaps because I have been in the habit of treating many of the cases that he treats by paracentesis, by simpler means.

It should be added to what has been said, that the paracentesis that is performed in chronic cases should be a larger one than the puncture made in a bulging membrane, to give exit to blood or pus.

From the experience which I have had, and from a careful consideration of the recorded experience of others, I think we may conclude—

I. That paracentesis, or incision of the drum-membrane in chronic non-suppurative inflammation, is by no means a dangerous or painful procedure.

II. That its chief value is in furnishing a means of treating the lining of the middle ear.

III. That it may properly be performed in cases of chronic

proliferous inflammation, that are still advancing in spite of local treatment through the Eustachian tube.

IV. Division of the tendon of the tensor tympani, and division of the adhesions existing between the membrana tympani and the walls of the cavity of the tympanum, are operations that deserve a trial, in cases of chronic inflammation of the middle ear, with symptoms of increased auricular pressure, not relieved by a fair use of the ordinary means.

In the choice of an instrument for a simple paracentesis, it seems to me too much has been said. For Weber's operation, Gruber's knife seems to me the best, and for Prout's operation peculiar instruments are required, which will vary according to the situation of the adhesions, their size, and so on; but for the ordinary paracentesis, whether we require a long or short incision, a puncture or a flap, an ordinary cataract-needle will do very well. Those who prefer an angular instrument will find Blake's knife, that which is attached to his modification of Wilde's polypus snare, (which should be lengthened in the shank, however,) one of the best. The use of an anæsthetic is not at all necessary, except where adhesions are to be divided, and the dissection is to be therefore prolonged. Some of the German authors find the membrana tympani very sensitive, even under chloroform; but I have usually found it so easy to make a perforation with very little pain —pain so trifling that it is forgotten in a moment—that I am at a loss to conceive any other reason why the membrane should be so sensitive in their cases, than the fact, well known to American surgeons, that Continental practitioners, who invariably use chloroform and not ether, as we do in this country, are so timid in using an anæsthetic, that, very often they do not place their patients in a condition that we would consider one of anæsthesia. The patient's head should have a good rest, and the otoscope be used on a forehead band, so that both hands may be free. In ordinary perforations for the purpose of washing out the cavity, the posterior and inferior quadrant is, perhaps, the best position for the incision.

Some of the instruments formerly recommended for perforation of the membrana tympani, were probably never actually used—such as one very like a cork-screw, and a red-hot trocar. Cooper employed a small trochar in a

canula, the point of the trochar projecting at the most, one and a half lines. Since the rigid canula would be apt to hurt the membrana tympani, upon which it was pressed before the trochar was pushed forward, Saissy used a canula of elastic wood, which caused no pain. Itard punctured the membrane with a blunt probe. Richeraud recommended that the opening be maintained by the subsequent use of the pure nitrate of silver, in solid form; but I have found the use of this caustic, one of the most effectual means of *closing* an opening from an old suppurative process.*

THE EFFECTS OF CONDENSED AIR UPON THE HEARING POWER.

From some peculiar, but unexplainable tendency in the human mind, to believe in marvellous cures from means not usually employed by those who make the practice of medicine their duty in life, we occasionally hear of persons who have had their hearing restored by entering and remaining in chambers—such as the caisson used in bridge building—where the air is condensed, or from a stay in the so-called pneumatic cabinets. The exact observations of Magnus, A. H. Smith, and Green of St. Louis, show that these accounts of cure of chronic non-suppurative inflammation are not based on facts. On this subject, Dr. Smith† says, "Three cases of extreme deafness came under my notice; two of them in laborers, and one in the person of a gentleman who was advised by a physician to visit the caisson in the hope that he might receive benefit from the action of the compressed air. In all these cases the hearing was very much improved while in the caisson, but on returning to the open air, the former degree of deafness immediately reappeared." I saw the gentleman to whom Dr. Smith refers, and diagnosticated his case as one of chronic proliferous inflammation of the middle ear.

It might as well be claimed that deafness is cured by riding in a railway carriage, because the hearing is temporarily improved while the patient is there, as to assert that a cure is found in condensed air because persons who enter

* The most complete account of the instruments used or recommended for perforation of the membrana tympani by various authorities, is found in Beck's Krankheiten des Gehororganes. Heidelberg and Leipzig, 1827, p. 45.

† The effects of high atmospheric pressure, before quoted in Chapter X.

an air-chamber when the atmosphere is condensed, hear better during their stay.

The only conceivable means by which a sunken drum-head could be improved in position and conducting power, by remaining in a chamber of condensed air, would be the rupture of the membrane from the force of the air, or the opening of the tubes by the patient's efforts to overcome the pressure. Certainly these ends can be accomplished in a simpler and safer way.

Dr. Smith found, however, that sounds, such as the ticking of a watch, were not heard more, but less distinctly in the condensed air of the caisson ; a fact which he accounts for by supposing that the great pressure on all parts of the auditory apparatus opposes a mechanical obstacle to the freedom of vibration. "At the same time the velocity of the waves of sound is greater, and hence the pitch is higher. A deep bass voice is changed to a treble, and the prolonged, heavy sound of a blast is so modified as to resemble the sharp report of a pistol."

Magnus* says that the conduction of sound is better in compressed air, and that we can hear the same tones better than in the ordinary atmosphere, provided that the membrana tympani is not placed in an abnormal condition—that is, an over pressure allowed upon it.

EXHAUSTION OF THE AIR FROM THE DRUM-HEAD.

Politzer, recommends the exhaustion of the air in the external auditory canal, by plugging the meatus with a bit of cloth, saturated with fat, as a means of drawing out a sunken drum-head, when we have reason to believe that the tensor tympani is retracted. Experience has not shown this to be a very efficient means of treatment.

Siegle's otoscope, or pneumatic speculum, which has already been described, as a means of diagnosticating adhesions between the membrana tympani and the walls of the tym-

* Archiv für Ohrenheilkunde, Bd I., p. 280.

panic cavity, has lately been much used by Dr. H. Pinkney,* assistant-surgeon to the New York Eye and Ear Infirmary, as a means of breaking up adhesions in the tympanic cavity, and of improving the hearing. Dr. Pinkney attaches the syringe of a stomach-pump to the apparatus, and exhausts the air by the use of this instrument. The membrane should be carefully watched during the process, lest too extensive ecchymosis or a rupture occur. I have employed the apparatus in cases of chronic proliferous inflammation, at Dr. Pinkney's suggestion, but as yet with no very decided results. I have also cupped the membrana tympani, and auditory canal, by placing a cup over the auricle, and exhausting the air by means of a syringe; but with no beneficial result.

RESULTS OF TREATMENT.

I began this subject with the statement that the greater part of the reproach that had been cast upon the therapeutics of aural disease, in justice applied only to the non-suppurative affections of the middle ear. Excluding the diseases of the labyrinth, which are happily much more rare than those of any other part of the ear, it is just this class of cases, that have now been considered—non-suppurative inflammation of the middle ear—that are most intractable. But when all this is said, before the unpleasant statistics of results are presented, a few words of explanation should be made. These affections are pre-eminently local in their character; that is to say, a person with this variety of aural disease may have the best general treatment the world affords, and be under the most appropriate hygienic conditions; he may live in a climate like that of Nice, Mentone, Naples, Aiken, or St. Augustine, and then he will not recover from his aural disease, nay, more, he will continue to grow slowly but gradually worse if his pharynx, Eustachian tubes, and middle ear, are not treated by the appropriate appliances and remedies.

Until ten years ago there was scarcely a medical college in the land, except the University of New York, where Prof.

* Verbal communication.

Post taught otology in his course of surgery, where diseases of the ear were even lectured upon with any fulness and correctness. And even now, attendance upon the otological course of our colleges is entirely a voluntary matter with the student. The result is, that the large mass of general practitioners know nothing of the rational treatment of aural disease, and a person who cannot afford to stay in a large city or town where there is a surgeon who practices otology, must go without treatment. Thus many, very many promising cases, from which good results might be obtained, are never treated. They are, perhaps, diagnosticated, but, inasmuch as the victims of them are surrounded by, and cannot get away from, those who "never meddle with the ear," they go down to their fate.

The following table gives the results of the treatment of four observers. I can only account for the fact that my percentage of cures is less than the others, from the supposition that I have seen a proportionately larger number of neglected cases than falls to the lot of other practitioners. It will be observed, however, that my cases show a larger percentage of *improvement* than those of the other observers. I have been very careful in the tables of results of treatment that I have published, to make the standard of cure very high. Those only are classified as "cured," in which the hearing was restored to a normal condition as tested by the watch, the tuning-fork, and ordinary conversation. Judged by the ordinary use of the term *cured*, this standard is too high. It is higher, for example, than that in ophthalmic practice, where the removal of a cataractous lens, so that the patient gets sight enough to read coarse print, is called a cure of the cataract, although the vision obtained may be only two-thirds of that enjoyed by a person who has never had cataract. In the same manner we speak of *curing* a bone affected with necrosis, by removing the diseased portion, even if considerable deformity be left. If a patient who has suffered for months or years from a morbid process in the cavity of the tympanum, recovers to such an extent that the hearing power is greatly increased, although it may not become normal, he would be said to be cured, under a standard no higher than

that usually adopted in medical statistics, but I have preferred in my table to put such cases under the head of "improved."

TABLE

Showing the Results of the Treatment of Chronic Non-suppurative Inflammation of the Middle Ear.

Reporter.	No. of Cases.	Cured.	Improved.	Unimproved.	Unknown
*Spencer (St. Louis)..	56	6, 16¾ per ct. of those actually treated.	18, 50 pr ct.	10, 27 pr ct.	20
†Schwartze (Halle)...	230	30, 20 pr ct.	94, 60 pr ct.	30, 20 pr ct.	75
‡Gruber (Vienna)	187	38, 32 pr ct.	61, 60 pr ct.	9, 9 pr ct.	84
Roosa (New York)...	514	23, 11 pr ct.	160, 62 pr ct.	171, 48 pr ct.	159

* Reprint from St. Louis Medical Journal.
† Archiv für Ohrenheilkunde, Bd. I.–V., *passim*.
‡ Monatsschrift für Ohrenheilkunde, Bd. I.–IV., *passim*.

CHAPTER XV.

ACUTE SUPPURATION OF THE MIDDLE EAR.

ACUTE suppuration of the middle ear commonly occurs as a direct and recognized consequence of an acute catarrh of the same part. A catarrhal process is unchecked, and passes on to a suppurative one. In some cases, however, 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. I have seen several cases where the patients have assured me that the first idea that they had of trouble in the ear, was the moistening of the canal from the flowing out of the pus. An examination of the ear in such cases has always revealed 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. It is my belief, however, that the 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, etc.; but that the failure to notice them is usually to be attributed to carelessness in observation, and to be regarded as another indication of the common indifference to an inflammation of the ear, that is not positively painful.

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. Neuralgia of the head, is a diagnosis often incorrectly made for the first stages of acute catarrh of the middle ear.

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 phthisis pulmonalis, 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 origin of acute suppuration is, however, a violent one. 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 becomes red, tender, and painful, the head throbs, and the whole system is seriously disturbed. In young persons delirium occurs, and in all subjects, there is general febrile excitement, 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 distension of the little space called 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, constitutional disturbance in the way of febrile action, 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. I suppose this fact is partly to be attributed to the failure in the general nutrition, and also to the contiguity of a diseased mucous membrane, which is constantly acting as an exciting cause of trouble in the pharynx and Eustachian tube.

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 nor-

mal distinguishing marks in the way of light spot and handle of the malleus. Yet this is not always the case. I have seen cases where the transparency of the drum membrane was almost unimpaired, and the accumulated pus and mucus which were bulging it out, could be seen through it. In one case, that of a young lady, I found pus not only in the cavity of the tympanum, but also between the mucous and fibrous layer of the drum-head. The pus moved when the head was moved. She recovered, with perfect hearing power, and a sound membrana tympani, without an artificial or spontaneous perforation of the drum-head. The treatment resorted to was the use of leeches, a gargle, and Politzer's method. There was considerable pain at the outset, but not the intense pain which is usually one of the characteristics of acute suppuration. The patient visited my office daily during the whole course of the disease, which occurred in the mild weather of spring.

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. I have not as yet seen any cases, where it seemed to me that an abscess was confined to the layers of the drum-head, without any communication with the cavity of the tympanum or the external auditory canal. It should be added, that the osseous portion of the bony canal is often found to be very much inflamed, in conjunction with the symptoms in the membrana tympani, the cavity of the tympanum, and the mastoid cells. I may be pardoned for reminding the student, that it is often impossible to draw the line between the affections of the three parts of the ear. Their anatomical connections show that they 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 inflammation of the labyrinth, 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 chief one is, exposure to cold —inflammation of the naso-pharyngeal mucous membrane being the usual starting point.

The violent use of the posterior nares syringe in an acute or sub-acute catarrh, will also in very rare cases set up acute suppuration in the tympanic cavity; at least I have seen it do so in one case, which was the following: A physician, aged 27, had suffered for years from chronic naso-pharyngeal catarrh. During the winter of 1872, he was attacked with acute coryza and pharyngitis. He had once used the nasal douche for a similar attack, and it caused such severe symptoms that he was obliged to desist from it. I was in the habit of using the naso-pharyngeal syringe for him at irregular intervals, in order to relieve the chronic naso-pharyngitis from which he suffered. On visiting him one afternoon, when he was suffering from the acute attack, his nostrils felt so full of secretion that he requested me to use the naso-pharyngeal syringe, which I did, injecting a lukewarm solution of chlorate of potash. The bulb of the instrument caused some gagging as it came in contact with the swelled wall of the pharynx. In an hour or two he was attacked with acute aural catarrh of the left side, which, in spite of the most energetic treatment by means of leeches, went on to suppuration before morning. Under appropriate treatment the patient recovered, with a sound drum-head, and with the hearing power as great as before the attack.

The fact has already been mentioned that 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 from the entrance of water, may produce acute suppuration.

Scarlet fever, measles, diphtheria, tonsilitis, bronchitis, pneumonia, and whooping-cough, play an important part in the production of acute aural disease, and usually, 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 tym-

pani, 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 opens —at times with quite a loud explosion—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, however, 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, the suppuration may extend into the brain or the circulation. 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 beneath into the jugular vein, and thus produce blood poisoning or pyæmia. 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, as the anatomy shows us, an integral part of the middle ear. Disease of the mastoid process is also a dangerous complication; but for a full discussion of the subject, I beg to refer the reader to the 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.

With a want of logical reasoning that is remarkable, some practitioners invite suppuration of the drum-head, in every case of acute catarrh, or "pain in the ear," and then declare, that nothing can be done for the hearing when the membrana tympani is once perforated. Our aim should always be to

prevent or limit suppuration in the ear, but if it do 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.

It should be observed, that 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; for it may prevent us from continuing the astringents which are indicated for the relief of the suppuration.

Treatment.—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 at once incised down to the bone, except in the case of young children, where the more yielding nature of the integument and the periosteum will admit of some delay. If the mastoid process be simply red and tender, but not swelled, the use of leeches will probably subdue the inflammation without an incision.

The ear should be douched very often, say every half hour, with lukewarm or hot water, 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 his room, and perhaps in bed, while pedeluvia and diaphoretics are employed.

If the membrana tympani have ruptured, the pus should be removed at least twice a day, by careful but thorough syringing. At the same time, Politzer's method of inflating the ear should be practised. This latter procedure gives no pain when carefully done, *i. e.*, 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 the one I usually use. In cases of scarlet fever, the pharynx will require the most careful and energetic treatment. The neck should be kept warm by poultices, 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. Dr. Sexton, of this city, has found great relief in tonsilitis from the use of the warm douche upon the pharynx, by means of Davidson's syringe, or rubber tubing attached to a water faucet.

Relapses of pain should be combated by leeches, warm water, and the internal administration of opium; 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 only applicable, if at all, to chronic aural disease.

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.

The astringent that I usually use in acute suppuration is 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, afterwards neutralizing it by syringing with a warm solution of salt and water. Indeed, it should be said once for all, that except in very rare and exceptional cases, cold fluids should not be dropped into the ear.

From the nature of things, the general practitioner will see a great deal of this form of disease—if he be on the look-out for it—since it occurs so often in the course of the exanthemata and in connection with diseases of the respiratory organs. It will be seen that there is nothing in the treatment of this affection that will prevent the usual care of the general disease. It is a great and often fatal error to wait the subsidence of the general symptoms before the aural ones are alleviated. They are quite as important as the most urgent constitutional disturbances. Indeed, they are often the unsuspected cause of most of the latter.

It only remains to be said that the results of treatment of this disease are very satisfactory. Of 32 cases reported by myself,* 15 were *cured*, i. e., *the membrana tympani was healed and the hearing power fully restored*, as tested by the watch and conversation. 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 my 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. Where one ear only is affected, we are apt to be led into error as to the amount of deafness, unless we are careful to exclude the sound ear as thoroughly as may be in our examination. Nine of the cases were improved, and the result in the remainder of the cases, eight in number, is unknown to me, although it is

* New York Medical Journal, August, 1869. Transactions Medical Society of the State of New York, 1871.

highly probable that many of them fully recovered, as they were chiefly cases occurring in consultation with brother practitioners, who undertook to carry on the case in the manner agreed upon, and who undoubtedly had a good result.

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 in the ear. And yet, to this day, there are medical men of very great general intelligence, who think lightly of such a disease, and gravely advise patients not to "meddle" with it. The author has been informed by a distinguished practitioner in this city, that a young man was once sent to him for advice by an eminent physician, after he had passed through a severe constitutional disease in which suppuration in the middle ears had occurred, for whose ears not one particle of rational advice had been given, although both membranæ tympani had been destroyed, the ossicula were gone, and the mucous membrane of the tympanic cavity was granular. Such neglect needs no commentary.

The course of acute suppuration occurring in the midst of a severe attack of scarlatina, is apt to be very 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.

It should also be said as supplementary to this subject, that 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 explained by the fact that 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 in such cases than in those occurring in persons with drum membranes of normal density and tension.

CASES.

CASE I.—*Acute Suppuration from Scarlet Fever—Loss of the Malleus of each side—Reproduction of the Membrana Tympani—Great improvement in hearing power.*

Harry ——, æt. 9. On February 27, 1872, I was called by Dr. G. S. Winston, to see the grandchild of a gentleman of this city, in regard to whose case I had already given advice by mail and telegraph. The history was as follows: The boy had gone back to his school, after spending the Christmas holidays at home, in quite as good health as usual; but soon after arriving he was attacked with scarlet fever, which rapidly assumed a very severe type, so that his throat was inflamed and the cervical glands were swelled, and the lining membrane of the middle ears was in a state of very acute inflammation. In spite of prompt and energetic treatment, by the physician of the school, suppuration occurred in a few hours. After the aural symptoms occurred, the discharge of pus became profuse, so that the ears needed cleansing every half hour. The malleus bone of each ear escaped in the pus, and I have them in my possession. When the severest aural symptoms had subsided, astringents were used in the auditory canal, and the Eustachian tubes treated by Politzer's method.

As soon as the little patient's general condition would allow, he was returned to his home, and in a deplorable condition. His ears were discharging thick, offensive pus, in such quantities, that it was only by the greatest diligence in cleansing that they could be kept clean; the naso-pharyngeal space was secreting muco-purulent material in great masses. The hearing power was so much impaired that it was only by speaking in a distinct and loud tone, close to the little fellow's ear, that he could be made to understand what was said to him.

The family and friends believed that he would become the inmate of a deaf and dumb asylum. Indeed, a gentleman—a friend of the family—who had a child that, having lost her hearing from the scarlet fever, had learned the method of speech by watching the lips, came to see Harry, and urged that very prompt measures should be taken to cause him to learn lip reading, inasmuch as he felt certain that he would never hear sufficiently to retain his speech. I at once instructed the family to converse regularly with the little patient, to read aloud to him, and to urge him to continue to talk, while the local and general treatment were carried on. This they did with a remarkable faithfulness; so that the boy, hearing what was said to him, never acquired an unnatural tone of voice.

On examination it was found that the membrana tympani of each side was gone, and that the cavity of the tympanum was filled up with granular mucous membrane. The hearing distance for the watch was $\frac{0}{48}$ on each side. The voice of a person speaking with great distinctness was heard two feet from the left ear, and one from the right. Air could be forced through both Eustachian tubes. The patient's general condition was fair; but he was suffering from some abdominal effusion. Dr. T. F. Cock was called in on this account, and ordered the tincture of the sesquichloride of iron. The weather being cold, the boy was kept in the house, and in a warm room; while a thor-

ough local treatment was entered upon. The ears were syringed by some member of the family every hour during the day, if necessary; while I visited him at first twice, and subsequently once a day, and cleansed the ears with the syringe and cotton-holder, inflated the ears by Politzer's method, and applied a solution of nitrate of silver, of the strength of forty grains to the ounce, to the cavity of the tympanum. The family applied a weak solution of sulphate of zinc in the evening. The naso-pharyngeal space was cleansed by the use of chlorate of potash. A weak solution of Labarraque's solution of chlorinated soda was used in the water employed for syringing the ear, in order to diminish the fetid odor of the pus. Under this treatment the patient steadily improved until the discharge of pus had entirely ceased from the left ear, and a membrana tympani had formed at the bottom of the canal, with a small central aperture, and in the right there was also a membrane, with a larger opening, and a very slight muco-purulent discharge. On May 11, about three months and a half from his return to the city, and about five months from the breaking out of the scarlet fever, he could hear the voice, with his face away from the speaker, for a distance of twenty feet, and the watch, R.E., $\frac{6}{48}$; L., $\frac{6}{48}$. He returned to school in good general health.

January 9, 1873.—He still continues at school, with hearing power the same as last noted. The membrana tympani of left ear is entirely closed. In the right there is still a small opening, and occasionally a discharge of pus. The ear is carefully cleansed at school, an astringent is still used, and Politzer's method of inflation is occasionally practised.

The above case illustrates what can be done for one of the severest cases of acute suppuration in the middle ear, resulting from the pharyngeal inflammation of scarlet fever. Hundreds of such cases have become inmates of deaf and dumb asylums, and are consequently educated in a necessarily imperfect manner. This boy, although under some obstacles, is being educated exactly as are his fellows, who enjoy good hearing power. I think the right membrana tympani will be finally closed, and that he will then be free from the dangers attending the chronic suppurative process.

CASE II.—*Acute Suppuration of the Middle Ear, occurring in a Child, in connection with the Whooping-cough—Membranes healed in about a Month.*

March 12, 1872.—Eugene ——, æt. 1, a rather delicate child, who is passing through the whooping-cough. A few days ago the child cried very much for some hours, and then a discharge of pus, mingled with blood, was found from each auditory canal. The spasms of coughing are very severe. I was called to see the little patient a few days after the discharge of pus occurred, and I found on examination that both membranæ tympani were ruptured, and that considerable pus was being secreted in the cavity of the tympanum. There was also some naso-pharyngeal catarrh.

The following treatment was entered upon: The ears were syringed three times a day, with lukewarm water, and a solution of sulphate of zinc, gr. ij. ad ℥j, was afterward dropped into the meatus, and kept there for a few minutes. I saw the patient three times a week, and cleansed the ear myself. On April 15, or a little more than a month from the time the perforation occurred, both drum-heads had healed and the discharge had ceased.

CASE III.—*Acute Suppuration in the Course of Chronic Nasal Catarrh—Paracentesis of the Membrana Tympani.*

George S., æt. 34. March 13, 1873.—Mr. S. has had "catarrh" for two years, for which he has been in the habit of using injections through the nostrils by means of Davidson's syringe. For the past few hours he has had a pain in the ears, but more particularly in the left, and he cannot hear well.

An examination shows that the patient has a severe form of naso-pharyngeal inflammation, attended by a profuse and fetid secretion. The hearing distance is, R. E., $\frac{1}{48}$; L. E., $\frac{8}{48}$. The right membrana tympani is sunken and red. The left membrane is very convex; a delicate pink tint involves the whole surface, and there is no trace of the handle of the malleus nor of the light spot.

The membrane was immediately incised in the upper and posterior quadrant, and a small amount of pus was evacuated. The ears were inflated by Politzer's method, and the auditory canals syringed with tepid water. A leech was applied upon the tragus of the right ear. A profuse suppuration occurred in the left ear; but it was soon checked by the use of a solution, gr. xl. ad ℥j, of nitrate of silver painted over the drum-head, and the patient disappeared from observation, with the hearing distance $\frac{12}{48}$ on each side, on March 22, or nine days from the date of the first visit. I afterwards learned that he considered himself entirely well.

CASE IV.—*Inflammation of Auditory Canal extending to the Membrana Tympani—Paracentesis—Cure.*

Mrs. G., æt. about 35. On April 16, 1872, I was sent for, by request of Professor T. G. Thomas, to see this patient, who had been suffering for a week or two from occasional attacks of severe pain referred to the depth of the right ear. These attacks had been alleviated by the application of leeches, but the pain continued to recur, especially at night, so that the patient was unable to sleep. I found the lady suffering very much, and she had been awake with pain all night. The auditory canal was found to be swelled, and there were two points of suppuration in the cartilaginous part of the meatus. The membrana tympani was red, but its whole surface could not be seen on account of the swelling of the canal. The auditory canal was scarified at two points, and the use of the douche ordered every hour; $\frac{1}{12}$ gr. of sulphate morphia was ordered to be taken every hour, until the pain was relieved. In the evening the pain not being markedly relieved, two leeches were ordered to be applied to the ear—one on the tragus, the other at the glenoid fossa. This, with the continuation of the morphia, quieted the pain very much; but, on the 19th, I was called early in the morning, to find that Mrs. G. had had a recurrence of

the pain, and that she was suffering very much. I then made a paracentesis of the drum membrane, although the swelling of the canal was so great that I could only judge of the fact of my instrument—a cataract needle—having passed through the membrane, by the depth to which it penetrated, and the yielding sensation communicated to the fingers as the needle passed through the drum-head. Immediate and great relief from the pain was experienced, and the patient, under the continuation of the douche, daily syringing, the use of Politzer's method of inflation, on May 11 she had fully recovered her hearing power with a moderate amount of suppuration.

I am not able to decide whether this case was primarily one of otitis externa, or otitis media. I am inclined to think that it was one of the former, and that the inflammatory process extended to the membrana tympani from without. I suppose that the membrane was unusually thick, perhaps from a previous morbid process, and that this accounts for its continuing intact for a longer time than usual, although a membrana tympani that is invaded by disease from the auditory canal, will withstand an inflammatory action without rupture much longer, than one whose mucous layer is the first affected.

CASE V.—*Acute Suppurative Otitis Media of some days standing, cured by one Application of a forty-grain solution of Nitrate of Silver.*

C. C. æt. 1 year. Feb. 16, 1873.—I was asked to see this little patient by *Dr. C. C. Lee.* There had been an acute naso-pharyngeal catarrh for some time, and for a few days there had been a purulent discharge from the left ear. On examination the drum membrane was found to be perforate, and there was a profuse discharge of pus. The ear was kept carefully cleansed, and a warmed solution of sulphate of zinc poured into it; but it did not yield in a day or two, when a solution of nitrate of silver, of forty grains to the ounce, was brushed over the canal and the perforated membrana tympani. At my next visit, the morning after this application was made, the discharge had completely ceased, and the membrana tympani had healed.

The foregoing cases illustrate the ordinary type of acute suppuration occurring in subjects of different ages. 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 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. If an opening in the drum-head 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 perforate, 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 I have seen this bubble when the membrane was intact, but fluid was lying upon it.

CHAPTER XVI.

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 known 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, I think, 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," and which has been so lightly regarded by the profession, that every year people die from its direct results, and under the observation of physicians, without the suspicion that the disease of the ear, and of the ear alone, was the cause of their death. In this and the following chapter, I shall attempt to set forth, in a plain and simple manner, the exact nature of this disease, and the reasons why it should never be neglected, but always kept under the most careful observation and treatment.

Chronic suppuration of the middle ear is often confounded with that *rare disease*, chronic suppuration of the external auditory canal. Very many times patients have been brought to me with what the attending physician supposed to be merely an external otitis, but which proved to be really a case of suppuration of the middle ear, with perforation of the membrana tympani. When it was demonstrated that the pus had its origin, not from the auditory canal, but from the middle ear, it was usually an easy task to convince the person

affected of the danger of a neglect of the disease. I feel confident that 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 avail to stop a formation of pus in the cavity of the tympanum or the mastoid cells, unless local treatment is also employed.

We might almost take it for granted, if such a practice were not improper in a physician who claims to observe with exactness, 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.

I have already, on page 120 of this work, alluded to this fact of the comparative infrequency of suppurative affections of the outer ear, as compared with those of the middle part of the organ; but the following table brings it out more strikingly than the mere assertion:

TABLE

Showing the relative frequency of Suppurative Affections of the External and Middle Ear.

Institution.	Number of Cases of Inflammation of External Auditory Canal, excluding Eczema.	Suppuration of Middle Ear.
Brooklyn Eye and Ear Hospital, 1870	93	246
Massachusetts Charitable Eye and Ear Infirmary, 1872	170 including 36 cases of myringitis.	464
Ophthalmic and Aural Institute, New York, 1870–71	38 including 11 cases of inflammation of memb. tympani.	181
New York Eye and Ear Infirmary, 1872	168	660
Manhattan Eye and Ear Hospital, 1872	33	218
	502	1769

All the cases under the heading Inflammation of the Auditory Canal, were not necessarily suppurative; while I have been careful to place only the suppurative cases in the middle ear column.

It will be seen by the table that the cases of chronic suppuration preponderate over the cases of chronic external otitis, in a proportion exceeding that of five to one. I am inclined to believe that the proportion is actually even larger than this, and that in some cases the diagnosis was made of external otitis, simply because at the outset the inflammation of the canal was so great as not to allow of a view of the drum-head, which was afterwards found to be affected. If I had been able to exclude the non-suppurative diseases of the canal, as I have those of the middle ear, the preponderance of middle ear cases would have been much greater.

Symptoms.—A discharge of pus from the ear is the most striking symptom in chronic suppuration of the middle ear. There can hardly be such a thing as a *chronic* suppuration in this part without a perforation of the drum-head, through which the pus escapes. Such a process may occur, however, as will be seen by reference to a case recorded in the chapter on the consequences of chronic suppuration, where, although pus had formed, and *probably* had existed for weeks in the mastoid process, it did not at all involve the drum-head. Such cases are, however, very exceptional. A chronic suppuration of the middle ear, almost always involves an ulcerative perforation of the membrana tympani. When the former term is used, the latter state of things is understood to exist, whatever other changes of structure may have occurred. The discharge of pus is sometimes very profuse and constant, so that it streams from the ear. This is more apt to be the case in young children. In such cases the auricle and external auditory canal become red, tender, and even excoriated from the irritation of the pus in which the parts are bathed. In other and more numerous cases, the pus lies only at the bottom of the canal upon the remains of the membrana tympani and in the cavity of the tympanum, enveloping the chain of bones, and passing into the cavities called the mastoid cells. In still other cases, there is no continuous outflow of pus, either by day, or at night upon the pillow; but at intervals there is a slight increase of the unpleasant symptoms, which even assume the dignity of an ear-ache, after which a free discharge of pus from

the ear occurs. On questioning such patients in regard to the existence of a discharge from the ear, they will usually state, that none occurs, except after an attack of ear-ache, although the fact is that pus is always lying in the part. If we examine such an ear when the discharge is supposed to have ceased, we shall find at the bottom of the canal, and in the cavity of the tympanum, a hardened mass of dried pus covered over by cerumen, or epidermis. Impacted cerumen is quite a frequent occurrence in the course of a chronic suppurative process in the middle ear. We shall often come to an erroneous conclusion as to the cause of a loss of hearing, if we judge of the case from the presence of hardened cerumen in the auditory canal without getting the history.

The membrana tympani presents the most varied appearance in different cases of chronic suppuration in the middle ear; sometimes, it is entirely swept away, and all the ossicula with it. The cavity of the tympanum is then an empty cavity opening upon the canal. Again, there is a rim remaining, with perhaps the incus and stapes in situ, or dislocated, but yet present, while the malleus is gone. In other cases the ossicula are intact and in position, but there are clearly-cut, well-defined holes, from one to three in number, in the drum-head. The chromo-lithographs exhibit such a perforation, with the blood-vessels that are about to repair it, radiating towards the opening. 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.

When we come to the consideration of the consequences of this disease, we shall see that besides these changes already mentioned, we often find growths springing from the mucous membrane of the tympanic cavity, so-called polypi. Exostoses may exist in the canal, or even in the walls of the tympanic cavity; the bone may be exposed, *i. e.*, 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 of facial paralysis is added to the disgusting detail of the ravages of disease.

I do not think there is any one point more than another, in the membrana tympani, where perforations are apt to occur. Sir William Wilde, and Moos, quoted by Hinton,* affirm 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 my own quite confirms. I have found them 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, Wilde thought that a pulsation at the bottom of the auditory canal was pathognomic of perforation of the drum-head. Where this pulsation occurs, it is a very suspicious circumstance; but, as has been before said in this volume, a thin membrana tympani, in a state of acute catarrhal inflammation, will sometimes exhibit this phenomena when the drum-head is intact. Mr. Hinton remarks in his excellent paper on Perforations of the Membrana Tympani, from which I have just quoted, "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."† 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 dwelt upon in treating of the chronic non-suppurative inflammations. 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

* Guy's Hospital Reports, 3d Series, vol. xii.

† L. c., p. 630.

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 usually impaired, even if none of the serious consequences have occurred. Such a drain upon the system is not tolerated with equanimity by nature. Dr. Hackley* has found albuminaria 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. He is inclined to think, that such cases are 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 that the author, in common with many others, has observed a very deeply rooted idea among the laity—an idea that was first inculcated, and which is even now encouraged by the profession—that there is no harm resulting from a chronic ulcerative process in the ear, when it is well out of sight. It is even at times gravely asserted that such a drain to the system is salutary, as if our Creator would not have made the human race with such a one if it were necessary. I have seen persons who allow their ears to become an offence to the nostrils of those about them, because they have been advised by their physician that it was not best to "meddle with the ear." If my reader feels that I have said too much on this subject, in the different parts of this volume, I beg that he will ask himself how many cases of death he has known as the result of a suppurative process in the ear, to consult his fellow practitioners on the same point, and finally to investigate the statistical tables of deaf and dumb asylums. In the answers to these interrogatories will be found a complete justification of my earnestness on this point. The anatomy of the middle ear, showing, as it does, the relations of this small portion of the organism to the most important parts of the system, to the great arterial and venous vessels, to the

* Verbal communication at New York Ophthalmological Society.

nervous system, to the organs of respiration, is also of itself a sufficient proof of the necessary importance of a long-continued suppuration in this part.

There still exists, however, even in the minds of some physicians, a prejudice against the stoppage of a purulent discharge from the ear. In the laity this prejudice is widely spread, and is chiefly dependent upon the erroneous teachings of the older French writers, Du Verney and Itard. As Wilde shows, in his classic article upon this disease in his text-book, "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." There is, I believe, 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 only 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 the most of the neglected cases do not so recover, and after a purulent discharge from the ear has once set in, "*we can never tell*," to quote again the words of Wilde, which should be impressed upon the attention of every prac-

titioner of medicine, "*how, when, or where it will end, or what it may lead to.*"*

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 skillful treatment, we cannot always succeed in all of these things. In some rare cases we do not succeed in any of them; but the patient, in spite of our best efforts, will go on to his doom.

The degree of the impairment of hearing, in cases of chronic aural suppuration, is very 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 probably to protect the tympanic cavity, and not to transmit the vibrations of the atmosphere, which when conveyed to the acoustic nerve we call sound. I know some persons who have large perforations in each membrana tympani, and who yet hear well enough for all the ordinary purposes of life, although not with perfection. One notable instance of this kind is that of a busy physician of my acquaintance. As has been already said in Chapter XIV., Sir Astley Cooper, in a paper published in the Transactions of the Royal Society in 1800,† showed that there could be very good hearing powers with a perforate membrana tympani; and yet I very often hear the question 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 seventy 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 have perhaps as many, if not more, important anatomi-

* Text-Book, p. 407.

† Philosophical Transactions, 1800, Part I.

cal 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 great jugular. 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.

Treatment.—The proper treatment of a chronic suppuration in such a space, should be a matter of the greatest solicitude. It involves not alone the hearing power, but also the life of the patient. There is one pre-requisite to the successful treatment of this affection, and that is, a *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 thoroughly cleansed.

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, is, from the very nature of things, sometimes impossible.

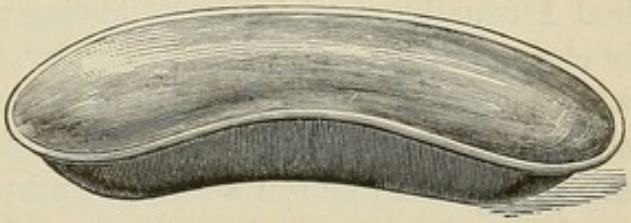
The old method of treating such a suppuration was to advise the patient to syringe the ears with soap and water, put a blister on the mastoid process, and at the same time the physician got the system to rights by using alteratives, laxatives, and purgatives. The general principle of treatment thus held in view was correct, but in the matter of the local treatment, which is of far more importance than the constitu-

tional, 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 instruction, thoroughly cleanse an ear by syringing. It is generally thought that any person can syringe an ear, when 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 (see page 128), the proper method of syringing has been carefully described, so that we need not dwell upon the subject again.

Sometimes the use of the syringe is not well borne by the patient, the shock of the water being too great. In such cases the aural douche of Clarke, is a good substitute for the syringe. Instead of the thin bowl that I have recommended as a receptacle for the fluid that comes from the canal, after having been injected, some practitioners use a vessel such as depicted in the accompanying cut—the "iter-becher" of the Germans. It

FIG. 72.



Vessel used in Syringing the Ear.

is certainly very convenient on account of the fact that it adapts itself so well to the glenoid fossa, but it is not deep enough if any prolonged syringing is required. Then the bowl will do better, and on the whole I think it is to be preferred.

I have known sad cases, 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 had sprung up, bony growths had occurred, which are positive evidences of the imperfect removal of pus and other hurtful material.

There are several methods of cleansing ears affected with a chronic suppurative process. That which I usually adopt is a combination of the suggestions of Politzer, Hinton, and Schwartze. It is, I think, a simple method, 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 medical man is 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 I submit that a suppuration in the cavity of the tympanum and membrana tympani is of equal importance, with the disease of the organ of vision.

The method I usually adopt is the following: The ear is first carefully cleansed with lukewarm water by means of a good hard-rubber 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 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 cotton-wool. 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. At the beginning of such a treatment, especially in chronic cases, small portions of inspissated or glutinous material will still be found. These should be then thoroughly removed under a good illumination from a mirror upon the

forehead, by means of a cotton-holder, which is simply a slender steel probe, roughened at one extremity. In the absence of this instrument, a thin bit of wood, or a match, about which cotton is carefully twisted, will do very well.

Having satisfied ourselves by inspection with the otoscope that the ear is thoroughly cleansed, the warm astringent solution should be poured into the ear, and allowed to remain for a period varying from five to fifteen minutes. If the membrana tympani be nearly gone, the solution may be swabbed about the bottom of the ear by means of the cotton-holder, used under the illumination of the mirror on the forehead.

The choice of an astringent is perhaps not so important as is often supposed. I usually use the sulphate of zinc for comparatively recent cases, and the nitrate of silver for old ones. The sulphate of zinc should be used in weak solutions —from 1 to 4 grains to the ounce—and the nitrate of silver in strong ones. Nitrate of silver seems to be of no value in these cases, unless used of the strength of 40 grains to the ounce. It may be even used as strong as 480 grains to the ounce. Dr. O. D. Pomeroy, of this city, reports a case* of "suppurative inflammation of the tympanic cavity, with subjective symptoms of mastoid inflammation," where, after using solutions of from 40 to 80 grains, he finally used the very strong one of 480 grains to the ounce of water. "It caused a slight feeling of warmth and fulness in the ear, but not real pain. The discharge was entirely arrested by this one application." The membrane was found to be healed on an examination made some six months afterward.

In Schwartze's paper calling attention to the use of the nitrate of silver, in what he regards as strong solutions, he advises against the instillation of nitrate of silver where granulations or disease of the bone exists. His exact words are: "The caustic treatment only promises a nearly certain result, when we may exclude with positiveness the existence of granulations upon the exposed mucous membrane, or upon the remains of the membrana tympani, and when there are no evidences of ulceration of the bone." †

* New York Medical Journal, Dec. 1872, p. 631.

† Archiv für Ohrenheilkunde, Bd IV., p. 2.

The experience of American otologists, has been that strong solutions of nitrate of silver may be safely and profitably used, even where there are granulations and polypi. Indeed I would especially recommend it for some of these cases, although I admit that their value is often strikingly seen in obstinate cases of chronic suppuration, where the membrane is not yet in what may be termed a very proliferous condition. It is not necessary to neutralize the solution by the use of salt and water.

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.

Mr. James Hinton, of London, recognizing the fact upon which I have laid so much stress, that thorough cleansing of the ear is the first requirement of all treatment of chronic suppuration in this part, advises 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 syringes the tympanic cavity through the Eustachian tube, and uses, both for this external and internal syringing, solutions of carbonate of soda, say of twenty grains to the ounce. I believe this latter method of washing out the cavity of the tympanum, was revived and applied to cases of suppuration, by Dr. Millinger, of Vienna. I have found the washing out of the middle ear, with the solution of soda, a very useful adjuvant in these obstinate cases now under consideration; for it must always be borne in mind, if we would avoid great disappointment, that these cases are usually obstinate, and often trying to the patience of the practitioner. I cannot say very much for the method of forcing fluid into the auditory canal, with the nozzle of the syringe placed hermetically into the meatus. I sometimes resort to it; but I have usually found it rather violent in its action, as it is apt to cause dizziness and vertigo.

It is necessary and proper, 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, unlike the others, is apt to cause pain, which usually passes away on pouring warm water into the ear. It is a method, however, only to be resorted to when other means fail.

I have not found powders useful in checking chronic suppurations of the ear. They usually act as foreign bodies, and fly up the meatus. There is a story told of an itinerant quack, who stopped discharges from the ear by filling the ear with plaster of Paris in a fluid state. Its hardening would certainly prevent any emergence of pus for some time.

As has been before said, the cleansing of the ear by the medical attendant should be performed about three times a week. If the suppuration be profuse, the patient should be seen daily. Here, as in other departments of otology, we meet with great prejudice on the part of the laity. They have been so accustomed to be sent off with a prescription for a "running from the ear," that they are quite amazed at being asked to come to the office daily, or three times a week. Yet this will often be necessary, and here as elsewhere there remains some pioneer work to be done in the education of the people.

Dr. Beard,* of this city, believes that the galvanic current is sometimes a powerful adjuvant in healing a suppurative process in the middle ear, just as it is in healing ulcers in other parts of the body. An electrode with a long narrow extremity, covered with a little cotton, is passed into the auditory canal through a rubber speculum. The canal is usually filled with warm water. The electrode is connected with the *negative* pole of the battery. The positive pole is placed either in the hands of the patient or at the back of the neck. Only very weak currents and short applications are borne, and the treatment should be cautiously conducted. Drs. Mathewson and Prout, in conjunction with Dr. Beard, have been testing

* Verbal communication.

the plan of treatment, in cases at the Brooklyn Eye and Ear Hospital. The character of the discharge soon begins to change under this treatment, and in some cases the cure seems to have been more speedy than it would have been without it.

Dr. C. I. Pardee,* of this city, believes that the choice of an astringent may be regulated by the character of the secretion. If the secretion from the exposed tympanic cavity be predominantly of a mucous character, Dr. Pardee uses nitrate of silver. When the secretion is chiefly purulent, he uses weak astringents of sulphate of zinc, acetate of lead, and alum. It would certainly be a great advance did we have more certain indications for the use of strong or weak astringents; but I am not prepared to give a positive opinion as to the correctness of Dr. Pardee's theory. I may only repeat, what was said in substance in the preceding part of this chapter, that any of the well known mineral astringents do very well, if the parts are thoroughly cleansed, and if none of the consequences of the suppurative process have as yet resulted. It should not be forgotten that the pharynx and nostrils will often require nearly as much treatment as the ear.

THE ARTIFICIAL MEMBRANA TYMPANI.

This contrivance is at times a valuable means of treating a chronic suppurative process in the middle ear. We have already, on page 43, seen that a 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 hear-

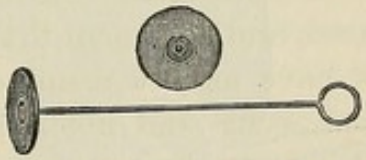
* Transactions of American Otological Society, Fourth Annual Meeting, 1871.

ing, 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.*

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 patient experiences an improvement in the hearing power. I have seen several patients who used this kind of an artificial membrana tympani, and who were very skillful in its employment.†

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

FIG. 73.



Toynbee's Artificial Membrana Tympani.

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 the original method of attachment of the wire, is to insert it spirally into the disk, like a cork-screw in a cork.

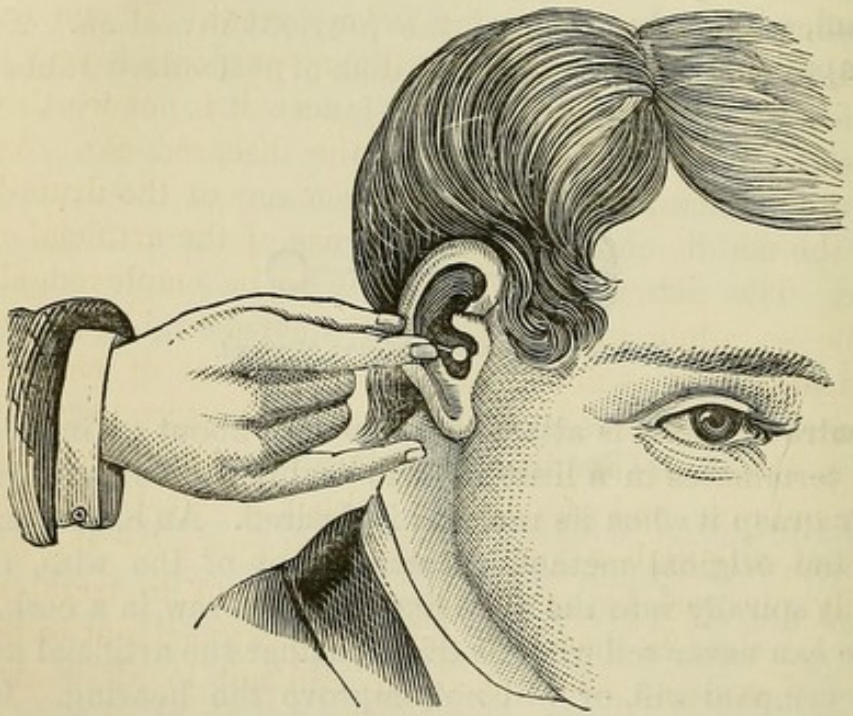
We can never tell without trial, whether the artificial membrana tympani will, or will not improve the hearing. Inas-

* Yearsley on Deafness, p. 245.

† An artificial membrana tympani was employed more than two hundred years before Yearsley, but *not for the purpose of improving the hearing.* Marcus Banzer, in 1640, recommended for this purpose a tube of elk's claw, which was covered by a piece of pig's bladder. Leschevin in 1763, Autenreith in 1815, and Lincke in 1840, continued to employ such an appliance. Lincke used thin silver or gold tubes, somewhat conical in shape, from five to eight lines in length, and of from two to three lines in thickness. The outer end of the tube had a rim to prevent it from slipping too far into the meatus. The inner end was covered by a thin piece of gold-beater's skin, which was varnished.—Lincke's Handbuch, p. 447.

much as I am 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. Von Tröltsch relates a case of a deaf judge who used to improve his hearing temporarily by pressing upon the membrana tympani with a probe; but I have never been able to increase the hearing power by any similar procedure upon a membrana tympani that was complete. 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

Fig. 74.



Method of Inserting Artificial Membrana Tympani.—Toynbee.

continuity of the ossicula auditus 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. Lest any should think, that the artificial membrane is not a practical and valuable means of alleviating some cases, I may state that I have now under observation five patients, for whom I first introduced the membrane, who have worn it for years, with uninterrupted benefit to the hearing power. I have taught several other persons to apply the membrane, and with benefit; but inasmuch as I have not seen them for a long time, it is not quite certain, although probable, that they are still using the substitute for the natural membrane. I am in the habit of tentatively applying the artificial membrana tympani in all old cases of chronic suppuration in the middle ear, when the loss of hearing is very great. If one ear be sound, so that the 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.

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. I have repeatedly seen it entirely restored after all but a narrow rim had been entirely swept away. This has occurred at times 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. Patients with phthisis pulmonalis seldom recover from a spontaneous rupture of the membrana tympani. The physician 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 regular and careful treatment by a physician, continued for months, fails to close the opening, or to cause the discharge of pus to cease, the patient may perhaps be given up, as one for whom there is no hope of cure. The family and friends should be taught to cleanse the ear thoroughly, as long as any purulent formation occurs, and they should know that the chief danger to the ear, and the general system, lies in an accumulation and retention of pus.

CASES.

CASE I.—*Chronic Suppuration of twelve years standing—Exostosis of Tympanic Cavity—Patient under treatment for more than three years—Both Membranæ Tympani healed—Hearing distance remains the same.*

W. P. H., æt. 32. June 1869. History—Ten or twelve years ago, from some cause to patient unknown, the right ear began to discharge, and then the left. They have discharged at intervals ever since. Occasionally there is pain in the ear.

The hearing distance is—R., $\frac{24}{48}$; L., $\frac{1}{48}$. The right membrana tympani is in a state of ulceration; about one-third is gone. The lower and posterior

quadrant remains. Considerable pus lies in the cavity of the tympanum. The left membrane is nearly gone. There is a small granulation springing from the cavity of the tympanum. The pharynx is tolerably healthy.

The patient was ordered to use the warm douche daily. He visited me three times a week, when the ears were cleansed by the syringe and warm water, and Politzer's method, and, an astringent, usually the sulphate of zinc, was instilled. In November, in about four months from the time of my first seeing him, the left membrana tympani had healed. The granulation disappeared with no other treatment than the cleansing and the use of an astringent. March 17, 1870—The right membrana tympani now exhibits a clearly cut opening in the posterior and inferior quadrant. A small amount of pus oozes from it. A minute but positive elevation of bone comes out to the opening. The hearing is at times very poor, on account of the blocking of the tympanic cavity by pus. The patient has been under my observation ever since first note, often coming to the office every day. Nitrate of silver, nitric acid, various astringents, with the continuance of the douche and syringe, have been employed in vain. March 17, 1871—The patient has just passed through an attack of acute catarrh, induced by taking cold. The hearing distance became $\frac{0}{48}$ during this attack. Leeches were used, and subsequently the catheter, steam being passed through it. After the subsidence of the inflammation, the opening in the membrana tympani was found to be very much smaller. It was then cauterized with the mitigated stick of nitrate of silver, melted upon a probe, and in a few weeks it healed entirely; so that in October, 1872, he was dismissed, with H. D. R., $\frac{24}{48}$; L., $\frac{4}{48}$, and both drum membranes healed.

I have not attempted to give the full notes of this interesting but tedious case. I have inserted it to show what perseverance on the part of the patient will finally accomplish in some cases of chronic suppuration. There were no peculiar means of treatment adopted during the three years the patient was under my care; but he was informed that it might require years to heal the drum-heads. He realized the danger from a continued suppuration, as well as the inconvenience and discomfort, and he determined never to give up the attempt to cure it. Very few patients will submit to such a prolonged observation or treatment without faltering in their allegiance to their medical adviser.

CASE II.—*Suppuration in both Tympanic Cavities for fifteen years, a result of the Pharyngeal Inflammation of Scarlet Fever—No treatment since first attack—Healing of one Drum-head, with great improvement to hearing power—Other Membrane still open.*

Mr. A., æt. 26. Nov. 1870—Since patient was 11 years old, when he had

scarlet fever, he has had a discharge from both ears, with great impairment of hearing. Hearing distance, right ear, $\frac{4}{48}$; left, $\frac{1}{48}$. The membranæ tympani on each side are removed by ulceration. There is a large amount of pus in each canal, with granulations which bleed readily.

The ears were treated by the warm douche, the syringe, and Politzer's method of inflation. The latter at once improved the hearing, so that the watch was heard at 4 inches, $\frac{4}{48}$, on the left side. Some inflammatory reaction was caused in a few days by the cleansing process, and the douche only, could be employed. The patient was seen from once to twice a week, and used the douche and an astringent at home. One year after, his hearing distance was, R., $\frac{8}{48}$; L., $\frac{24}{48}$. The left membrana tympani has just healed.

April 16, 1872, or nearly a year later, having been seen at longer or shorter intervals ever since, and having kept up the treatment at his home, the hearing distance of left ear is $\frac{36}{48}$. The patient has still occasional attacks of subacute suppuration from right ear. His hearing power for conversation is excellent, and no true pus is found in right tympanic cavity, but some stringy mucus is forced out by Politzer's method. January, 1873—The patient is still seen at long intervals. The condition of the ears remains about the same.

CASE III.—*Suppuration of both Middle Ears, occurring without pain—Half of each Membrana Tympani gone—Moderate amount of pus secreted—Treatment did not avail to improve the Hearing Power—Artificial Membrana Tympani used with benefit.*

E. R. T., æt. 28. Nov. 1872—Three months since, patient found, on awaking in the morning, that both ears were discharging. There was no pain experienced in them. He had had naso-pharyngeal catarrh for some time, which had been treated regularly by the use of the nasal douche and the posterior nares syringe. The patient is not in very good general health. He has had a pulmonary hemorrhage, and evidently has phthisis pulmonalis. He hears the watch six inches on the right side, two inches on the left. Hearing distance, R., $\frac{6}{48}$; L., $\frac{2}{48}$. The pharynx is granular. The anterior and inferior quadrant of the membrane is gone. The remainder of the membrane is white, and does not reflect light. The left membrane also has a large perforation, the anterior half being absent, and the remainder of the membrane looking like the right. There is a moderate amount of pus secreted in the tympanic cavity. The auditory canals are red and sensitive. The patient has already had more or less systematic treatment, and he cleanses his ears daily by syringing. There are great variations in the hearing power.

The patient was seen daily for some six weeks, and efforts made to heal the membrana tympani by the use of sulphate of zinc, alum, sulphate of copper, nitrate of silver, in solution and in solid form. Cod-liver oil was given, and the general condition improved, but the membranæ tympani did not heal in the slightest, although the discharge was lessened, and the condition of the auditory canals was improved.

February 15, 1873.—The patient's hearing power continued to grow worse, when the artificial membranæ tympani were inserted, with immediate benefit

to the hearing power, so that he could transact his business, which was that of a commercial traveller. Hearing distance, R., $\frac{6}{48}$; L., $\frac{4}{48}$.

April 15.—The patient is still wearing the membranes with the same benefit. The ears are daily cleansed by syringing, and an astringent is dropped upon them. Mr. T. says that he cannot hear "at all" without the artificial membranes.

It has been a common observation with the patients who use an artificial membrana tympani, that they cannot hear as well after removing the artificial drum-heads, as they did before wearing them. Yet in some cases, the improvement continues for hours after they are removed. The latter effect is probably due to the fact that the restored continuity of the ossicula and the fenestra ovalis is kept up, even after the agent that caused the restoration is removed.

CASE IV.—*Chronic Suppuration of ten years duration stopped in three days, by the removal of a small granulation through the Drum-head, and the application of nitrate of silver—Hearing power improved.*

R. R., Nov. 8, 1872, sent to me by Dr. H. C. Eno. When the patient was 16 years old he "got cold in the right ear;" the ear was very painful; it discharged and has continued to do so ever since. It has been under careful treatment for some months, and does not discharge as much as it did. The hearing distance is $\frac{1\frac{1}{2}}{48}$.

On examination, a slight amount of pus is found upon the membrana tympani. On removing this, a small granulation is seen to come through the membrane in the anterior and inferior quadrant.

November 9.—The granulation was removed by means of a pair of angular forceps. A solution of nitrate of silver, gr. 40 ad ℥ j, was applied in the opening, after a thorough cleansing of the ear by syringing and Politzer's method.

November 10.—The opening in the membrane has closed. The patient remained under observation until Nov. 22, and suppuration did not again occur. The hearing distance became $\frac{4}{48}$.

It may be thought that these cases illustrate the bright side of the treatment of chronic suppuration; but I do not think they are any more than average specimens of cases of simple ulceration, that is, ulcerations unattended by death of bone. When caries or necrosis of any part of the walls of the cavity has occurred, the prognosis is very unfavorable for a perfect arrest of the morbid process. I have not found so much difficulty in relieving uncomplicated cases of chronic suppuration, as in finding patients who were patient enough

to submit to the tedious treatment necessary to a cure. Distrust of the advice of the profession is nowhere more common than in cases of chronic suppuration, in regard to which the laity have been taught two erroneous and contradictory doctrines, first, that a discharge from the ear is seldom checked; second, that it is dangerous to arrest it, if we can.

CHAPTER XVII.

THE CONSEQUENCES OF CHRONIC SUPPURATION OF THE MIDDLE EAR.

If a chronic suppurative process in the middle ear remained a simple ulcer, with none of the consequences that are very liable to result from it, it would, perhaps, be a condition of things to be preferred to a chronic proliferous process in the same part. For in simple chronic ulceration the hearing power is often very good, the tinnitus aurium is not usually excessive, and sometimes does not exist, and it may generally be relieved by simple syringing and inflation of the ear. These are the symptoms which are so trying, in the non-suppurative form of disease, that people have become insane on account of them. But the almost inevitable consequences of chronic suppuration in the middle ear, are dangerous to the health and life of the patient. Hence the importance of the subject, and the interest which every physician should take in arresting the advance of these sequelæ of disease.

It is in view of these effects of chronic suppuration of the middle ear, that English life insurance companies are said to decline to insure the lives of persons that are affected with the disease. A little consideration will show, that 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.

On page 237 of this volume, these consequences are tabulated. It is now proposed to enter into a discussion of their

nature and treatment. At the risk of reiteration, it should be again said, that none of the results of chronic suppuration should ever be regarded as independent affections.

—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 or 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. It is probably too late, or too early, to effect any change in the nomenclature, and we must be content with the name aural polypi for all the growths that occur in the ear, except for those of an osseous structure or a cancerous nature.

The best classification of aural polypi seems to me, to be that of Steudener,* who divides them into three varieties:

1. Mucous polypi.
2. Fibromata.
3. Myxomata.

To this we may add a fourth class:

4. Angioma; a case of which, as occurring in the ear, was first reported by Dr. A. H. Buck.†

Cases of epithelioma, sarcoma, and cholesteatoma have also been reported, but they do not properly belong to the subject of aural polypi, although they are sometimes confounded with the simple growths, and perhaps arise from them. For the sake of convenience, their consideration will be deferred until the benignant tumors have been considered. Kessel‡ also reports a peculiar growth which is called a clot of blood in process of organization, but it hardly requires a separate classification.

* Archiv für Ohrenheilkunde, Bd. IV., p. 203.

† Transactions of the American Otological Society, 1870.

‡ Archiv für Ohrenheilkunde, Bd. IV., p. 187.

The mucous polypi are altogether the most frequent of those found in the ear. The fibromata, or polypi made up of denser connective tissue than the mucous growths, are next in frequency. Buck thinks that about one in ten of all the polypi that have been microscopically examined, belong to the class of fibroma. Myxoma has been reported by Steudener only, so far as I have been able to find.

Nature of Aural Polypi.—In an article published in 1864,* I attempted to show on clinical grounds, that aural polypi were analogous in structure to exuberant granulations, occurring as direct results of an ulcerative process. This view at once clears up the nature of these growths and takes away the fictitious importance which the view that regards them as independent tumors caused them to assume. Professor Theodore Billroth, in 1855, whose monograph I had not then seen, examined seven polypi which were found in the external auditory canal, and Kessel † quotes him as stating that the chief contents of those polypi were granulation material, although he states that the existence of ciliated epithelium and the vascular network entitles them to the rank of independent tumors. Billroth's idea as to the nature of mucous polypi is perhaps the most correct and the simplest. They consist of a delicate but loose stroma of connective tissue. In the meshes of this connective tissue are round, spindle-shaped or stellate cells, and they are covered by a single or multiple layer of epithelium cells.

The fibrous polypi consist of a dense connective tissue, having but few cellular elements in its fibres and covered by pavement epithelium.

Angioma is made up of newly formed vessels, or of vessels in whose walls are newly formed elements. It is quite a common variety of tumor, although the case to which allusion has already been made, is the only one that has been reported as having been found in the ear. Virchow ‡ named the form which Dr. Buck examined, *angioma cavernosum*, because it was

* American Medical Times, August 6, 1864.

† Archiv für Ohrenheilkunde, l. c.

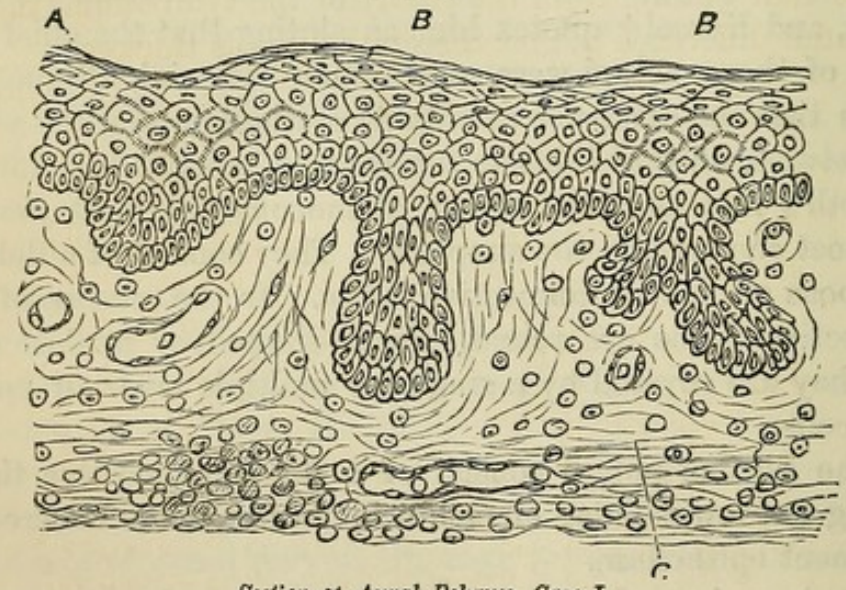
‡ Die krankhaften Geschwülste IV., Bd. I., Hf. ., p. 307.

characterized by the existence of a network of blood spaces, occupying the place and doing the work of capillary vessels.

In Dr. Buck's case the angioma seems to have been secondary to a common mucous polypus, which was removed a few days before. The angioma assumed its character of a vascular growth from that removal, and such a tumor would probably be sometimes found were microscopic examinations made of the growths that often spring up after the removal of simple mucous polypi.

Dr. H. C. Eno, pathologist to the Manhattan Eye and Ear Hospital, and assistant-surgeon to the New York Eye and Ear Infirmary, examined three specimens of aural polypi, which I removed from the auditory canal, and made drawings of their structure. These drawings will, I think, better illustrate the nature of these growths than further remarks.

FIG. 75.



Section of Aural Polypus, Case I.

A. *Layer of laminated epithelium, similar to that of skin.* B, B. *Epithelial cones, the commencement of gland formation.* C. *Loose connective tissue, containing round and spindle cells and some fibres.* D. *Blood-vessels.*

CASE I.—Thomas Gibney, age 23. March 14, 1871. Brooklyn Eye and Ear Hospital.

History.—Seven days ago extensive swelling in meauricular region; granulations springing out of auditory canal.

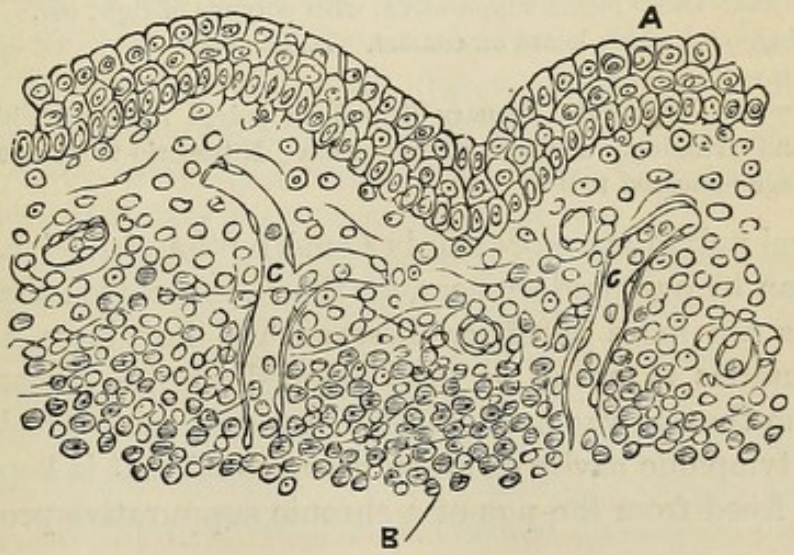
Diagnosis.—Abscess of anterior wall of auditory canal, with polypoid growth arising from same point.

Treatment.—Polypus removed and abscess opened; ordered chloral hydrate,

gr. xv.; if does not sleep well to-night, to come at 12 M. March 16th—Continue treatment. March 18th—Touched polypus with nitric acid. March 21st—Much better, touched with argent nit. mit.

It should be said that the usual point of origin of aural polypi, is the cavity of the tympanum. They may arise from the auditory canal, but if so, they are the result of suppuration, that has been prolonged, or that has been augmented by the use of poultices, and which have rapidly broken down the integument of the canal, and rendered it more like its neighbor, the mucous membrane of the tympanic cavity. Polypi and granulations often, however, have their seat in the canal, but they are usually accompanied by the same growth in the deeper parts, when the whole character of the tissue lining the canal has been changed by an ulcerative process, extending from the tympanic cavity. As will be seen by comparing the illustrations of Case I., which arose from the auditory canal, with those that sprang from the cavity of the tympanum, the only essential difference is that the epithelium is thicker.

FIG. 76.

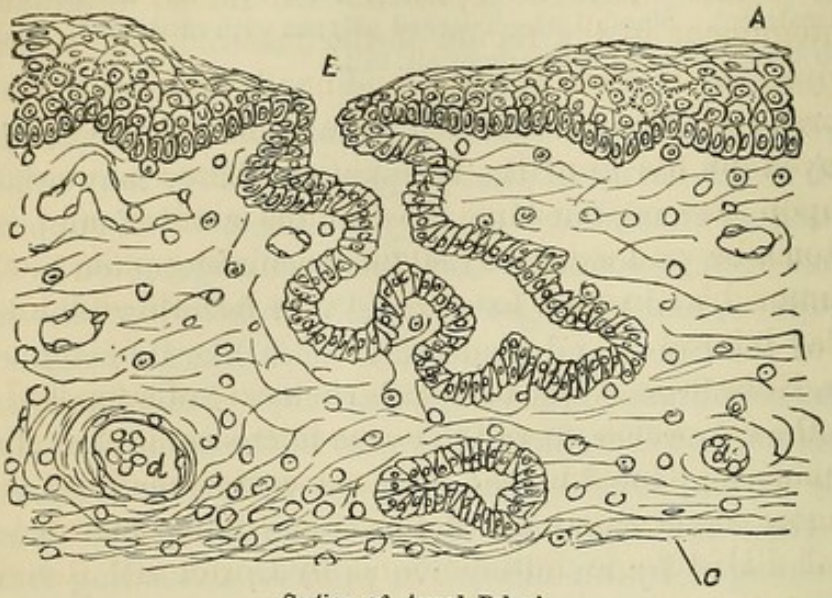


Section of Aural Polypus, Case II.

A. *Epithelium.* B. *Substance of polypus, made up of a mass of round cells about the size of white blood corpuscles.* C, C. *Capillary vessels, containing white blood corpuscles.*

CASE II.—Mary Jane N., æt. 13. January 10, 1872. Manhattan Eye and Ear Hospital. Otitis media suppurativa, with polypus in right ear. Polypus nearly fills auditory canal. Discharge from both ears from scarlet fever since a child. Large perforations in membranæ tympani. Polypus removed with snare.

FIG. 77.



Section of Aural Polypi.

A, C, *and* D, *same as in Fig.* 75. E. *Gland lined with cylindrical epithelium.* F. *Transverse section of the same.*

CASE III.—Mary Ann McC., age 14. January 24, 1871. Manhattan Eye and Ear Hospital.

History.—Discharge from right ear since a child. Cause unknown.

Diagnosis.—Otitis media suppurativa, with polypus of right ear.

Hearing.—R., watch heard on contact. L., normal.

Meatus.—R., full of pus.

Treatment.—Syringed. January 31st—Two polypi removed with snare. Douche and syringing. Politzer, warm douche. Nitric acid to stumps. Hearing distance increased to 2″.

Aural polypi are more rarely found by the physicians of to-day, than by our predecessors, for the simple reason that aural diseases are more carefully observed, and they have no such opportunities to occur, as were enjoyed when a discharge of pus from the ear was not treated. A tumor can scarcely arise from a tympanic cavity or an auditory canal that is kept thoroughly freed from the pus of a chronic suppurative process.

MALIGNANT GROWTHS.

The malignant growths that have as yet been found in the ear, and which may be mistaken for malignant polypi, are epithelial carcinoma, fibrous and medullary carcinoma. Gruber*

* Text-book, p. 597.

relates a case where an epithelial carcinoma originated in the integument in the region of the mastoid bone, gradually destroyed the mastoid process, and finally reached the mucous membrane of the middle ear. The membrana tympani was destroyed by the growth. The patient heard a watch when laid upon this ear; he had no tinnitus aurium, and so few symptoms beyond extremely slight lancinating pain, that after the tumor had existed for three years he still did his work as a day laborer.

Dr. Robertson of Albany,* reports a case of supposed polypus in the ear, which proved to be, on microscopic examination, a specimen of "fasciculated sarcoma corresponding to plates of tumors constituted by embryonic tissue, found in the Manual d'Histologie Pathologique, by Cornil and Ranvier of Paris." An attempt to remove the growth by cutting off pieces of it, caused a hemorrhage of fourteen fluid ounces in a few moments. The hemorrhage was arrested by a tampon of cotton dipped in a solution of persulphate of iron.

Cholesteatoma, the pearl tumors of J. Müller, have also been found in the cavity of the tympanum arising from an inflamed or ulcerated mucous membrane. They consist, according to Gruber,† 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.‡ The patient died of meningitis. Wilde§ reports an interesting case of osteo-sarcoma. A boy of seven years of age, in apparently good health, was brought to Mr. Wilde on account of a discharge from the external auditory canal. A small polypus was discovered. It was removed, but it returned quickly on the third day. It was again and repeatedly removed, but it recurred again and again, and subsequently the child was seized with an epileptic fit. A fluctuating point was then found upon the mastoid process; this was cut down upon at once, and the opening gave exit to a large amount of pus. The abscess communicated

* Transactions of the American Otological Society, 1870.

† Lehrbuch, p. 597. ‡ Gruber, l. c. § Text-book, p. 208.

by a fistula with the external auditory canal. A fungous growth soon sprouted up through the incision. Repeated attacks of epilepsy occurred, and death soon ensued. Upon examination there was found an osteo-sarcoma of the petrous and mastoid portions of the temporal bone. Wilde, thinks that the original disease was in the bone, and that the aural discharge and fungous were but secondary appearances. The history is not detailed enough to allow us to state with any positiveness the first cause of the affection, but it may have been an ulcer in the tympanic cavity, which secondarily involved the bone.

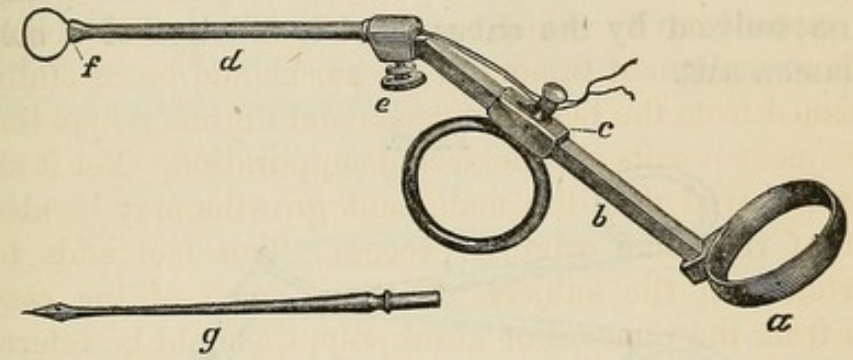
These malignant tumors of the ear should be carefully distinguished from the benign mucous and fibrous polypi that are the frequent results of a neglected suppuration. Yet it should be remembered that the malignant growths may be also the result of the same original process. This fact adds to the importance of the subject. Perhaps some of the cases of death from the removal of aural polypi, should be referred to the extension of the malignant disease, rather than to the excision of a tumor from the ear.

Treatment.—The treatment of an aural polypus should begin with the removal of the growth. I have said *begin* 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; moreover, we are often obliged to remove them several times from the ear, especially where we cannot have full control of our patients and cause them to attend to the after-treatment.

Wilde's snare, as modified by Blake, will be found the best instrument for the removal of well-defined polypi with a pedicle. In Wilde's snare, the bar which carries the slide, and the arm which supports the wire used in cutting off the polypus, are in one piece. Dr. Blake has substituted a movable tube of German silver (*d*) for the fixed arm. "This tube expands at the outer ends into a flattened head (*f*), having two openings for the passage of the wire; the inner end of the tube fits

into a broad band on the slide-bar (*b*). The ends of the wire passing down the tube are fastened to a pin on the upper part of the slide (*c*), below which is a ring, by which traction can be made." The instrument is better than Wilde's, because it can be turned in any direction without injuring the walls of the canal. A paracentesis needle may also be used in the handle, but it should be rather longer than the one in the cut.

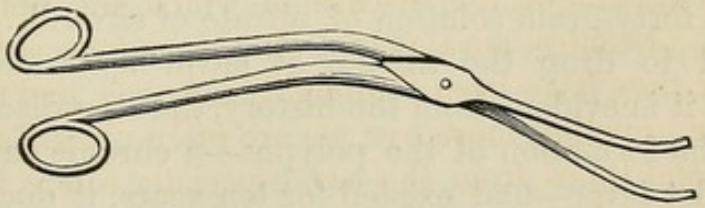
FIG. 78.



Blake's Modification of Wilde's Snare, with Paracentesis Needle.

Scissors may sometimes be used with advantage to remove aural polypi. I have found those that are here represented very convenient, especially for the removal of growths from the walls of the auditory canal.

FIG. 79.



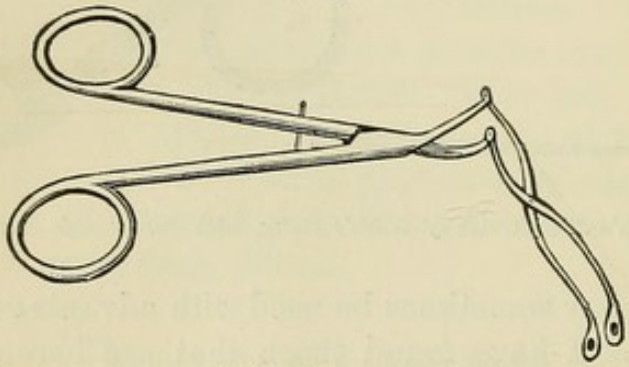
Scissors for the Removal of Aural Polypi.

Forceps may sometimes be employed, although I prefer the snare and scissors to all other 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, such as was found in the case recorded on page 385, may be often removed by the simple angular-toothed forceps, figured on page 80 of

this work. . True exuberant granulations, having no pedicle, but arising from a broad surface, usually resist treatment with great obstinacy, because they are difficult to reach and entirely remove with instruments, and because they usually cover carious or necrosed bone. Caustics are perhaps the only means of removing such growths. The agents I usually employ for such cases are strong solutions of nitrate of silver—from 40 to 480 grains to the ounce—and fuming nitric acid. The nitrate of silver may be poured in upon the part, and then neutralized by the subsequent instillation of a solution of common salt.

Fig. 80.



Hinton's Forceps.

Dr. O. D. Pomeroy* reports a case of "the removal of a polypoid granulation of ten years standing, by four applications of a forty-grain solution of nitrate of silver." A pipette was used to drop the nitrate of silver upon the growth. Although it is evident from the history, that the disease which allowed the formation of the polypus—a chronic suppuration from scarlet fever—had existed for ten years, it does not certainly appear that the polypus had been in the ear so long. The polypus is said to have sprung from the membrana tympani, which was perforate, however.

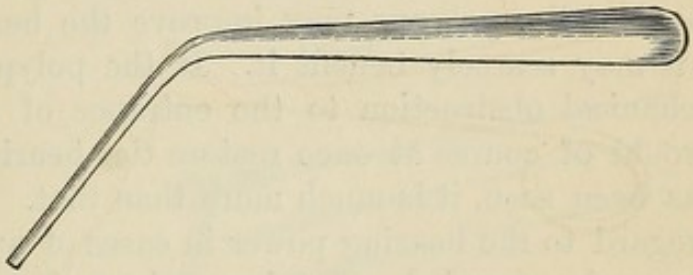
I am in the habit of treating granulations that arise from the cavity of the tympanum, where it is somewhat dangerous to use forceps, scissors, or snare, by numerous punctures with a cataract needle. The puncturing causes considerable hemorrhage. After the blood is wiped away, a caustic should be

* Medical Record, vol. vi. Reported by D. Webster, M.D.

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. The granulations are of such a low grade of organization that they have very little sensitiveness. 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.

Fig. 81.



Angular Glass Rod for applying Acids to the Cavity of the Tympanum.

Dr Edward H. Clarke often injects a solution of the perchloride or persulphate of iron into the interior of a polypus, and with the happiest results.* Two or three drops of the liquor ferri perchloridi, of the liquor ferri persulphatis, are injected into the growth by means of a hypodermic syringe.

The galvano-cautery is said to be an efficient and painless method of removing granulations from the cavity of the tympanum. Dr. Blake does not consider it a painless method of perforating the drum-head however, he having witnessed its operation, in Vienna, in some experiments made by Politzer, Chemani, and Moos. Allusion has already been made, on page 331, to this means of puncturing the membrana tympani. In each of the cases observed by Blake, where an attempt was made to perforate the membrana tympani with a galvano-cautery, the pain was so severe that further attempts were aban-

* On Polypus of the Ear, p. 61.

doned. It is probable, however, that it is not so painful a process when used to remove granulations. Schwartze* speaks very highly of the galvano-cautery for the purpose of removing morbid growths. Although the pain is considerable, much more severe than from the use of the pure nitrate of silver, the reaction is slight. Schwartze also believes that the galvano-cautery is a more efficient means of removing the growth than the ordinary caustics.

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 hemorrhage from their removal is usually trifling. If it be excessive, as in Dr. Robertson's case of carcinoma, a tampon saturated in sulphate of iron will arrest it. I usually employ Rohland's styptic cotton for the arrest of hemorrhage from the base of a polypus, if the use of cotton-wool do not check it at once.

BLAKE'S MIDDLE EAR MIRROR.

Dr. Blake has invented a 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.† It is said to be especially useful in detecting the exact site 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

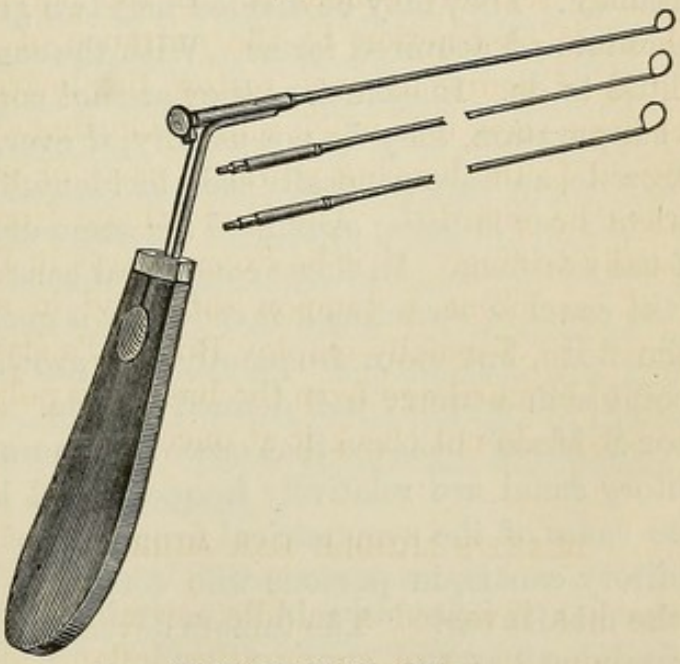
* Archiv für Ohrenheilkunde, Bd. IV., p. 8.

† Transactions of the American Otological Society, 1872, p. 83.

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 Dr. Blake thinks a larger mirror may be used. "The mirror is made by flattening out 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 rotated by movement of the stud in the handle."*

FIG. 82.



Blake's Middle Ear Mirror.

For the benefit of the student and young practitioner, we may formulate our knowledge of aural polypi as follows:

I.—True aural polypi are morbid growths analogous to exuberant granulations.

* Messrs. Otto & Reynolds, of this city, have greatly improved Weber's tenotome and Blake's middle ear mirror, by placing the tenotome and mirror in a slit canula, so that no unscrewing is needed to remove them.

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 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.

EXOSTOSES.

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 caliber of the canal is sometimes invaded by a general thickening of the bone, but more frequently the growths extend from one point with a pretty well defined pedicle.

Professor S. Moos* believes that osseous tumors in the external auditory canal are relatively frequent, and he has 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. Moos thinks that these cases were consequent upon irritative processes occurring at the time when the annulus tympanicus unites with the squamous portion of the temporal bone. Dr. Gruening reported

* Archives of Ophthalmology and Otology, vol. ii., p. 136.

two similar cases at a meeting of the New York Ophthalmological Society, in April, 1872.

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 motions of the jaw—cannot produce the same effect upon the narrow passage.

Bonnafont* reports an interesting case of an aural exostosis, which, so far as I can judge from the history, which is not very detailed nor exact, seems to have been congenital, and to have continued to grow after birth. It completely obliterated the auditory canal: "*Observation d'un cas de surdite complète de l'oreille gauche due à l'obliteration de conduit auditif par une tumeur osseuse, siégeant près la membrane du tympan, guérie par le trepanation de la tumeur.*" There was no history of previous pain or suppuration. By the use of a point of nitrate of silver, for six sittings, the bone was exposed at the centre of the growth, and it was then removed by boring into it with a rat-tailed file. In ten applications of this file, which were not very painful, an opening was made. A whalebone probe was then fastened in the opening. This opening was kept up for some months, and after it was made the tick of the watch was heard for some inches. Some years after, the opening through the exostosis still remained.

Professor H. Welcker,† of Halle, in an article upon bony growths in the ear, found upon the dead subject, gives some interesting facts in regard to these formations. Welcker quotes from Seligman, who found exostoses very frequently in the external auditory canals of the skulls of American Indians, that had been misshapen by pressure exerted upon them in infancy. "Of six such skulls, five were found to have this kind of exostoses." Seligman was inclined to believe that these growths were a peculiarity of race; but Welcker does not agree with him, because he found them in other Indians not of the tribe whose skulls were examined by Professor Seligman, and whose bones had not been changed by pressure. Welcker also adds that these exostoses are not

* Monatsschrift für Ohrenheilkunde, Jahrgang II., No. 8. Lue à l'Académie Impériale de Médecine, 26th May, 1868.

† Archiv für Ohrenheilkunde, Bd. I., p. 171.

extremely rare among the cultured population of Europe, and as shown by the text-books and C. O. Weber's collection, the external auditory canal is a favorite position for them. Welcker thinks that Seligman's observations show that exostoses of the external auditory canal are more frequent among the Indian tribes than among the people of Europe, although he does not think there is any race peculiarity in them. The exostoses found by Seligman, in such relative frequency among North American Indians, seem to plainly belong to the class of congenital growths which have been reported by Moos, Gruening, and Agnew; but I have no doubt that their origin was, as Moos states, due to some local irritation, which caused a proliferation of bone.

INFLAMMATORY OR ACQUIRED EXOSTOSES.

The cases of acquired exostoses are a much more 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. Such a case will be found at the close of this section. 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.

Toynbee was inclined to ascribe great importance to the existence of a rheumatic, gouty, or syphilitic diathesis in these cases of acquired and growing exostoses. In his work upon the ear, he details nine cases of bony growths in the external auditory canal, which he evidently regards as an independent disease, and he remarks that "they seem to be the result of a rheumatic or gouty diathesis." The author published four cases,* in which there was no such diathesis, but in which the growths were general enlargements of the periosteum, and of the bone structure beneath. They were morbid growths consequent upon local irritation. A more complete experience has substantiated this view. Besides, a careful examination of the history of Mr. Toynbee's cases causes the doubt to be raised

* New York Medical Journal, vol. ii., p. 424.

whether a diathesis had much to do with the formation of several of them; while some of the others probably belonged to the congenital form. In Case III., reported by Toynbee, a discharge had existed from the ear for eleven years. There was a perforation of the membrana tympani. In Case VI. there was also a discharge. In Case VII. the exostosis was found to be the base of a polypus. In Case IX. there had been a discharge from the ear when the patient was a boy. Nine cases are reported in all; but the histories are not very fully given.

Virchow* says 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 influence 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 recently the seat of inflammation.

Dr. Agnew† has seen quite a number of cases of exostoses arising in cases in which the membrana tympani was sound, and which he believes were due to local irritation after birth, such as the use of instruments for the purpose of cleansing or scratching the canal, the formation of furuncles in the same part, and so forth.

The cases of acquired exostosis that I have seen, with one exception, arose in connection with suppuration in the middle ear. In that one exception, the exostosis was so large that

* Die Krankhaften Geschwülste II., Bd. I., Hälfte, p. 73, et seq. passim.

† Verbal communication, New York Ophthalmological Society.

the condition of the membrana tympani could not be positively known, and, unfortunately, I saw the case but once.

Treatment.—The treatment of these growths should reach the starting point—the middle ear. We should endeavor to cause the suppuration in this part to cease. If this is impossible, as it may be in the chronic cases in which exostoses occur, the parts should be kept scrupulously free from pus, so that no blocking up of the morbid material may occur. The patient should be taught to use a cotton-holder and the warm douche with which to cleanse the canal, and Politzer's method, to force the purulent material into the tympanic cavity. Iodine may be painted on the growths with, I think, some benefit, and if a diathesis play a marked part in causing their enlargement, the appropriate constitutional treatment should be given. If the exostoses grow to such an extent as to occlude the canal, Bonnafont's operation should be performed, and a space made through the growth for the exit of pus.

CASES.

The following cases will give a fair idea of the appearance of the exostoses that are consequences of chronic suppuration. Some of them have been previously published;* but inasmuch as the subject is an interesting one, and the book in which they appeared is now out of print, they may perhaps be reproduced with propriety.

Case I.—Mr. C., æt. 39, was seen in April, 1864, in consultation with Dr. C. R. Agnew, under whose care he had been for some time. He had lost, before coming under observation, the hearing of his right ear by inflammation and caries of the middle and internal ear. Previous to the above date, Dr. A. had removed a sequestrum consisting of the cochlea and semicircular canals from the depths of the external auditory canal of the ear, and thus terminated the inflammatory action. In early life, Mr. C. had also suffered from "inflammation" of the left ear, producing the bony growths in the external auditory canal, which render his case the subject of present description. He now hears with his ear a watch tick at a distance of five inches. In the auditory canal, near the meatus, are two bony enlargements, which rise from the anterior and posterior walls, and project in a conical form, so as to occupy at least three-

* Von Tröltsch on the Ear, second American edition, p. 131..

fifths of its caliber. These tumors have all the physical appearance of exostoses, and seem to have originated in periosteal inflammation. They have been steadily treated for many weeks by the local application of the saturated tincture of iodine, and certainly not diminished in size. Pressure upon them excites pain and induces an increase of swelling in the skin which covers them, and thus temporarily adds to the deafness. The entire absence of hearing in the fellow ear, and the failure of simple means to render the exostoses smaller, have suggested the propriety of some surgical operation for their removal. Such a proceeding has been thus far postponed by the occurrence of an acute attack of inflammation in the parts extending to the tympanum, with symptoms of more than usual cerebral irritation. From this disagreeable complication he has entirely recovered under Dr. Agnew's care.

His general health being impaired, he went abroad, and while in London consulted Mr. Toynbee, who used bougies, hoping to dilate the canal; but, according to Mr. C.'s statements, they caused much pain and accomplished nothing. Through Dr. Agnew's courtesy, I again saw the patient in the spring of 1865, and found that the growths had so much increased that only a small probe could be passed between them, and the hearing more impaired. The patient could still, however, hear the watch tick, but only when laid on the auricle.

The patient whose case is here given, died about two years after, of inflammation of the membranes of the brain, induced by suppuration in the cavity of the tympanum, the pus not being able to find an outlet on account of the presence of exostoses. Dr. Agnew exhibited the brain and temporal bones before the New York Pathological Society. The history of the other ear of this unfortunate patient will be found in the section on caries and necrosis.

Case II.—A gentleman, æt. 40, whom I saw but once, in June, 1864. He states that he had a "running" from his right ear for a number of years. For some two or three years past he had observed that the ear was stopped up. He was accustomed to remove the accumulating discharge by thrusting in a match armed with cotton. There is seen a bony growth arising from the posterior wall of the meatus, and involving the whole caliber of the canal, except a space large enough to admit an ordinary sized silver probe. Through this opening a slight amount of purulent discharge, constantly makes its way. There was some hyperæmia of the pharynx, and there was a small ulcer on one of the tonsils. The patient was in excellent general health, was rather a free liver, and said he had constitutional syphilis; but no good evidence of its existence now existed. The patient had never had rheumatism or gout.

Case III.—Mr. S., æt. 25, Conn. February 6, 1865 (a patient sent to me by Dr. Alfred North, of Waterbury, Ct.).—When the patient was three or four years of age he had scarlet fever, at which time his ears began to discharge, and they

have continued to do so at intervals ever since, with attacks of pain in the ears, which sometimes lasted for weeks, and prevented him from any occupation for the time. Eight years ago his ears were examined and polypi discovered, one of which was removed by caustics. The attacks of pain have continued to occur, the discharge continues, and his hearing is become more and more impaired. He is just now suffering from acute pain referred to the left ear. He hears the watch about one inch from each ear.

In the right meatus there is seen a bony growth reaching nearly out of the orifice of the external meatus, and arising from the posterior wall. The space between the growth and the anterior and upper wall is about large enough to admit of the introduction of a camel's hair brush. In the left meatus, there is seen a gelatinous granulation, also reaching nearly out to the orifice of the meatus.

On blowing air into the cavity of the tympanum, by means of the Eustachian catheter, air and fluid are heard making their exit into the external meatus; but the blocking up of this passage prevents their emergence. On the right side pus may be seen in the orifice between the bony growth and the wall of the meatus.

The confinement of the fluid in the middle ear accounts for the pain in the left side, and the indication of treatment was to secure its free exit. This was done by removing the gelatinous growth by torsion, the patient being etherized, and rendering the Eustachian tubes permeable by the use of the well-known means—the catheter and Politzer's method. The granulation was found to have its origin from a general bony expansion of the meatus. This growth had no one growth of attachment, but involved all the sides of the meatus, somewhat more expanded externally, giving the bony canal rather a funnel-shaped appearance. The bone was roughened. The pain in the ear disappeared as soon as these means for securing an outlet to the pus, constantly secreted from the cavity of the tympanum, and passing through the perforated membrana tympani, had been taken, and the hearing was so much improved that the watch was heard about four inches from the left auricle. He remained under treatment for a few days, and then returned to Waterbury, and has been under the careful and able observation of Dr. North, who has applied remedies of various kinds to the left meatus, the patient keeping the Eustachian tubes permeable by means of gargles and Politzer's apparatus. The last time I saw the patient was in October of this year (1865), when the following note was made: "He had had no attack of pain in the ear since the first date. There is still a considerable discharge of pus from each ear. He hears ordinary conversation well, and the watch ten inches from his left ear, and two inches on the right: a gain of one inch and nine inches respectively." The bony growth on the right side has not increased any, and that on the left is now smooth, and has a somewhat glistening appearance. June, 1868—Patient still remains free from any disturbing symptoms.

Dr. North writes me, March 25, 1873, that "the patient's general health is good. He hears ordinary conversation readily, and Dr. North's watch 8½ inches from the left auricle and 1½ from the right. The bony growth has a smooth, shiny appearance, and only admits the passage of an ordinary sized probe. The discharge from the ear is slight and of a watery nature. He has

no pain in either ear. Any increase of the impairment of hearing is always relieved by an application of tincture of iodine to the bony growths."

CASE IV.—Woman, æt. 27, at the New York Eye and Ear Infirmary. No reliable history could be obtained from the patient as to her ears, except that she had been occasionally hard of hearing for some years. She was quite sure that she never had had a discharge from the ears; was in good general health, and had always been so. She could hear the watch two feet from the left auricle, and twelve inches from the right. The left membrana tympani showed evidences of previous inflammatory action, there being thickening of its mucous and fibrous layers. There is a bony enlargement of the posterior wall of the right meatus, so large as to prevent any view of the membrana tympani. The patient was seen but a few times, not continuing under treatment.

CASE V.—Mr. W., æt. 23, a patient sent to me by Professor Fordyce Barker, of this city. Had scarlet fever when young, and since that time has suffered from purulent discharge from the ear, and has been quite deaf. General health is excellent. No gouty, rheumatic, or other diathesis. Hears ordinary conversation very near at hand with very great difficulty. The watch is heard when pressed upon right meatus; not at all on left. A gelatinous polypus was found attached to the hypertropic posterior wall of the auditory canal. It was removed by torsion, and nitric acid applied to its roots. On left side there is a pedunculated bony growth, arising from the posterior wall, nearly occluding caliber of canal. Naso-pharyngeal catarrh. June, 1868—Patient has been under observation since first date. Now hears conversation much better; watch at a distance varying from one to two inches on right side. Secretion of pus, which when patient was first seen was profuse, is now slight. Growths remain the same.

CASE VI.—Miss ——, æt. 25. March, 1873. I was asked by Dr. E. G. Loring to assist him in the examination, under ether, of a case of tumor blocking up the external auditory canal, with a view to its removal if practicable. The tumor was so sensitive to the touch of a probe, that no thorough examination could be made. The patient was about twenty-five years of age, and had suffered a great deal from what she called rheumatism of the back, but which seemed to have been neuralgia. She was rather small and delicate, but in fair general health. She was placed under the influence of ether, and a thorough examination was made by Dr. Loring, Dr. Pardee, and myself. The tumor arose from the posterior portion of the osseous canal of the right ear, and nearly occluded the passage. There was a minute opening between it and the anterior wall, through which a No. 2 Bowman's probe could be passed into the cavity of the tympanum. The tumor was of bone, and covered by a movable integument, which was red and very sensitive. On passing the probe into the minute opening that has been mentioned, it could be passed under the growth, and when pressed upon the growth was seen to move slightly.

The history of the case was, that there were frequent attacks of pain in the ear, without discharge, until the patient was eleven years old, since which

time there has been no true "ear-ache," and no discharge, although the parts are tender, and there is a great feeling of fulness in the ear. The watch is not heard at all on the affected side. The tuning-fork is heard better than in the other ear, which is normal. The examination, during the anæsthetic state, of the tumor by the probe, caused it to be very sensitive when the patient recovered from the ether. The aural douche was used to quiet the pain. The patient was advised to continue to use the douche; but inasmuch as there was no pus in the tympanic cavity, and the removal of the growth seemed to involve considerable danger from periostitis, any further treatment was delayed until urgent symptoms should arise. May 8, 1873—There is considerable pain in the depth of the ear, and Dr. Loring and I advise, that some operative means be taken to remove the growth.

The history of this case indicates that there was originally a suppurative action, for we can hardly believe that very severe pain occurred so frequently as was stated, until the patient was eleven years old, with no suppuration. The exostosis, which probably then began, has been growing ever since, until it has reached the present limits, where it seriously threatens the future of the patient.

MASTOID DISEASE.

As we have seen, in considering the diseases of the middle ear, and in discussing its anatomy, the mastoid process is necessarily involved in any severe inflammation of this part of the organ of hearing. This may also be the case in an acute or chronic inflammation of the auditory canal, for the mastoid process opens into this part also. Yet there is a form of mastoid inflammation which assumes such importance, and overshadows the inflammatory action in other parts to such a degree, that it demands an especial study, and especial treatment. The usual treatment of an acute inflammation of the external and middle ear soon causes the symptoms of the inflammation of the lining membrane of the mastoid cavities to subside; but when the mastoid process is involved in the course of a chronic suppurative process, the ordinary treatment will not avail. More prompt and decisive means are usually required. Under such circumstances, diseases of the mastoid often assume such proportions of severity and danger, that we are justified in speaking of mastoid disease as a com-

plication requiring especial notice and treatment. Perhaps it is a complication or consequence of chronic suppuration in the middle ear, only second in gravity to an extension of the inflammation to that portion of the dura mater covering and running into the tympanic cavity.

The diseases of the mastoid that may arise as a consequence of a chronic inflammation of the middle ear may be divided into the following varieties:

1. Inflammation of the periosteum.
2. Caries and chronic suppuration.

It is true, as has been already indicated, that the first form often arises in the course of an acute catarrh, and that it perhaps always exists to a more or less extent in this disease; but it is no less true that a chronic suppurative process that has been going on quietly for years perhaps, will suddenly become an acute inflammation of the mucous membrane and periosteum of the part, and require especial and prompt treatment. The mucous membrane lining the mastoid cells is so closely connected to the bone, that, like the mucous membrane of the cavity of the tympanum, it is essentially a periosteum.

Caries and necrosis are of course the same affections that occur so frequently in other parts of the middle ear, and from the same cause—imperfect removal of the pus that has been forming.

Sclerosis and hyperostosis of the bone has also been considered as a separate morbid condition by Agnew* and A. H. Buck,† but as admitted by the latter author, the cases are not yet numerous enough to allow us to make a positive diagnosis of this disease from clinical facts. We are, perhaps, justified, in this practical treatise, in classifying this class of cases under the head of periostitis.

Symptoms.—The symptoms of mastoid periostitis are usually sufficiently striking to arrest the attention of the medical adviser so soon as they occur.

During the course of an acute or chronic suppurative process in the middle ear, the patient begins to complain of great

* Transactions of the American Otological Society.

† Archives of Ophthalmology and Otology, vol. iii., No 1.

pain behind the ear, the mastoid process becomes red, tender, and swelled. This is the usual course, although at times the pain is not referred especially to the mastoid, even when it is evidently involved, as shown by the redness or tenderness of the part. The pain is usually of the severest kind, preventing the patient from sleep and from his usual occupations, although he may not be confined to the house.

The early diagnosis of this affection is by no means an unimportant matter. A delay in the recognition of the true state of things allows of the extension of the disease to the brain through some of the numerous foramina which transmit the minute branches of the middle meningeal artery. Pus may also be carried into the circulation through the mastoid vein which passes to the lateral sinus.

Professor Alfred C. Post, of this city, who was one of the first physicians in this country to give diseases of the ear the same attention that was paid to other parts of the body, has seen several cases where disease of the brain and death have resulted from the non-recognition of mastoid disease.

Many neglected cases run their course, however, with great suffering to the patient, and with much loss of function, without destroying life. This is proven by the frequency with which mastoid cicatrices are seen in our aural cliniques. The history of such patients usually shows that they have had a narrow escape, but that nature has at last given relief by an external opening through which the pus and dead bone made their way.

Treatment.—The treatment of mastoid congestion and periostitis is very simple. An incision should be made through the integument and periosteum down to the bone. The incision should be from below upward, lest the knife should slip and pass into the tissues of the neck. The opening should not be a puncture, but a cut of from three-quarters to an inch and a half long, or even longer, according to the age of the subject. The incision should be parallel to the attachment of the auricle. Even if the posterior auricular artery be wounded, the bleeding can be readily arrested by pressure or torsion. I have never found any alarming hemorrhage. A free escape of

blood is desirable. The surgeon who has not made this incision in cases of mastoid periostitis will, perhaps, be surprised at the depth of the tissues when they have become infiltrated from an inflammatory action of some days standing. I have sometimes been amazed at the depth to which the scalpel entered, especially when pus has formed. Pus will not be found in the majority of the cases, but the indications for an early, free, and deep incision are imperative when we find redness, tenderness, and swelling of the mastoid process in connection with an inflammatory process in the ear.

It should be remarked, however, that there are some innocent cases of mastoid disease that may occur in the course of an acute catarrh—cases that will not demand the incision that has been described. Young children, especially children of strumous habit, at times suffer from an infiltration of the tissues of the mastoid, which may, *if carefully watched*, be allowed a little more delay than the same class of affections occurring in an older subject. There is a phlegmonous inflammation of this part occurring in young subjects, which does not go on so rapidly or painfully as a periostitis. Still, in case of doubt, it is better to err on the side of making the incision. Furuncles in the auditory canal may cause an œdema of the parts about the mastoid, that will not require an incision. A little care in observation will show, however, that while these cases simulate a periostitis in the swelling and redness, there is not the exquisite tenderness and dreadful suffering of a true periostitis. The mastoid gland may enlarge during the course of an acute catarrh, or in strumous subjects who have no aural disease, but such an enlargement will hardly be mistaken for a periostitis.

If the incision be made in the early stages of mastoid periostitis, pus will not be found, but the relief to the pain from the hemorrhage, and the letting up of the great tension of the inflamed periosteum, will be no less marked than if suppuration has occurred. The incision will be as useful as the division of the periosteum in a case of paronychia—a comparison which Dr. Post has been in the habit of making in lecturing upon these cases. The incision that is recommended for the relief of mastoid periostitis, was first urged

upon the profession by Sir William Wilde. His writings upon the subject have undoubtedly saved many lives.

After the incision a poultice should be applied, and the opening maintained by the insertion of a tent a longer or shorter time, according to the severity of the accompanying symptoms. The importance of maintaining the opening for some time in cases of chronic suppuration, was very well illustrated by the following case:

In June, 1872, I saw in consultation with Dr. E. G. Loring, a somewhat remarkable case of chronic suppuration in the middle ear, with mastoid periostitis, in a gentleman of more than seventy years of age, in which the opening was maintained by Dr. Loring, by means of trimming up the edges with scissors, the use of caustic, a drainage tube, and so forth, for some three months. Dr. Loring found that the instant the opening was allowed to close, pain in the back of the head, and in the depth of the ear, began to recur, which threatened even the life of the old gentleman who was the subject of the disease. The patient finally made a perfect recovery from the mastoid disease, and although a man of more than seventy years of age, he is actively engaged in the daily care of large business affairs. The mastoid periostitis in his case was a consequence of an unusually severe acute suppuration of the middle ear, which swept away the drum-head in a short time.

ILLUSTRATIVE CASES OF MASTOID PERIOSTITIS.

The two first of the following cases are from the notes of Dr. David Webster, House Surgeon in the Brooklyn Eye and Ear Hospital, where they were under my care, and are striking evidences of the prompt relief afforded by timely interference:

CASE I.—*Chronic Suppurative Otitis Media—Cessation of Discharge—Mastoid Periostitis—Incision—Recovery.*

Eliza N., æt. 18, had a discharge of pus from the right ear for two months. The discharge suddenly ceased, and the patient was attacked with severe pain and swelling over the mastoid, which grew worse and worse for several days, and caused her to visit the hospital. Dr. Roosa diagnosticated mastoid periostitis, and at once (May 10, 1869) made a free incision down to

the bone. No pus was found, but there was free hemorrhage, which was encouraged by the use of warm water. The membrana tympani was found to be removed by suppuration, but there was a slight discharge from the canal. A tent was placed in the wound and a poultice applied over it. May 11, patient has had no pain and has slept well. The tent was reapplied and the poultice continued. May 16, the swelling of the mastoid is gone. There has been at no time a discharge of pus from the incision, but there was a copious one from the meatus. The patient was very pale when first seen, but the administration of iron and the cessation of pain have restored the normal condition. She has not since returned to the hospital.

CASE II.—*Chronic Suppurative Otitis Media—Mastoid Periostitis and Caries —Incision—Recovery.*

Margaret O., æt. 48, came to the hospital June 21, 1869. Three months previously she had variola, and in the third week of that disease a purulent discharge began from the left ear. This discharge ceased, when, a week and a half ago, great pain, preventing sleep, set in. There was found to be considerable swelling and puffiness above the ear, with tenderness behind it, but no swelling. There was great œdema of the eyelids, and the patient seemed to be in great agony. The auditory canal was swelled, but scarcely any pus was found in it. Dr. Roosa made incisions down to the bone above and behind the ear; from the latter pus escaped, and a probe passed in a direction slightly upwards, forwards, and downwards into the mastoid cells. The surface of bone about this opening was roughened. The same treatment as in the former case was prescribed. Hydrate chloral gr. xv. was given at bedtime. Dr. Webster saw the patient the next day, when the pain had entirely ceased. June 28, no pain or tenderness. Politzer's method of inflation was practised, and the warm douche used.

July 12. A minute opening about a quarter of an inch from the attachment of the auricle still exists. The probe passes upwards and forwards into a superficial opening in the bone. No swelling, pain, or tenderness about the ear. The membrana tympani has healed. Hears the watch 6″.

CASE III.—*Chronic Suppurative Otitis Media—Mastoid Periostitis—Incision—Recovery.*

William G., æt. 30, came to the Manhattan Eye and Ear Hospital, June 13, 1870. In December, 1869, he first experienced a sharp pain in the left ear, which was most severe at night. This pain continued for two months, at the end of which time a discharge occurred from the ear, which has continued more or less until now. Two months later the mastoid process became swelled and tender, and it was opened and poulticed by a physician. A great quantity of pus, as the patient says, was discharged, and the pain, which was severe, was relieved. About four weeks after this the pain in the ear again occurred, and the patient presented himself at the hospital. He presented the appearance of a great sufferer; he was pale and haggard, his hands were tremulous, and his countenance was anxious. He complained of great pain, referred to the depth of the ear and to the head. The mastoid process

was red and hot, but not swelled or tender. The auditory canal was exceedingly sensitive. The membrana tympani had been removed by suppuration, and there was a thin coating of pus on the floor of the cavity of the tympanum. Air was forced into the middle ear by Politzer's method, and leeches were applied to the tragus and mastoid. On the next day warm water was frequently instilled.

June 14. The pain in the ear has decreased, but there is more redness of the mastoid. Leeches, to be followed by a poultice, were ordered. I did not see the patient after his second visit, in consequence of my absence from town, until the 20th, when I found fluctuation in front of the meatus, as well as great tenderness over the mastoid, with an increase of the constitutional symptoms. The patient was then admitted as an in-patient, and having given him a dose of whiskey on account of his very shattered condition, I proceeded to make free incisions down to the bone in front of and behind the ear. The bone was not denuded or roughened. A tent was inserted and a poultice, the latter to be renewed every three hours. The patient slept well that night for the first time in some weeks, taking a dose of fifteen grains of hydrate of chloral.

June 28. The patient has since been free from pain. The incisions have nearly healed. There is a slight discharge of pus from the auditory canal. He hears a watch when it is laid upon the ear. His general condition is now very good, and he is discharged at his own request.

It is somewhat remarkable that this patient experienced so many painful symptoms of mastoid disease for so long a time, and yet escaped without disease of the bone. His affection was never more than an affection of the lining membrane, with some periostitis, while in a case about to be detailed, of much less severity, death of the bone occurred, and meningitis, with a fatal result, supervened. I now think that a free incision should have been made over the mastoid when I first saw the patient, although there was then only some redness of the process and no tenderness, the pain being referred to the depth of the ear. In the light of my present experience, in all cases where there is deep-seated pain referred to the *cavity of the tympanum*, which is not at once, that is to say, in a few hours, relieved by leeching and the warm douche, even if the mastoid cells do not seem to be involved, I should consider myself as giving the patient the benefit of a doubt by such a depletion as a free incision will afford.

CASE IV.—*Chronic Suppurative Otitis Media of years' standing—Exacerbation —Mastoid Abscess—Incision—Recovery.*

CASE IV.—Gracie B., æt. 13. April 25, 1872, I was summoned to Newburgh, by Dr. S. Ely, to see a case in consultation, which Dr. E. justly regarded

as urgent. The patient was a healthy girl, who had had a discharge from her left ear for years, and who for the past few weeks suffered from an exacerbation of the disease, with acute symptoms. Dr. Ely had observed that the mastoid process had become red, and swelled, and tender, within the last few days. We found the patient in bed, and evidently in great suffering, with considerable constitutional disturbance, hot skin, and frequent pulse. The neck was very much swollen, as was the whole integument of the mastoid. There was a profuse discharge of pus from the ear. On consultation it was agreed that an opening down to the periosteum should be made at once, which I proceeded to do, the patient being under the influence of ether. The opening was surprisingly deep, so that the knife passed through three-quarters of an inch of tissue before the bone was reached. Pus escaped quite freely. The wound and the ear were syringed with lukewarm water, and an examination made for a fistula, but none was found. The bone was denuded of periosteum. The membrana tympani had been long since removed by suppuration. The patient had a fair night, sleeping without an anodyne, and rapidly recovered after the opening had been made. A poultice was applied for a short time, and then the opening was allowed to heal. The ear was treated in the usual manner in cases of chronic suppuration.

June 19, 1872. The patient came to town to visit me. On examination, the membrana tympani was found to be removed by ulceration, and a small amount of pus lay in the tympanic cavity. The cicatrix on the mastoid is one inch long and one-half inch from the auricle. The patient states that the wound healed in about one week after it was made.

Dr. T. Blanch Smith, of Nyack, has furnished me with the notes of the following case of mastoid disease, which terminated fatally. Although the affection of the mastoid cannot be said in this case to have been a consequence of a chronic but of acute suppuration, it is none the less instructive.

CASE V.—*Otitis Media Acuta, with Mastoid Periostitis—Acute Suppuration—Apparent Recovery—Recurrence of Symptoms—Coma—Death.*

December 31, 1870, I visited Mrs. B. V., æt. 58, and found her suffering from pain in the left ear and side of head, moderate febrile excitement, occasional rigors, nausea, and vomiting at long intervals. There was much tenderness over the left mastoid process and the infero-posterior margin of the meatus externus. Glances which I obtained of the membrana tympani did not reveal any marked change in its color or shape.

These symptoms, which I referred to acute inflammation of the tympanum, came on with considerable rapidity about thirty-six hours before I saw the case, and were clearly traceable to an antecedent catarrhal pharyngitis.

The sore-throat, though moderately severe, had existed two weeks before attention had been attracted to any ear trouble, and had been allowed to run on without systematic treatment up to the time of my visit.

Verat. virid., nitrate potash, and morphia internally, with warm water and

laudanum locally, served to mitigate considerably the distressing symptoms until on January 3d, the fifth day from the commencement of the aural symptoms, there was a purulent discharge from the ear followed by marked alleviation, but not complete removal, of pain. Quinine and iron were next used internally, and carbolic acid solution locally.

A discharge, pain in the ear (tolerably severe at times), and decided tenderness over mastoid cells, without redness of surface or fluctuation, continued to about January 9, when the abatement of these symptoms was so decided that the patient drove out in a closed carriage, and her general health continued to rapidly improve to a point when I discontinued regular attendance.

On January 24, not having seen Mrs. V. for four days, I was requested to call again. I learned that she had gone on very smoothly up to the 21st, when she found that the discharge had ceased, and the tenderness and pain were gradually becoming intensified. The patient thought she had "taken cold in the ear" by neglecting to carefully protect her head when accompanying her friends to the outer door. Her pains I found were *now* more severe than before, and extended from the meatus over the sides and back part of the head and neck. There was neither redness nor swelling over the mastoid cells, and the tenderness was less acute than in the first attack, but the fever was sharper, nausea more persistent, and vomiting more frequent.

With the addition of a brisk cathartic, the same treatment was adopted as in the early period of the disease. On the 25th, I found my patient in a much less comfortable condition than I had anticipated, the distressing symptoms not having been so decidedly mitigated by the prescription as on previous occasions. The patient seemed exhausted by loss of sleep, pain, etc. I ordered the anodyne to be given at shorter intervals unless the pain abated or sleep was secured. On the 26th, visited Mrs. V. at my usual hour, and on meeting her husband, was told by him that she did not seem any better, although she was very drowsy or stupefied. On reaching the bedside, I saw my patient was in a perilous condition. The pupils were moderately dilated; conjunctiva of left eye so œdematous as to protrude between the partly opened lids, and deeply stained by large ecchymoses; respiration 42, not stertorous; pulse 128; surface of face and hands livid; top and back part of head hot; slight discharge from ear; no convulsive movements. Mr. V. stated that at 11 P.M. preceding night, she complained of a very curious and unpleasant sensation, saying she felt as if she wanted "to fly in the air," and also of something wrong about her eyes, repeating, "I can't see anything." These peculiar sensations and expressions the husband attributed to the effects of morphia, and so was not specially alarmed until I told him I thought her in a hopeless condition. She continued to sink, without remarkable change in the symptoms, until she died, fifty-eight hours from the development of these grave features of the case.

CARIES AND SUPPURATION OF THE MASTOID.

Caries of the mastoid is an extension of the inflammatory process that has been described under the head of periostitis. The pathology of caries of this bone is well described by

A. H. Buck,* as follows: "The cells being filled with a swelled and congested mucous membrane, a stasis occurs in the local circulation, the bone is not well nourished, and the contents of the cells break down into pus. The bony partitions then become dissolved, a granular detritus is formed, or the bony parts separate as a whole from the surrounding healthy parts." This form is, of course, more dangerous than mere periostitis; and yet cases of caries and necrosis are sometimes relieved at the great cost of unnecessary suffering to the patient, by Nature's slow process of casting out diseased bone. After the detailed account that has been given of the symptoms of mastoid periostitis, it is perhaps unnecessary to dwell at length upon the clinical features of caries and necrosis. It is, moreover, oftentimes impossible to draw the line between a case of periostitis and one of caries.

In many cases the symptoms of caries of the mastoid do not differ essentially from those of mastoid periostitis. There is then the same redness, tenderness, and swelling of the process, attended by deeply seated and intense pain. In others, however, the redness, tenderness, and swelling are entirely absent, while the pain referred to the depth of the ear, will be the only marked symptom. This pain is not relieved by leeches, and anodynes will only veil the symptoms for a brief period. Usually, however, even in the insidious cases, tenderness will be shown upon firm pressure on the part. Yet the surgeon may cut down upon a bone to find it diseased, when he had not been previously able to positively diagnosticate this state of things. It may be said, however, in general terms, that any deep-seated pain referred to the mastoid or its region, occurring in the course of an inflammation of the ear, should be looked upon with suspicion, even if there be no redness, tenderness, or swelling of the process itself.

The auditory canal is often involved in cases of caries of the mastoid. A fistulous opening is sometimes found leading from this part into the mastoid cells, in which case, granulations are usually found in the canal. The presence of granu-

* Archives of Ophthalmology and Otology, vol. iii., No. 1.

lations in the canal should lead us to examine the part very carefully to see if a fistula may not be found. As will be seen by reference to Case I., dead bone may sometimes be removed through the canal. A clinical fact of some importance in the diagnosis of mastoid disease, is the one that the chronic or acute suppurative process in the middle ear, is often very much less violent, or entirely checked at the time of the outbreak of the periostitis. This fact applies to both forms of the disease. Yet it is a mistake to suppose that mastoid periostitis, or caries, may not occur while a free discharge of pus is taking place from the ear. While these pages are passing through the press, I am treating an acute case of mastoid suppuration and caries, in which the discharge from the auditory canal is profuse.

Treatment.—The first step in the treatment of a case of supposed caries of the mastoid, is to divide the tissues over the process down to the bone, as was recommended for cases of mastoid periostitis. If a fistula be found, it will be simply necessary to enlarge this, so as to give a free exit to the pus. If the bone be very soft, a stiff probe will sometimes be sufficient, but usually a small drill will be required. If there be no fistula, and we have decided that dead bone is probably beneath the outer table, a small trephine may be used, and the process opened—the periosteum being, of course, first dissected up. The trephine should be worked in a direction inwards, forwards, and upwards. There can be no positive directions given as to the depth to which the instrument should go. By reference to the anatomy of the mastoid process (page 206), it will be seen that the thickness of the outer layer of bone varies somewhat in different cases. The operation should go on very slowly, frequent pauses being made to see how deep the instrument has gone. It is impossible to say in a given case at what depth we shall reach the cells, or free spaces, and thus make an outlet for the pus. Dr. Agnew was obliged to go to the depth of five-eighths of an inch in one of his cases, and then found only sclerosed bone. Dr. D. C. Ambrose, of this city, removed a piece one inch long from the mastoid process of a young woman of twenty years of age.

The cell structure will ordinarily be found at a depth of from one-sixth to one-fourth of an inch. In infants the outer shell of bone is so thin that true trephining will probably never be required; but any firm instrument will make the required opening. In case of an emergency, a surgeon has been known to use a common gimlet, to open the mastoid process (see Case III.). The lateral sinus will always be avoided by keeping the instrument as directed above.

The after treatment is the same as that of an operation for necrosis in other bones. The wound should be dressed from the bottom with lint, and kept open for some time. The patient should be kept free from all noise and excitement.

Historical.—The history of the operation of trephining or opening the mastoid process, is an interesting one. It is here given as it appeared in an article upon the affections of the mastoid by myself, with some amplifications, that a subsequent investigation have allowed me to make.*

From a monograph on this subject by J. Arneman* Professor in the University of Göttingen, published in 1792, we learn that Riolanus (in 1649, according to Adolph Murray†), was the first author who inquired into the propriety of perforating the mastoid process *in cases of occlusion of the Eustachian tube*, for the purpose of removing, by injections through the opening, morbid secretions in the mastoid cells and cavity of the tympanum. Rollfink, afterwards, in an anatomical dissertation, published at Jena in 1656, also advocated the operation. J. L. Petit, according to Von Tröltsch,‡ was the first who actually performed the operation, which he did by means of a gouge and hammer.

Then we come to Valsalva's case, published nearly a hundred years after the suggestion of Riolanus, which has been claimed by all the authors as a case of perforation of the mastoid, and injection through it of the middle ear. One writer (Von Tröltsch) states that an otorrhœa was thus cured by

* Transactions of American Otological Society, 1870.—Medical Record, 1870.

† Lincke's Sammlung, IV., p. 33.

‡ Bemerkungen über die Durchbohring des Processus Mastoideus in gewissen Fällen der Taubheit.

Valsalva. I have examined the original passage in order to verify this claim made for Valsalva, and, if I am correct, there is no such claim by Valsalva himself. He simply states that he injected a fistula existing in this part, in the case of a nobleman; with what result he does not say. The following is the side-note to the passage:* "*Observatio ulceris processum mamillarem, per quod injecta, statim in oris cavitatem, licet undequaque illasam transmittebantur.*" The passage itself is as follows: "*Adeoque mitto prolixius confirmare per quondam meam in viro humane observationem, de nobili scilicet viro, ulcere ad processum mamillarem, cum hujus carie laborante in quod quæ injiciebantur, illico ad fauces perveniebant adeoque a tympano, quo per illius processus sinuositates ascendebant, per tubam certe derivebantur*," etc.

I have ventured to translate the passage with some freedom, but with correctness, as follows. After speaking of the Eustachian tube as a passage to the pharynx, Valsalva says: "I beg to confirm what I have said, by an observation made on the living subject, a nobleman, who was affected with caries of the mastoid process. The fluids that were injected into this ulcer passed through the sinuosities of the mastoid process into the tympanum, and thence through the tube to the fauces."

Valsalva is here demonstrating the function of the Eustachian tube. He makes no claim to have perforated the mastoid, but he simply asserts that he has injected a fistula in the mastoid, and that the fluid thus injected passed into the mouth. I cannot find any evidence in the passage or the context that his patient was cured of an obstinate otorrhœa, as asserted by Von Tröltsch, so that I think Valsalva must be left out, so far as any evidence from this passage goes, in the enumeration of those who have recommended or performed the operation of which we are speaking.

The surgeon to whom we are indebted for having fairly established opening of the mastoid as a legitimate surgical procedure, is Jasser,† a regimental surgeon, who, in 1776, first performed it. His patient was a soldier, who had suffered for

* Tractatus de aure Humana, 1742, p. 89.

† Lincke's Sammlung, Bd. IV., p. 195.

many years from suppuration and pain in the ears, which was not relieved by active but judicious antiphlogistic treatment. In this case there was an abscess of the mastoid, and death of the bone,—and thus the operation was performed under indications which any good surgeon of the present day would accept as peremptory. Although Jasser's operation was a creditable one to its author, it has been misunderstood, and classed by Wilde in the list of the same operations performed with such indications as "obstinate deafness."

Arneman, in the pamphlet before alluded to, details five other cases, from Fielitz, in which the operation was performed, and claims that in only one was there a bad result, and then death ensued. He admits, however, that it may be performed without avail. The bad result occurred in the case of Berger, a Danish surgeon, who caused it to be performed on himself, and died of meningitis induced by the operation. Berger had suffered for years from very great vertigo and noise in the ears, and gradually lost his hearing power. He got no relief from the ordinary means of treatment, and his malady, which placed him out of the society of his friends, troubled him very much. He finally determined to have the operation of trephining the mastoid performed, in order to inject the parts and remove the hardened secretion. Berger evidently suffered from what we should now term chronic proliferous inflammation of the middle ear; and viewed in the light of our present knowledge, there was no proper indication for the operation of trephining the mastoid. Dr. Kölpin perforated the process to the depth of three lines. The incision does not seem to have reached the cells, for an injection made in the opening did not pass into the throat. On the day after the operation a chill occurred. These chills continued to recur, and on the twelfth day Dr. Berger died. Adhesions of the dura mater to the skull were found, and effusion of a transparent gelatinous fluid between the arachnoid and pia mater, as well as over the whole surface of the cerebrum and cerebellum.

The second case detailed by Arneman, has no more accurate statement as to the pathological condition of the ears of the patient upon whom it was performed, than that *he was*

wholly deaf in both ears. The operation did no good, but caused temporary blindness and faintness. In the third case there is also no account of the cause of the deafness: the result was an improvement of the impaired hearing as long as the wound was kept open. The opening was maintained by means of a leaden probe until cicatrization occurred.

The fourth case was that of an old lady, who had lost her hearing from a quartan fever. She had noise in both ears. The process was perforated, and injections of lukewarm water, which passed out of the nostrils, were made. After the injections had been made for four days there was a complete restoration of the hearing (*sic*), while the openings closed readily.

The fifth case was one of chronic suppuration in the ear, with acute exacerbations. The result was a cure, after injections for twelve days.

These statements must of course be taken with some allowance, inasmuch as with the exception of two cases—the first and the last—there is no exact knowledge of the disease causing the symptoms of deafness and tinnitus. But even these show that perforation of the mastoid is not a dangerous procedure, and that when performed under such indications as those in Jasser's case, it is not only a very simple, but a very beneficial operation.

In Frank's treatise on the ear several cases are alluded to; but here also the indications which direct their performance are wanting, and they are consequently useless as guides to the surgeon.

A surgeon named Weber, in 1825,* made an opening into the mastoid in a case of caries of the bone, but evidently with great anxiety, lest he might not undertake a sound surgical procedure, although his patient had symptoms which would not allow us to hesitate for a moment. He used a trocar, and went about three lines before he came to the cells. The patient recovered.

Arneman, in a style of surgical writing which has now, happily for us with our more accurate knowledge, passed away, lays down the following indications for the performance

* Lincke's Sammlung, Bd. IV., p. 90.

of the operation. They are inserted here in order that the distrust with which surgeons have looked upon interference with the mastoid process in aural disease, may be accounted for.

I.—In any case of absolute deafness, or in any case where the impairment of hearing is constantly increasing, and for which all other remedies have been used without effect.

II.—When, in case of an ulcer or suppuration of the ear, the morbid material has become collected in the cells of the mastoid, or the cells have become carious. (This is certainly a good indication, and the one upon which Jasser acted.)

III.—If the normal mucous secretion has become hardened or collected in excessive quantity.

IV.—In cases where pain and noise, which would finally destroy the hearing, have existed in the ear for a very long time.

V.—In cases of stoppage of the Eustachian tube not remedied by injections.

The simple operation of creating an external opening for retained pus, and thus preventing its passage to the brain and into the circulation, was thus so distorted from its proper application, by the improper indications for its performance, that the leading writers seem to have been in as great a state of bewilderment about it as were the English and American surgeons, until a few years since, in regard to the use of the Eustachian catheter. The text-books either mention it to condemn it, or in such a way as to plainly show that they do not realize the true indications for its performance.

So valuable a work as that of Wilde, for example, confounds such an operation as that performed by Jasser with the others quoted by Arneman, which were undertaken because the first operation had been successful, and without any regard to the condition of the ear, but for the relief of a symptom—deafness.

In the general advance of our exact knowledge of diseases of the ear, the merits of the operation of perforating the mastoid were again discussed, and it has now been replaced where Jasser first placed it, on a sound basis. Von Tröltsch, in 1861, reported a case of acute suppuration in the middle ear, with perforation of the membrana tympani, in which he

opened the mastoid with a probe, some days after he had made Wilde's incision with only partial relief.

In such disrepute was this operation at that time, because of the unhappy fate of Berger, who caused it to be performed with no good indications, that Von Tröltsch confesses that he would have hesitated to undertake this simple surgical procedure with any but the instrument which he employed. The case was a successful one. Eight cases are reported by Tröltsch; that of Petit is considered the first, and Jasser's the second; but Valsalva's injection of a fistula already existing is considered as an operation.

Jacoby* has especially put the profession under obligations by his valuable reports of cases, with the indications for the performance of the operation. Very recently Köppe and Schwartze report a case of epilepsy caused by retained pus in the middle ear, which was relieved by perforation of the mastoid.

In concluding this subject, before giving the illustrative cases, the conditions under which the mastoid may be properly operated upon, either in periostitis or caries, may be formulated as follows:

I.—The integument and periosteum should be freely divided over the mastoid in all cases in which there is pain, tenderness, and swelling in the part.—(*Wilde.*)

II.—Such an incision should also be made whenever severe pain, referred to the middle ear, exists, and is not relieved by the usual means, *i. e.*, leeches, warm water, etc.

III.—An explorative incision should be made when we have good reason to suspect the existence of caries and retained pus in this part.

IV.—The mastoid bone should be perforated after such an incision wherever the bone is found diseased, or a small fistulous opening should be enlarged. It should also be perforated when we have good reason to believe that there is pus in the middle ear or mastoid cells which cannot find an exit by the external auditory canal.

V.—The mastoid should be perforated in the case of a suppuration of long standing, with frequent and painful exacerbations.

* Archiv für Ohrenheilkunde, Bd. IV., p. 212.

The operation may now be sure to be fairly established, and is frequently undertaken, it having been performed by Follin, Schwartze, Pagenstecher, Hinton (London), Jacoby, Agnew (New York), Colles (Dublin), and by myself since 1859.

Dr. A. H. Buck has appended to his article on mastoid disease, from which I have quoted, a table containing thirty-four cases of opening the mastoid, beginning with Arneman. Drs. Weir, Laight, and Buck of this city, Drs. Newton of Brooklyn, and North of Waterbury, Conn., are among the surgeons who have operated since 1870, and this sound surgical procedure may be said to be fairly established in the profession. Twenty-six of the thirty-four cases reported by Buck resulted in recovery.

CASES.

It would be easy to insert very many cases of trephination of the mastoid that are now to be found in the literature of otology, but in adherence to the plan of this work, a few are selected which will clearly exhibit the symptoms of caries of the mastoid, and the clinical facts of those cases for which perforation of the process is performed.

CASE I.—*Otitis Suppurativa Media—Caries of Mastoid—Incision through Periosteum—Removal of Sequestrum through External Auditory Canal—Recovery.*

This was under my care at the Manhattan Eye and Ear Hospital, and has already been reported by Dr. C. I. Pardee,* but chiefly with reference to its being a case of *otitis media*, caused by the use of the nasal douche. I saw this patient, who was a man of about thirty-five years of age, soon after the inflammation of the ears had occurred, which was about nine months before he presented himself at the hospital in October, 1869. He was then suffering from a suppurative inflammation of the middle ear, but the amount of pus discharged through the perforation in the membrana tympani was slight. There was considerable swelling of the mucous membrane of the cavity of the tympanum, and the hearing was greatly impaired. He could not hear a watch at all. He was under my care for this suppuration of the ears for eight weeks, when he disappeared, and I next saw him, as just stated, some nine months after, at the hospital, when I found his condition had become worse, and that it was alarming. He complained greatly of pain in the head, which prevented him from pursuing his avocation, which was that of a plumber. The auditory

* New York Medical Gazette, vol. vi., No. 23.

canal of the left side was filled with granulations, the mastoid process was red, tender, and painful. Just in front of the meatus there was an abscess, and a small fistulous opening just above the same part. The hearing on that side, as tested by the watch and voice, was completely gone. On the other side, the ear was in substantially the same condition as when I first saw him.

I immediately made incisions down to the bone, rather against the patient's will, just behind, above, and in front of the attachment of the auricle. I found no dead or exposed bone, but quite a large amount of pus was evacuated. The patient immediately began to improve. In a few days Dr. Pardee removed a piece of the mastoid structure through the auditory canal, the pain in the head disappeared, the suppuration from the mastoid ceased, the granulations were removed from the canal, and the patient resumed his occupation.

The notes of the following case, except so far as they relate to matters observed by myself, were furnished me by Dr. Hubbard, of Bridgeport, through whom I saw the patient.

CASE II.—*Sub-acute Aural Catarrh—Membrana Tympani intact—Suppuration in Mastoid Cells—Opening of Mastoid Process—Death.*

Dr. Hubbard was consulted in December, 1869, "by W. E. S., æt. 38, by profession a mechanic, with good physical development and unexceptionable habits, on account of a severe influenza, from which he was suffering, and which was at that time epidemic in this city (Bridgeport). His mother and one sister, I have reason to believe, died of tubercular inflammation. Hitherto he had suffered no severe illness since the ordinary diseases of childhood, from all of which he made perfect recoveries. The attack of influenza was characterized by severe irritation of the whole respiratory system, with marked impairment of the special senses of taste and smell. The auditory apparatus was not at first, however, specially implicated. I prescribed for his 'cold' several times during the acute stage, as an office patient. But he at those visits made no mention of any trouble about his ears. Later he reported that he had lost his cough, but complained of catarrh of the fauces and nasal passages, for which I prescribed the nasal douche, and gargles made stimulant and astringent by alum, chlorate of potash, chlorate of sodium, tannin, etc. To the use of these he ascribed considerable improvement. I then lost sight of him until about the first of April, 1870, when he consulted me on account of an annoying tinnitus affecting only the right ear. At the same time he reported that he had occasionally, for several weeks immediately preceding, suffered moderate hemicrania of the affected side. Inspection showed marked enlargement of the mastoid process, which he declared had been at no time the seat of pain, and yielded no suffering under firm pressure. Specular examination showed a moderate degree of congestion of the membrana tympani, and by Politzer's method the Eustachian passage was found to be pervious. The middle ear was occasionally inflated, however, and warm water injections to the meatus externus ordered daily at bedtime, and a blister directed to be applied over the mastoid process. At the same time I continued constitutional treatment by quinine, iron, and strychnia, as he had been the subject some

time previously of malarial infection. Under this course the apparent congestion of the membrana tympani disappeared, but the tinnitus was in no degree diminished. At this stage of the case, having met, as well as I was able, all rational indications, leaving to me only an empirical course, I advised him to consult Professor Roosa, and he advised me to renew the blister to the mastoid region, also to apply a leech to the tragus, and repeat it after a stated interval, after which he requested to see him again."

My notes, on seeing the patient, are:—Hearing distance, right side, 2″, tested with a watch that should be heard 3′; membrana tympani opaque; no light spot; handle of malleus injected. A very feeble current of air passes into the Eustachian tube. Patient complains of a very annoying buzzing sound in his ear. There is a very slight want of symmetry in the mastoid, no pain referred to it, no tenderness in any part of it; no pain in the ear. Two leeches ordered to the tragus and a blister to the mastoid. One week later I again saw the patient; the symptoms were the same. He had had some pain in the ear one night since his visit. I injected steam into the middle ear, and suggested that leeches be again applied.

(I again copy Dr. Hubbard's notes.)

"These measures were faithfully carried out, but with no good results. The time having come for another visit to Dr. Roosa, the patient called at my office, when examination revealed fluctuation at the summit of the mastoid process, indicating, however, a small quantity of fluid, and attended, as it seemed to me, with too little pain to be explained by the theory of a periostitis. I thereupon advised him to postpone his visit to New York, and poultice the tumor for twenty-four hours, and then report again. At his next visit I found the swelling and fluctuation slightly increased, and I freely incised the integuments to the bone, liberating about half a drachm of thick, healthy-looking pus without disagreeable odor. I then probed the wound, expecting to find denuded bone, but I failed to detect a greater degree of roughness than is peculiar to that portion of the cranium. I advised him to keep the wound open and favor the discharge by poulticing. The discharge for the succeeding few days was little, but resulted in a marked diminution of the tinnitus and a corresponding sense of relief to the patient. He now failed to report to me for about a week, and meanwhile, from lack of attention, the incision healed, and when he presented himself again there was a re-accumulation of pus in much greater quantity than previously. This I evacuated, and found it of the same character as before. Thereafter the wound was kept open and the tinnitus ceased, and the patient declared to me and others that he was 'a new man.' From this time my regular attendance ceased until May 12, 1870, when I was recalled and obtained the following history. He had continued in his improved condition until the evening previous, which he was passing in social enjoyment with his family and a brother who was paying him a visit, and, when laughing violently at some burst of humor, he stopped suddenly and exclaimed: 'There, I guess I have laughed too hard, for I have made my head ache.' No further reference was made to his suffering until he had retired to his room at bedtime, when he informed his wife that he was suffering from an intense frontal headache; he also complained of rigors, and passed an uneasy, sleepless night. Notwithstanding a resort to several domestic remedies,

May 13, I found the patient still suffering from pain through the forehead and temples; pulse 70, regular, and with steady rhythm; tongue brawny, a thin white fur upon it; intellect clear; skin unusually open, and feeling like the third stage of a paroxysm of intermittent fever, which I confess I was disposed to consider it, inasmuch as he had previously suffered from that disease. I did not consider the symptoms sufficiently clear to indicate anti-periodic treatment, and I therefore temporized by giving the following palliative (a mixture of morph., aconite, and camphor water). May 14th, found him no better. Skin still open; pulse 68, with slight unsteadiness of rhythm, coating still more inflammatory; headache the same; urine rather copious; intellect in the morning clear, but once had requested an imaginary window-frame to be removed from his bed; pupil unaffected, no intolerance of light or sound; temper cheerful. I abandoned the malarial theory, and expressed myself to the friends as apprehensive of basilar meningitis, consecutive to subacute inflammation of the mastoid cells. Ordered an active cathartic, and ʒ ss bromide of potassium, combined with the iodide. May 14th, P.M.—Visited him in consultation with my partner, Dr. D. H. Nash. No relief; on the contrary, an increase of the cerebral disturbances, occasionally delusions and illusions of mind, and mostly of the ludicrous sort; pulse slow and somewhat staggering; *no pain in the ear or its surroundings;* bowels had moved freely two or three times; urine still copious; has had no sleep. Continue the bromide of potassium mixture, apply large blister to the nape of the neck, and give gr. xx hydrate of chloral, and repeat in four hours if necessary. 15th—Had slept about two hours; general condition no better; decidedly humorous in his behavior; double vision, without apparent strabismus, could not read; pulse 60, more irregular; had less pain in the head, or at least he said less about it. Continued same line of treatment, with addition of gr. ij calomel once in four hours. Blister acted thoroughly. 15th, P.M.—Condition little changed. Prognosis to family—fatal result, qualified by suggestion of possible relief from trephining mastoid process. May 16, A.M.—Patient worse; suggested the counsel of Dr. Roosa; treatment the same. Met him at 9 P.M., with Dr. Nash. Agreed to diagnosis of meningitis, with probable origin from mastoid cells. Determined on free explorative incision upon the mastoid process, and use of trephine if developments indicated it. Accordingly Dr. Roosa made an incision one inch and a half long, parallel with the attachment of the auricle (about one half-inch posterior), down to the bone, permitting thorough examination with the finger as well as with the probe. This means, however, failed on the part of either of us to discover either necrosis or a denuded state of the bone. After a long search, and when the search and further procedure were about to be abandoned, the probe (in the hands of Dr. Hubbard, R.) —Bowman's No. 1—caught in a little depression, and by considerable pressure passed the external table of the cranium, into the interior of the mastoid portion of the temporal bone, to the depth of one and a half inch, without other resistance than that afforded by the external table. The orifice was now enlarged sufficiently to favor the escape of any pus that might be in the depths of the bone, an opening three-eighths of an inch in diameter, but no great quantity of pus escaped (just a trace, R.). Subsequent examination with the probe revealed a cavity of considerable size, caused by the breaking down of

the mastoid cells. (The incision was carefully syringed with tepid water, and the opening plugged with lint, R.) 17th—I first observed dilatation of the pupils, with gradually increasing drowsiness, attended by delirium. This condition continued, with occasional aggravations, until the 19th, when the patient passed slowly into a state of profound coma, and he died without convulsions, at 2 o'clock A.M., May 20. No post-mortem examination could be obtained."

I have only to add a few words to the history thus so graphically given by Dr. Hubbard. On the evening of the operation, or the third and last time I saw the patient, I examined the case as carefully as possible, and I found the membrana tympani intact and translucent, no congestion whatever. There was no bulging in any part of its surface. The patient, who recognized me perfectly, and showed that his memory was unimpaired, heard my watch about six inches from the ear—a decided improvement upon the hearing power on the two occasions when I had previously seen him. *There was absolutely no tenderness in any part of the mastoid.* Besides a very minute opening near the superior boundary of the process, which was scabbed over, there seemed to me to be no abnormal appearance in this part, and I examined it very carefully. On probing this minute opening, which was the trace of Dr. Hubbard's incision of some weeks before, there was no escape of pus.

So doubtful did the case seem to me, even with the history of the abscesses which had been opened, that I hardly expected that the free incision which I made would reveal anything abnormal.

There are several points in this case which distinguish it from any that I have seen, or that I have been able to find reported.

I.—There never was a suppuration of the membrana tympani. A primary inflammation of the mastoid cells or their lining membrane, or of the periosteum in this region, is very rare, as is a middle ear inflammation in which the mastoid becomes involved, without suppuration in the cavity of the tympanum. I have seen one case, however, in which the use of the nasal douche caused an inflammation of the mastoid of one side, without suppuration in any part of the ear, while in the other, suppuration of the membrana tympani occurred. But the mastoid inflammation was quickly overcome by the use of leeches.

II.—Until the formation of the abscess, there were no marked symptoms indicating the true seat of the disease. The symptoms were rather those of a chronic inflammation of the middle ear, that is to say, tinnitus, fulness, and occasionally slight pain. Certain it is, there was none of the

agonizing distracting pain of which patients with periostitis usually complain.

III.—The interval of apparent recovery after the evacuation of the pus.

In reviewing the case, the conclusion seems to me inevitable that we had from the beginning to do with a subacute inflammation of the mastoid portion of the middle ear, and which smouldered until the blazing up in the abscess opened by Dr. Hubbard. The origin of this was, of course, the coryza, or cold in the head. It was perhaps an inflammation of the mastoid and tympanic cavity which extended less rapidly than usual to the periosteum and tissues lying upon it, and it was on this account a concealed and dangerous foe. According to a theory of mine the second attack was essentially a new process attacking the former seat of disease, or *locus minoris resistentiæ*—"the weak spot," as patients say, induced by some exciting cause that is unknown. The integrity of the nerve, up to a late period, is shown by the amount of hearing power exhibited on the evening that the perforation of the bone was made.

Dr. C. R. Agnew reports a case which has been alluded to in the account of caries of the mastoid, an outline of which, made up from Dr. Agnew's report, is herewith presented.

CASE III.—*Acute Otitis Media—Mastoid Periostitis—Opening of Mastoid by a Gimlet—Subsequent Trephining—Hyperostosis of Mastoid Cells—Recovery.*

Miss X, in middle life, caught cold and a sore throat, after exposure in the country on the 26th of August, 1864. Immediately after she was seized with violent pain in the right side of the head and corresponding ear. On September 5, a swelling began in the mastoid region, the severe pain from the ear having continued until that time. On the 30th of September, the pain extended rather suddenly down behind the course of the sterno-cleido-mastoid muscle. On the 2d of October, an incision was made over the mastoid, and it was perforated by means of a gimlet. Pus followed the incision through the periosteum, and also on the withdrawal of the gimlet. Dr. Agnew first saw the case a year after this, when there was considerable swelling of the auditory canal. The concha and mastoid region was tender to the touch, and over the center of the mastoid was a small fistulous opening which passed into a narrow sinus, running through the bone towards the tympanic cavity. This sinus was with difficulty entered by a No. 4 Bowman's probe. The principal subjective symptoms were pain in the temporal bone, apprehension of brain dis-

ease, slight loss of memory, nervousness, and wakefulness. The face was anxious; the operation was advised, but it was declined.

In February, 1870, the patient had an alarming attack. The principal symptoms were a feeling of "general agony," and paralysis of the right 7th nerve, with obstinate vomiting. This was on Friday, and on the Wednesday following, the paresis had disappeared, but there was some loss of memory and a slight degree of aphasia.

On February 21, 1870, Dr. Agnew "proceeded to trephine the mastoid through a sweeping cut, using for the purpose a half-inch instrument (trephine) with the pin in the mouth of the sinus," a dense button of bone nearly three-eighths of an inch thick. Dr. Agnew believes that the cells were filled by a dense bony growth. Drs. Van Buren, Loring, Keyes, and myself were present at the operation. The sinus was enlarged by using a triangular steel bit, so that the entire depth of the track opened was about five-eighths of an inch. No pus was found; no caries of the bone. The patient experienced a marked amelioration of her symptoms after the operation, and, as Dr. Agnew informs me, continues well at this time, now three years since the operation.

Dr. D. R. Ambrose, formerly house-surgeon to the Manhattan Eye and Ear Hospital, lately trephined the mastoid process, in a case of peculiar interest, the notes of which the Doctor has given me, besides allowing me to see the patient.

CASE IV.—*Mastoid Periostitis—Abscess—Incision—Polypoid Growths from Wound—Trephining—Bone found very dense—Removal of Plug one inch long—Recovery.*

"Miss S. C., age 19, came under observation February 15, 1872, complaining of deafness in right ear, and stated that about four years ago she had an attack of severe pain in that ear, accompanied with slight hemorrhage, and followed by discharge of pus. H. D. R. E., watch pressed upon auricle. Voice in *very loud* tone about six inches from the ear. There was a small quantity of cerumen adhering to the wall of canal. The membrana tympani was clearly visible, but showed evidences of previous trouble. Right Eustachian tube closed, and impervious to Politzer's method or the catheter, after frequent local applications of nitrate of silver.

"Left ear normal.

"The small quantity of wax having been removed, treatment by electricity was commenced and continued three times a week for about six weeks, at the expiration of which time H. D. R. E.; voice, in tone of ordinary conversation, distinctly heard at fifteen feet. This gave great satisfaction, as she had been much disheartened by prospect of complete and permanent deafness of that ear. Patient was now discharged.

"On 20th of April, 1872, she had an acute attack of periostitis in external auditory canal, which involved the mastoid cells, and in spite of leeches, warm-water douches, and incision down to the bone of the canal, resulted in abscess of mastoid cells.

"The abscess protruded through the posterior wall of canal, and, on being opened with a bistoury, discharged a considerable quantity of pus.

"The ear was now frequently cleansed with lukewarm water; but, notwithstanding this, there soon sprang from the mouth of the abscess polypoid growths, which astringents, including the solid stick of nitrate of silver, and several excisions, failed to subdue. There still remained a constant aching, with, occasionally, sharp darting pains in mastoid process, which radiated to different quarters of temporal region. On two occasions patient found small, thin scales of bone in the purulent discharge. I then passed a silver probe, bent, through the opening of the abscess, and could distinctly detect dead bone, both in posterior and superior portions of mastoid cells. The end of the probe was blackened with sulphur or phosphorus. I was very careful not to push the probe beyond the level of the mouth of the abscess, lest I should do irreparable damage to the labyrinth wall, and not too far behind or above, for fear that in the former direction I should encroach upon the transverse sinus, and in the latter push through to the dura mater. Meanwhile the mastoid process, at its lower portion, became red, slightly swollen, and very tender to the touch.

"After patient and persevering efforts to effect a cure by keeping the ear cleansed as thoroughly as possible, and by taking tonics and nutritious diet for six weeks without any substantial improvement, I resolved upon trephining, lest by further delay the inflammatory action should extend to deeper and more important parts, and hopelessly destroy her power of hearing in that ear, if not terminate her life.

"On the 1st of June, 1872, after making an incision two inches and a half long, down to the bone, parallel with the auricle, and half an inch from its attachment, I separated the periosteum from the bone to an extent sufficient to admit a quarter-inch trephine, and inserted that instrument on a line with superior border of external meatus, and about half an inch from the attachment of the auricle, directing the instrument slightly forward in a horizontal position. After the trephine had penetrated to the depth of half an inch, and finding myself on just as firm bone as at the commencement, I heartily wished the affair was over with; but remembering that Tröltsch says that 'the depth to which we must go is sometimes very considerable,' I regained my courage and persevered with the operation until I felt a slight yielding beneath the instrument. I immediately withdrew it and tried, with moderate force, to extract the plug of bone with bone forceps, to which, however, it did not yield in the slightest degree. Again the trephine was replaced, and, after a few more gentle turns, there was a very perceptible sensation of further yielding beneath the instrument; and a second time the trephine was withdrawn and a second ineffectual effort made to extract the plug, though it yielded slightly to lateral pressure. The trephining was again renewed, and, after a few gentle turns, withdrawn; and now the plug was easily extracted. The instrument was repeatedly withdrawn and very lightly worked after the first yielding was detected, lest by a sudden giving way of parts beneath, it should be suddenly plunged into the mastoid cells, and, in a moment, defeat all my hopes from the operation. The plug having been withdrawn, I was surprised at the small amount of pus that escaped, for this, together with the bone dust, certainly did

not exceed one drachm. This led me to suspect that I had not entered the mastoid cavity at all; and to remove all doubts upon this point, I passed a bent probe through the opening of the abscess, and another through the wound just made, and could distinctly touch and move the one with the other.

"The wound was then syringed with warm water, to which was added a few drops of carbolic acid, and then plugged with lint, which treatment was continued daily, and sometimes twice a day, for six weeks, when the wound completely healed, without any discharge from the ear, and without a *single* uncomfortable sensation remaining. The constant aching and frequent darting pains with which the patient had been so long harassed were almost instantly relieved; for the next day, after all effects of anæsthetic had passed off, she complained of nothing but the soreness of the wound, nor did she complain of anything more from that day throughout the entire healing process. The polypoid growths also, which had resisted all other measures that I had used, ceased, in a few days, to grow, and soon entirely disappeared, without any additional treatment than simply cleansing the ear. This was apparently a perfect cure until *four* weeks after the wound had healed—ten weeks from the date of the operation—when, after exposure to a draught of damp air, she was suddenly seized with sharp pain in the same ear, which was soon followed by a throbbing sensation.

"Examination revealed inflammatory action only on anterior and inferior walls of canal. The application of mild current of electricity would relieve all pain within ten minutes, while a strong current aggravated it. But the pain would return again during the night, and sometimes within an hour after the application. Injections of warm water were then substituted with similar results, and patient was put on quinine and iron, and five grains of iod. potass. three times per day. These attacks of aching and darting pains became of very frequent occurrence—every two or three days, and sometimes as often during twenty-four hours—with an occasional discharge of a few drops of blood from the ear. Upon the superior wall of external canal there is a hard bony substance, almost invariably covered with a purulo-gelatinous material, a little of which, on the end of the probe, emits a very offensive cadaverous odor. This part is very tender when pressed upon by the probe.

"H. D. R. E. Voice slightly raised above ordinary conversation heard distinctly at fifteen feet.

"March 17th, 1873.—I induced the patient to go to the Manhattan Eye and Ear Hospital, to get the advice of Dr. Roosa."

I found the patient in a comparatively comfortable condition, able to pursue her ordinary avocation, and it seemed to me that there was an exostosis of the osseous canal, and perhaps of the tympanic cavity, and that the pain was due to periostitis. I advised the use of iodide of potassium and the continuation of the warm douche. The process of sclerosis of the osseous structure is probably going on. The change in the bone is similar to that which occurred in the preceding case.

CARIES AND NECROSIS OF THE TEMPORAL BONE.

The surgeon is often baffled in his efforts to check a discharge of pus from the ear, because it comes from a part of the bone that has been softened by a carious process. It is not always possible to positively decide that the bone is in this condition, for the part thus affected may be sufficient to maintain a suppurative process, and yet be very small and hidden from view. Even the proper use of a probe in a diseased cavity of the tympanum, in order to enable us to decide as to the existence of caries, is a delicate matter, and should be undertaken with care, lest important parts be penetrated. The careful surgeon is, therefore, often in doubt as to how much of the bone may be invaded, even when he finds a superficial point that gives evidence of disease. The probe cannot be used in the ear as a diagnostic means, with that freedom that it is employed in solid parts that have no such important and delicate surroundings.

All parts of the temporal bone may become carious as the result of a chronic suppurative process. The osseous portion of the auditory canal is one of the favorite positions for such a morbid change. The upper wall of this canal is but a short distance from the dura mater and the cerebrum, and we have already discussed the relations of the mastoid cells to the lateral sinus. Thus we may have inflammation of the brain and affections of the venous circulation, even when the caries is confined to the external ear. It is probable, however, that caries of the auditory canal is usually the result of a chronic suppuration of the middle ear, and not of a primary and independent affection of the peripheral portion. The anatomical relations of the cavity of the tympanum, than which there are none more important in the whole system, necessarily involve serious consequences from caries of any part of its walls. These consequences also necessarily include great impairment of the hearing, while we may have meningitis, cerebral abscess, pyæmia, paralysis, or fatal hemorrhage. Indeed, in the treatment of any of these consequences of a chronic suppuration, we are always treading upon dangerous ground, which may break under our feet at any moment. In

some fortunate cases, however, none of these unpleasant results, except the loss of hearing, occur; the diseased bone is thrown off, and the parts heal. Nearly the whole of the temporal bone may be cast off in this manner without involving the life of the patient.

It has already been seen that the ossicula auditus may become carious and lost in the course of an acute suppuration. The same thing may occur in the course of a very chronic process, and small points of dead bone are frequently found when the cavity of the tympanum has been for a long time exposed from a loss of the membrana tympani. It is shown, however, by Case II., page 426, occurring in my practice, that caries may occur with an intact drum-head. Dr. Orne Green* has also published a report of a post-mortem examination, that illustrates the same fact. Dr. Geo. E. Francis, of Worcester, made the autopsy.

A man twenty-five years of age, who was subject to catarrh, had had a discharge from his ear for two years; at times acute symptoms occurred. Two months before death he could not hear conversation. He also had cerebral symptoms, dizziness, headache, double vision, and partial paralysis, but of what regions is unknown. He died comatose, and at the autopsy a collection of pus was found in the brain, just over a carious spot communicating with the tympanic cavity. The pus lay directly upon the bone.

Dr. Green examined the bone, and found a sinus through the upper osseous wall of the auditory canal, just above and external to the small process of the malleus. The point of an ordinary probe could be inserted in this opening, and it communicated with the auditory canal and the small cavity in front of the handle of the malleus. From this cavity it passed backwards and inwards into a circular cavity about one-quarter of an inch in diameter in the cancellated structure of the bone. The roof of bone over this cavity had entirely disappeared, so that there was a direct communication with the brain. All the walls of this space were irregular and carious. "*The membrana tympani was entire and apparently healthy, and*

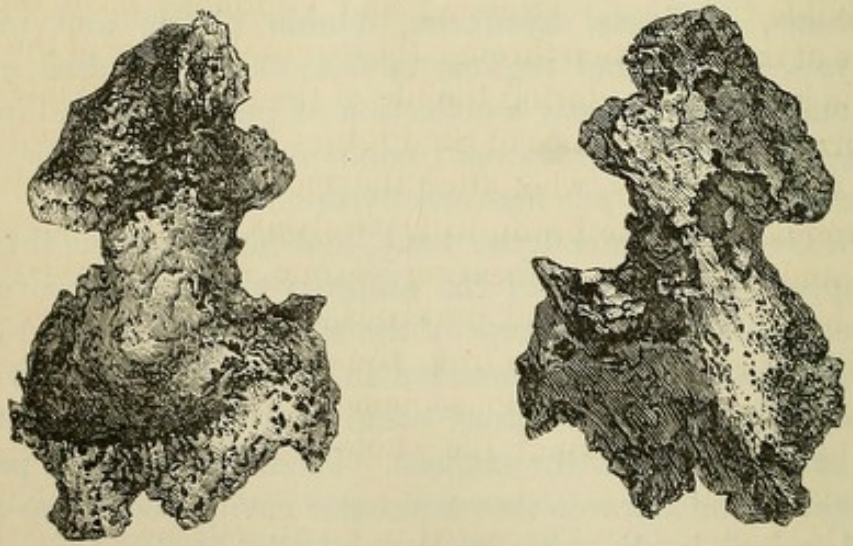
* Transactions of the American Otological Society, 1871.

of normal transparency and thickness in every part below the small process of the malleus bone."

The head of the malleus and the whole of the incus were wanting, but it could not be positively stated, that they were not removed during the dissection. They must certainly have been in a softened, diseased condition, or they would not have escaped so readily. Von Tröltsch reported a similar case to this, and called attention to the little cavity, which is a part of the tympanic cavity, and is situated just above and external to the head of the malleus. In a normal condition, it is separated from the auditory canal by an extremely thin layer of bone. Von Tröltsch dissected a specimen in which he found a polypoid growth springing from this point and projecting into the canal.

Dr. O. D. Pomeroy* has reported a case of exfoliation of the whole of the temporal bone, except the lower part of the external auditory canal and the inner part of the petrous portion. The patient recovered, of course with loss of hearing and

FIG. 83. FIG. 84.



Two Views of Temporal Bone exfoliated in the course of Chronic Suppuration. From Dr. Pomeroy's Collection.

facial paralysis. The patient was a boy aged twenty months, and had a discharge from the ear, accompanied by severe

* Transactions American Otological Society, 1872.

pain for three months before Dr. Pomeroy saw him. There was mastoid periostitis, and an incision was made. Two days after another was made, and the bone was found uneven and rough, and there was a fistula leading into the mastoid cells. For three months after, the child did moderately well, although there remained considerable swelling in front of the auricle. At the end of this period, a small piece of dead bone was observed behind and a little above the external auditory canal, and in about a month afterwards it became movable, and was grasped by forceps and some traction was made upon it, but so much hemorrhage was caused that the attempt to remove the dead bone was given up. In about six weeks the mother brought the child to the Manhattan Eye and Ear Hospital, and also the dead bone that is represented in the accompanying engravings, which were made from a photograph prepared under the direction of Dr. Pomeroy.

Six months after the child was doing well. The aperture through which the sequestrum passed had closed. The discharge of pus was moderate and the general health of the child was good.

Wilde,* Agnew,† Gruber,‡ and Voltolini§ have reported cases of the extraction through the external meatus of the whole of the internal ear, during the life of the patient. Wilde's case occurred in the practice of Sir Philip Crampton. The patient was a young lady, who, after the most urgent symptoms of inflammation of the brain, with paralysis of the face, arm and leg, and total loss of hearing of one side, recovered from the head symptoms and paralysis of the extremities after a copious discharge of pus from the ear. "One day Sir Philip perceiving a portion of loose bone lying deep in the cavity of the meatus, drew out the whole of the cochlea and semicircular canals."

Dr. Agnew's case occurred in a patient who suffered from exostosis consequent upon chronic suppuration of the opposite ear, and who afterward died of brain disease dependent

* Text-Book, p. 37.

† Von Tröltsch on the Ear, American Edition,

‡ Lehrbuch, p. 542.

§ Monatsschrift für Ohrenheilkunde, Jahrgang IV., p. 84.

upon retention of pus by the exostosis. The case as regards the exostosis will be found on page 404 of this work.

The patient was a gentleman of thirty-eight years of age,* who had suffered from chronic suppurative inflammation of the middle ear for the greater part of thirty-two years. Three years before the patient came under Dr. Agnew's observation, after a severe exacerbation of the aural inflammation, complete loss of hearing occurred in the ear, and paralysis of the facial nerve of that side. Granulations continued to recur constantly. On the 16th of April, 1862, the patient was in a deplorable condition; he had suffered for months from pain in the ear, loss of sleep, loss of appetite and dizziness. The concha was swelled and extremely tender; a pear-shaped polypus, of fibrous character, which was kept bathed in very fetid pus, projected from the meatus. Dr. Agnew placed the patient under the influence of chloroform, and removed the polypoid mass by means of Wilde's snare. In attempting to get the snare about the base of the polypus, he encountered a solid body in the middle ear, which proved to be the necrosed internal ear. An incision was then made into the auditory canal, in order to enable the forceps to grasp the sequestrum. Dr. Agnew's report says: "Having got the body in the grasp of the forceps, a slight rocking motion, with traction, enabled me to extract it." The whole of the internal ear —vestibule, semicircular canal, and cochlea—were found to be removed." This patient lived four years after this, and never had any painful symptoms from that side of the head afterward.

Gruber's case occurred in a child thirteen years of age. Both cochleæ were exfoliated, and yet the patient recovered, with no facial paralysis—an evidence that the cavity of the tympanum was left in a comparatively sound condition.

Voltolini's† case was one that occurred in the practice of Dr. A. Jacobi, of Berlin. The whole labyrinth was removed from the ear of a child that is still living. The substance of the cochlea was not fully united with the surrounding bony substance of the petrous bone, which, as Voltolini remarks, is

* American Medical Times, vol. vi., p. 183.

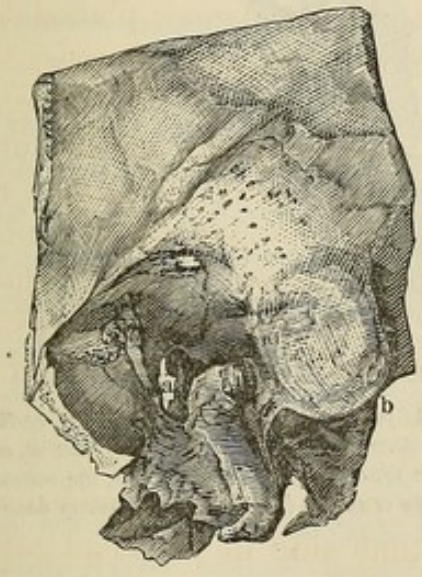
† Monatsschrift für Ohrenheilkunde, Jahrgang IV., p. 84.

evidence that the disease dates back to an early period in the life of the child.

Toynbee* reported four cases of necrosis of the cochlea and vestibule, in which the parts had been exfoliated during life. One of them is Wilde's case, already quoted. The patients were adults, with the exception of one, a child of seven years old.

The following engravings illustrate the ravages which chronic suppuration makes upon the bony tissue of the ear. They were made from photographs of the bones, and are from the collection of Dr. C. E. Hackley, who kindly allowed this use of them.

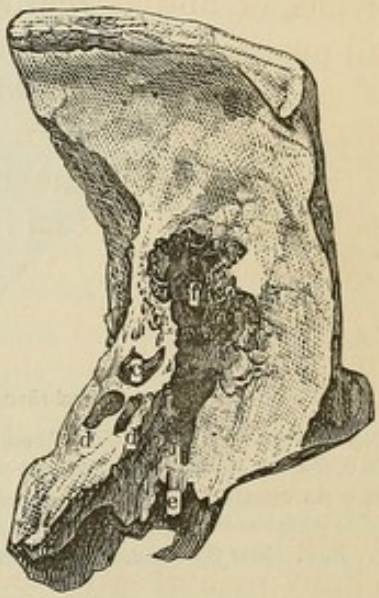
FIG. 85.



Left Temporal Bone, from Case I.

Exterior view, showing the external meatus, a, *from which the anterior wall has been removed, as has also the inner wall of the middle ear.* b. *The mastoid process.*

FIG. 86.



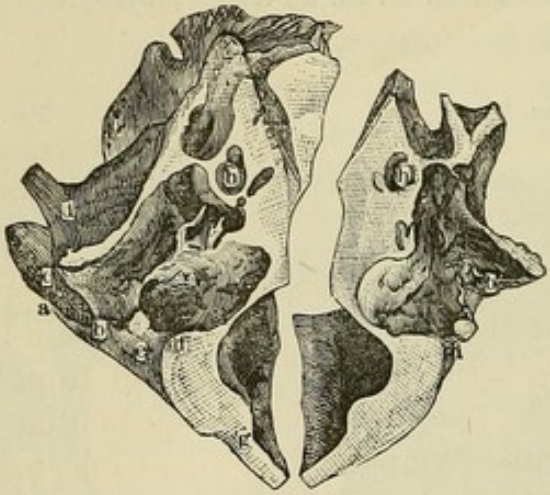
Inner Surface of the same Specimen, showing c. *The vestibule.* d. d. *The windings of the cochlea, which have been exposed by sawing away portion of the bone.* e. *The tympanum, communicating with* f, *the mastoid cells, which have been exposed by chipping away a thin layer of bone.*

History.—CASE I. (Figs. 85 and 86).—Left temporal bone from a man who had phthisis, and died suddenly of pneumothorax, August, 1866. His hearing distance was nothing for the watch, nor could he distinguish words, though he seemed

* Archiv für Ohrenheilkunde, Bd. I., p. 113.

to hear the sound of the voice. He was very much debilitated when he entered the New York Hospital, consequently no *thorough* examination was made of his ears. He had profuse discharge from both ears, and polypi on both sides. On the left side, the post-mortem examination showed polypus attached in the middle ear and extending forwards into the meatus, and backwards into the mastoid cells; membrana tympani gone; stapes only one of ossicles present; membrane of fenestra rotunda gone.

Fig. 87.



Left Temporal Bone, sawed through External Meatus, Middle Ear, and Cochlea.

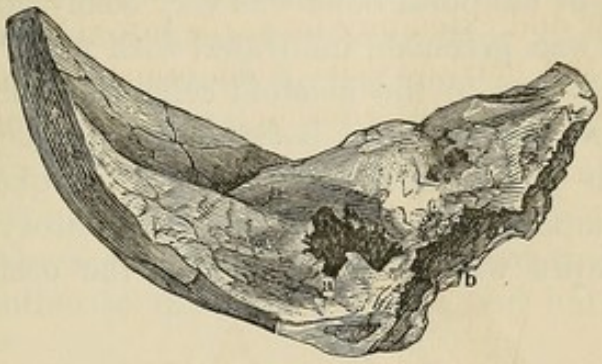
The pieces are turned to one side, showing—a. *Mastoid process.* b, b. *External meatus, ending in* c, *the middle ear. At* d *there was an opening downwards through the bony meatus, and at* e *an opening upwards, by which there was a free communication with* f, *the mastoid cells, which were separated from the interior of the cranium by a very thin layer of bone at* g. h, h, *show the cochlea sawed through.*

Case II. (Fig. 87).—Left temporal bone from ——, who entered the New York Hospital August, 1866, with great fever and pain in the left ear; had been sick two days. His disease ran much the course of typhoid fever, without marked head symptoms other than the acute pain in the ear (which only existed the first two days). When a child he had discharge from the ear and post-aural abscess and disease of mastoid process.

On the autopsy, pus was found under the dura mater and in mastoid cells; the whole temporal bone was gone from the infiltration of pus through it; the membrana tympani was completely destroyed; the base of the stapes was the only

part of the ossicula remaining; there was an opening from the outer part of the bony meatus upwards into a cavity which also had an opening outwardly.

Fig. 88.



Right Temporal Bone, from Case V., showing the Cranial Surface of the Bone.

At a *the bone was very thin, and broke away when the dura mater was removed; the bone was much hollowed out about* b, *the middle ear.*

Case V. (Fig. 88).—August 18, 1868.—H. O. applied at New York Eye and Ear Infirmary, on account of pain in right ear, saying he had a "kernel" (wax?) removed from his ear two years previously, by one of the surgeons of that institution. The right membrana tympani was found injected, right Eustachian tube obstructed. H. D.—Right ear, pressed; Left, $\frac{12}{36}$. Applications of warm water, with occasional leeching, were ordered. After some time the walls of the meatus swelled so that the walls of the membrana tympani could not be seen. Under varying treatment the state of the case was sometimes better, sometimes worse, till March, 1869. During his attendance the patient twice stopped coming, thinking he was well, when he complained of pain over the right side of the head, starting from the ear. Expecting meningitis, he was taken as an in-patient at the Infirmary, April 1st, 1869, treated again with leeches, cold to head, bromide of potash, and tonics. About May 1st, 1869, he showed occasional delirium, and contraction of the muscles of the nape of the neck; had retention of urine; pulse 110–130; temperature 102°. Died May 10th. No discharge from ear for thirty-six hours preceding death. On autopsy, twelve hours after death, we found the brain slightly congested; the right optic nerve (which went to an atrophied eye) was atro-

phied both before and behind commissure; the meninges of the base of the cerebellum, and upper part of the spinal cord, were covered with lymph and bathed in sero-pus (about two oz.); right auditory nerve very red; periosteum over the posterior part of the right temporal bone was very easily detached; the bone under it was greenish, infiltrated with pus; the passage from the middle ear to the mastoid cells was much enlarged, with only a thin wall of bone between it and the brain. On detaching the pericranium this wall was broken through. Membrana tympani entirely gone; the promontory was roughened; the stapes was the only one of the ossicles left in position.

Prognosis.—The prognosis of caries and necrosis of the temporal bone depends upon several factors. To a marked degree it is influenced by the age of the patient. Young children will throw off quite large portions of the bone, and yet come off with their lives, while older persons will usually succumb to one of the many consequences, such as pyæmia, hemorrhage, abscess, which may result from death of bone in this part of the body. The situation also of the dead bone will influence the prognosis of caries to a marked degree. Caries of the mastoid, especially when occurring in young children, is very often recovered from. Caries and necrosis of the walls of the middle ear is of course the most dangerous of all that may occur, especially caries of the upper and lower wall. It has been seen that the whole internal or labyrinth wall may be destroyed, and the contents of the external ear be exfoliated, and yet the patient recover. In these cases the necrosed internal ear seems to have passed through a sound tympanic cavity.

The prognosis of caries and necrosis of the temporal bone is, however, always grave under any circumstances, and no life can be said to be what the life insurance companies call a good risk, if a chronic suppurative process has gone on to this extent. The ossicula auditus may be thrown off with comparative impunity, as we see by cases all about us; yet even these cases, unless the suppuration has entirely ceased, belong to a class of cases whose results we must always

stand in dread. Until the parts have healed, and some kind of a neo-plastic membrana tympani has formed, we are not safe in giving a decidedly favorable prognosis.

Treatment.—It is impossible to give any specific rules for treating caries and necrosis of the bony parts of the ear. 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, I 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.

Gruber* mentions one means of treating caries of the temporal bone, in which I have no experience, but of which he gives a favorable report, in some cases where the severe pain was not relieved by local antiphlogistic and anodyne treatment. This is the actual cautery. The iron is applied at several points over the mastoid process. After the bony slough is removed, an irritating salve may be applied to continue the counter irritation. Dr. Post, of this city, also speaks well of the actual cautery as a less painful means of treating mastoid periostitis than the incision. I have no doubt, judging from a recent experience in a case of Dr. H. G. Newton's—which I saw in consultation—where Dr. Newton trephined the mastoid process for continuous and severe pain referred to the middle ear, but without finding dead bone, that such openings will do very much to relieve the deep-seated pain of caries that is referred to the ear and the brain.

The facilities for treating chronic suppuration, since we have Politzer's method of opening the Eustachian tubes, are much greater than those enjoyed by our predecessors. We may, by the employment of this method, more thoroughly cleanse the tympanic cavity from pus than by the simple use of the syringe. In the chapter on chronic suppuration, a detailed account of the means of thoroughly cleansing the ear has already been given.

* Lehrbuch, p. 552.

A patient with caries of the temporal bone should be made aware of the gravity of his condition, so that he and his friends may be on the lookout for serious symptoms, which may be promptly treated, and that they may not fall into the error of supposing that no harm can possibly come from "a simple running from the ear."

If polypi or granulations have occurred in connection with caries of the canal or tympanic cavity, they should be removed with care, lest severe hemorrhage occur, or other harm to the parts. The galvano-cautery has proved an efficient and safe means of removing such granulations,* and of causing the bone to heal.

Fatal hemorrhage has occurred from caries of the bony canal, in which the internal carotid passes through the apex of the petrous portion of the temporal bone, as well as from destruction of the bony wall that separates the mastoid process from the lateral sinus, and also from the breaking down of the thin plate of bone that forms the floor of the cavity and separates it from the jugular vein. Fortunately for the lives of many patients, there is a tendency to thickening, or hyperplasia of the bony walls of the tympanum, in some cases, and thus they are protected from the corroding effects of pus.†

CEREBRAL ABSCESS.

The proceedings of pathological societies and surgical records show, that abscess of the cerebrum more frequently results from disease of the middle ear than from any other single cause. Of seventy-six cases of cerebral abscess collected by Drs. Gull and Sutton,‡ twenty-five, or about one-third, were

* Archiv für Ohrenheilkunde, Bd. VI., p. 116.

† Gruber, Lehrbuch, p. 543. Gruber states that Billroth has tied the common carotid artery for a case of aural hemorrhage, which occurred not from caries, but from a congenital defect in the bony wall. The hemorrhage ceased for ten days after. After all attempts to restrain the hemorrhage were fruitless, Billroth ligated the left carotid, and two days after the patient died from severe hemorrhage from the right ear, the nose, and mouth. A child, for whom parents would not allow the operation, died from the same cause. Koeppe reports a case of hemorrhage from the lateral sinus, through the nose and ear. This was in consequence of destruction of the bone.

‡ Reynold's System of Medicine, vol. ii., p. 544.

directly traceable to chronic suppurative processes in the middle ear. Lebert,* in his article upon this subject, considers that aural disease is the cause of cerebral abscess in about one-fourth of the published cases.

There is usually caries in connection with the cerebral abscess, but cases have occurred in which, although the disease of the ear extended to the brain, there was no death of bone. The anatomy of the cavity of the tympanum, especially of the roof, or tegmen tympani, where a process of dura mater actually extends into the tympanic cavity, and where there may normally be a gap in the bone, has taught us how easily this may occur. The cause of the extension of a suppurative process to the brain is undoubtedly very often that which Mr. Toynbee so clearly sets forth in his chapter on this subject—that is, the non-escape of the pus externally through the membrana tympani. The perforation of the membrana tympani in acute inflammation usually prevents any such disaster as the passage of the pus to the brain or the circulation.

Rupture of the membrana tympani is, therefore, a conservative process, if suppuration has once been established; for there is no other safe way of escape for the pus, except through the Eustachian tube—a means of exit which is one of the last that nature chooses. Abscess of the brain in acute disease was only once observed by Mr. Toynbee.

A direct communication usually takes place between the diseased mastoid or petrous portion of the temporal bone with the brain substance through the meninges, but the dura mater and other membranes may be healthy, and even a portion of healthy brain may lie between the diseased bone and the cerebral abscess. The chronic disease of the ear may be going on very well, until some mechanical injury—exposure to cold, or the like—sets up an acute process, which extends to the brain through the delicate bony walls of the tympanic cavity, or the cancellous structure of the mastoid bone.

Patients suffering from chronic suppuration of the middle ear cannot be too much guarded against blows or falls upon the ear, or against exposures to sudden changes of temperature,

* Virchow's Archiv, Bd. X., p. 391.

drafts of air, or the like; for the table of cases appended to this chapter, shows that meningitis, cerebral abscess, and pyæmia may, from such exciting causes, be the termination of a purulent discharge from the ear.

The symptoms of brain disease are sometimes very insidious. At times there is a chill or a convulsion, or nausea and vomiting; at others, only increased pain in the ear, followed in rapid order by paralysis, coma, and death. In very rare cases there are absolutely no symptoms, except those of a chronic suppurative process in the ear, until death occurs.

The table of fatal cases of aural disease resulting from chronic suppurative processes, that has just been alluded to, was compiled from various sources, in order to show the variable character of brain symptoms supervening on otitis media purulenta, and the anxiety with which such a case, especially if united with caries or necrosis of bone, should be regarded.

It is interesting to note how slowly the profession came to recognize the fact that when pus was found in the brain communicating with the ear, that it was on its way inwards, and not making an external opening. It seems to have been hard for the medical men of a few generations back, to believe that aural disease could cause any serious affection, or that it was a matter of much account, although people were dying all about them from the results of aural disease alone. Lebert* says that Morgagni, "with his good tact and close observation of Nature," discovered that the ear was often the cause of purulent affections of the circulation and brain substance; but Itard took a step backward, and discovered a kind of cerebral abscess which broke out through the ear. Lallemand again placed the subject in its right light, and showed, what we now clearly see, that in cases of cerebral abscesses occurring in connection with suppuration of the ear, that the organ of hearing was the part first affected.

It is generally believed that a *suppurative* process in the ear is necessary for the production of an abscess of the brain,

* Virchow's Archiv, Bd. IX., p. 382.

and this is probably the fact; but one case that I observed, leads me to suspect that there may be such a thing as a chronic cerebral abscess leading to disturbing aural symptoms, such as tinnitus aurium and pain in one side of the head, without any primary aural affection. I treated a gentleman of about twenty-nine years of age, for some months, for such symptoms as have been indicated, and when he died a cerebral abscess was found. He could hear the watch for but three inches from the left ear, which was the affected one, and the drum membrane was sunken. I supposed the case to be one of chronic proliferous inflammation of the middle ear. The patient got no relief; he became very despondent on account of his tinnitus aurium and pain, gave up his business, and died at Sag Harbor, L. I., of malignant pustule, about two years and a half after I first saw him, and three years and a half after his first aural symptoms. Dr. Geo. A. Sterling, of that place, made a post-mortem examination. He found "great injection of the pia mater over petrous portion of temporal bone, and an abscess about the size of a ten cent piece in the brain substance. It was bounded by inflammatory adhesions, and contained about ten drops of pus. The abscess was situated on the left side, in the superior lobe, one inch from the median line and two inches from the coronal suture." This patient never had a suppurative inflammation in the ear, and it is possible that the cerebral abscess was the cause of his very distressing symptoms, although the data are not full enough to allow us to give a positive opinion. There is no account of an examination of the temporal bone.

The text-books on pathology give very full accounts of cerebral abscess. The author has had but the space to plainly mark them out as one of the consequences of chronic suppuration of the middle ear.

PYÆMIA.

The author has already (on page 292) related a case which shows that pyæmia, or metastatic abscesses, from the entrance of pus into the circulation through the mastoid veins or the lateral sinus, may result from aural disease.

Mr. Prescott Hewitt,* in 1861, related a similar case, and with the like happy result of recovery. Mr. Hewitt's case was in substance as follows: A young lady, eighteen years of age, had a discharge from the ear, as a consequence of measles. About four weeks after the occurrence of the discharge, she was seized with severe chills, which were followed by much fever, a furred tongue, and typhoid symptoms, with suppression of the discharge. When Mr. Hewitt saw the patient the chills continued, the skin had assumed an earthen hue, and the fever was intense. The intellect was clear, but there was pain extending down the side of the neck, along the course of the jugular vein, and the head was inclined to that side. There was swelling at the base of the neck. In eight days pus appeared in one of the sterno-clavicular articulations. In a few days one knee became involved, and symptoms of pneumonia appeared, which soon subsided. In about seventeen days from the beginning of the phlebitis, swelling and pain occurred over one of the hip-joints, a deep abscess formed, but it was opened early, and the joint did not become involved. The patient ultimately recovered under treatment by wine and morphia.

This case and the one already referred to, give the clinical features of purulent infection from suppuration in the ear. The pathological characteristics of the disease are seen in the table of fatal cases appended to this chapter. Professor Lebert† has given us the fullest account of the inflammations of the sinuses that may lead to purulent infection; but the proper limits of this volume do not allow of a fuller discussion of this dangerous, but by no means hopeless disease.

PARALYSIS.

Paralysis of the seventh nerve, as it passes through the tympanic cavity, in the Fallopian canal, must of necessity be a consequence of many suppurative and carious affections of this part, and yet it cannot be said to be a frequent affection in the course of chronic suppuration of the middle ear. In

* London Lancet, Feb. 2, 1861.

† Virchow's Archiv, Bd. IX., p. 381.

the greater number of the cases in which it occurs, it is permanent, from the fact that the nerve tissue is destroyed by the ulcerative process; but I have seen cases of temporal paralysis of the seventh, which were probably due to pressure upon the nerve trunk; for, when the suppuration of the ear was checked, the functions of the nerve were restored, and the face resumed its normal appearance.

Paralysis of other parts of the body, and complete hemiplegia, may occur in the course of meningitis and cerebral abscess; but these necessary consequences of the destruction of brain substance hardly require a separate notice.

It is possible that a blood clot might form between the dura mater and the bone, from rupture of a branch of the middle meningeal, from caries of the temporal bone, and hemiplegia be induced by pressure communicated to the motor tract, or as Mr. Hutchinson says, as quoted by Dr. Hughlings Jackson,* by squeezing the blood from the corpus striatum, or thalamus opticus. The author has published two cases of hemiplegia, occurring in coincidence with chronic suppuration of the middle ear,† which are here reproduced as good illustrations of the subject, although it is not claimed that they should be regarded as positively consequences of chronic suppuration. A boy ten years of age was brought to me for advice on May 10, 1869. He had had a discharge from the left ear since he was an infant, and about four weeks ago he was affected with a number of paralytic symptoms that came on gradually. He became unable to speak distinctly, or to swallow his food properly, and finally he could not walk steadily. There was paralysis of the seventh pair on the left side, and of the left arm and leg, so that he could not grasp well, and he dragged his foot in walking. These symptoms came on gradually, in the course of some hours, a fact which indicated hemorrhage between the dura mater and the bone. The right membrana tympani was intact, but thickened, and it had no light spot. The left was ulcerated and perforated. Its remains were very vascular. His hearing distance was $\frac{0}{48}''$ from the right ear, and $\frac{1}{48}''$ from the left. Under the usual treatment the membrana tympani healed, and

* Reynold's System of Medicine, vol. ii., p. 505.

† Transactions of the American Otological Society, 1870.

the hearing power became normal. The paralysis was nearly gone when he disappeared from observation.

June 8, 1870.—The patient was again brought to me, and his mother stated that he was seized with dizziness and loss of sight while at school. He became so affected that he was fifteen minutes going two or three blocks, and he was stupid when he reached home, although he had complete control of all his limbs. He had sight enough to go about, but not to read. Two months after this attack, his vision was $\frac{1}{5}$ in the right eye, and $\frac{1}{4}$ on the left. The field of vision was greatly limited on the periphery. The ophthalmoscope did not detect any lesion in the fundus oculi. Under expectant treatment the boy slowly recovered his vision.

The second case was that of a farmer, aged 62, whom I saw in October, 1869, in consultation with Dr. Losee, of Red Hook, N. Y. The patient had suffered from chronic suppuration of the right ear, since he was a child. Occasionally acute attacks would occur, culminating in abscesses of the mastoid. For six years past, the ear had been very quiet. About six weeks before I saw the patient, he was seized with hemiplegia of the left half of the body, coming on in the course of a few hours. When I saw him he was slowly recovering from the paralysis. The hearing power on the right side was completely destroyed. The cavity of the tympani was exposed and empty. There was a cartilaginous band extending across the canal, which I divided, and found that it contained small bits of dead bone, which seemed to come from the posterior wall of the canal. The patient fully recovered from the paralysis, and is still living.

Dr. Hughlings Jackson,* in lecturing upon epileptic, or epileptiform convulsions occurring in connection with discharges from the ear, says, that arguing from the fact that cerebral or cerebellar abscess may follow disease of the ear, "it becomes legitimate to inquire if *minute* changes in tracts of the brain may not occasionally follow a disease of this apparatus, which changes may allow occasional discharge of nerve force." He is anxious to learn if epileptiform seizures occurring in cases

* British Medical Journal, June 26, 1869.

of discharge of pus from the ear, may not result from minute changes in *venous* tracts. There are still great gaps in our knowledge of epilepsy and paralysis dependent upon aural disease. Dr Jackson* urges that in all cases of hemiplegia in children the ear should be examined, and that in such autopsies the possibility of venous thrombosis from aural disease should be borne in mind.

The table on the next page, which I have compiled from various sources, illustrates in a striking manner the fatal consequences of some cases of aural disease. Taken in connection with the fact already stated, that suppuration of the ear is more frequently the cause of cerebral abscess than any other one disease, these cases form a complete justification, if one were needed, for the giving up so much space to the consequences of chronic suppuration of the middle ear. If the table shall startle some mind hitherto inattentive to this subject, into a realization of its grave importance, and lead to a more careful consideration of an ulcerated middle ear, it will have accomplished its object.

* London Medical Times and Gazette, July 13, 1872.

TABLE

SHOWING THE COURSE AND SYMPTOMS OF CASES OF MENINGITIS, CEREBRAL ABSCESS, AND PYÆMIA RESULTING FROM AURAL DISEASE.

No.	Sex.	Age	Cause.	Symptoms.	Seat of Abscess or Disease.	How long before Death acute symptoms set in.
1	Male.	66	Discharge from the ear for several years.	Deafness on one side. Went to bed as well as usual. Next morning paralysis of one side, also ptosis. Paralysis persisted for some days; became giddy, had severe rigors, drowsy, delirious at intervals; face flushed; head hot, convulsions; gradually sunk and died.	Abscess in centre of right cerebral hemisphere.	Twenty-three days.
2		18	Disease of the temporal bone.	Convulsions just before death.		No acute symptoms until just before death.
3	Male.	20	Disease of the ear. Discharge for nearly four years.	Head and neck rigidly curved forward, and spine curved. Some rotatory movements of the head. Was unable to swallow; died on 2d day after these symptoms.	Abscess in the pons varoli.	
4	Male.	22	Disease of the tympanum. No caries.	Sore throat for one week, and became generally ill. Discharge from the ear; great effusion. Admitted to Hospital April 25, and died May 4, after rigors and semi-comatose condition.	Abscess in middle lobe.	
5	Female.	41	Suppuration of the right internal (middle?) ear.	Discharge from the ear for several years. Admitted to Bartholomew's Hospital one month before death. Loss of power of right half of face. Some spasmodic pain. Constant pain on right side head. Became drowsy and semi-comatose.	Abscess in the middle of right lobe of the cerebellum. It communicated directly with the diseased portion of the temporal bone.	About forty-two days.

6	Male.	23	Caries of the temporal bone. Discharge from ear and ear-ache for years.	Admitted the day before his death, with great pain in the back of his head. Occasionally vomited. Illness began eleven days before admission, with rigor, followed by constant pain in the head. He walked to the hospital the day before he died.	Abscess in right lobe of cerebellum. Caries.	About fifteen days.
7	Male.	25	Chronic disease of the tympanum.	Two or three restless nights. Severe frontal headache. On the fourth day vertigo and delirium; efforts to vomit. Fifth day, cerebral oppression. Sixth, paresis of left side. Seventh, coma and death.	Acute abscess in middle lobe of cerebrum on right side; dura mater; sloughing.	About seven days.
8	Female.	23	Chronic disease of the tympanum.	Severe headache, principally over the right side of the head. Pain in the right ear, and frequent vomiting for fourteen days.	Diffuse suppuration and acute sloughing of the middle lobe of right hemisphere. Dura mater over roof of tympanum. Bone carious; sloughing.	About seventeen days.
9	Female.	20	Disease of the tympanum following a blow on the ear.	Paralysis of right seventh nerve, and discharge from the ear, and headache after a blow. After three weeks headache increased; referred to forehead and occiput. Pain on moving the neck. Rigors, nausea, vomiting, sweating. No delirium. Death from syncope on the fourth day after the increase of the headache.	Abscess in cerebellum. Inflammation of the vein of the aquæductus vestibuli.	About twelve days.
10	Male.	13	Chronic disease of the ear.	Languor for some days. Syncopal seizure. Convulsions with insensibility, relieved by a discharge of pus from the right ear. Severe headache on following day; nausea, delirium, convulsions. Intense pain and cramp in left leg. Death in sudden coma on fifteenth day.	Abscess under the posterior lobe of right hemisphere. Caries.	Fifteen days.

No.	Sex.	Age	Cause.	Symptoms.	Seat of Abscess or Disease.	How long before Death acute symptoms set in.
11	Male.	28	Disease of the ear. Discharge for years.	Three weeks before admission received a blow upon the side of the head; week after delirious; and twenty-five days after became comatose and died.	Abscess in the anterior and middle lobes of left hemisphere. Caries of petrous bone communicating with abscess.	Twenty-eight days.
12	Male.	27	Caries of internal ear (middle?) and diseased lateral sinus. Purulent discharge for six months.	Pain in the head; paralysis of right side of the face. Death from hemorrhage (from lateral sinus).	Dura mater sloughing. Lateral sinus inflamed and sloughy.	Three months and nine days.
13	Male.	8	Caries of temporal bone. Slight discharge from the ear since quite young.	Vomiting, convulsions, paralysis of left upper eyelid. Limbs all weak; twinges of pain in left ear. Became dull and drowsy; semi-comatose, convulsion, coma.	Abscess in outer part of left cerebral hemisphere.	Twenty-seven days before death.
14	Female.	26	Right temporal bone.	Two weeks' purulent discharge from right ear. Delirium, opisthotonos, coma.	Abscess in under surface of middle cerebral lobe.	Fifteen days before death.
15	Female.	51	Caries of temporal bone. Coagulum in sinus.	Cough, pain in limbs, pulse quick. Purulent discharge from left ear. Convulsions, coma.	Abscess in left cerebral hemisphere.	Fifty-three days.
16	Female.	23	Disease of the ear.	Epilepsy, slight convulsions, pain in the head. Pyrexia, intense agony, convulsions. Sensible until death.	Abscess. Coagulum of fibrin and blood in left lateral sinus.	Twenty-nine days.

17	Male.	54	Necrosis of right temporal bone.	Six months before admission had a fit after a hearty meal. Recovered to some extent, but the mind remained affected. Pains in forehead, stupor, epilepsy, loss of consciousness and sensibility, stertor, and died in a convulsion.	Abscess in the middle lobe of right hemisphere.	Unknown.
18	Female.	7	Disease of the left ear. Discharge.	Great debility; epilepsy after syringing. Fits continued.	Abscess in under part of left lobe of the cerebellum.	Four days.
19	Male.		Disease of the internal (middle?) ear. Caries of temporal bone.	Sore throat of week's standing, with difficulty in swallowing. No ulceration at back of throat. Discharge from the ear ceased suddenly. Rigors and collapse. Pain in right side. Became stupid, heavy, and comatose.	Abscess in right middle lobe. Pyæmia. Abscess in the lung.	
20	Female.	26	Disease of mucous membrane of tympanum. Discharge from ear since a child.	Jan. 26.—Earache on right side. Headaches and giddiness for last six months. Paroxysmal pain. Feb. 17.—Insensible comatose.	Abscess in upper part of right cereb. hemisphere. Tympanic mucous membrane soft and covered with cheesy matter.	Twenty-three days.
21	Female.	9½	Caries of upper wall of tympanum. Discharge from the ear.	May 5.—Fever, vomiting. On the 7th seemed well. 8th, Bad symptoms recurred. 10th, Excruciating pain in the ear. Slight paralysis of left side; comatose, and died in twelve days.	Abscess in middle of left lobe of cerebrum.	Twelve days.
22	Female.	12	Caries following blow upon the head.	July 2.—Severe blow. 3d, Violent pain, fever; an abscess formed beneath the temporal muscle.	Abscess in the middle lobe.	Twenty-two days.
23	Male.	32	Caries of right lateral wall of sinus. Inflammation of lining membrane of the mastoid. Discharge from ear for two years.	Rigors and general malaise. Pyrexia; abscess behind the ear; slight stupor; rigors; convulsion.	Abscess in middle cerebral lobe. Pus between the diseased mastoid and dura mater.	Thirty-one days.

No.	Sex.	Age	Cause.	Symptoms.	Seat of Abscess or Disease.	How long before Death acute symptoms set in.
24	Male.	35	Caries of the mastoid. Severe earache at times for years, with discharge.	Five weeks before death a polypus removed from external meatus; great pain at back of head, neck, and shoulder of right side; stupor, coma, death. Gait was usually unsteady.	Abscess in the right lobe of cerebellum.	Cases up to 26 reported by Drs. Gull and Sutton. Reynolds' System of Medicine, vol. ii., p. 545.
25	Male.	13	Caries of the petrous bone. Discharge from ear.	Fever, headaches, thick speech, hemiplegia, vomiting, drowsiness, paroxysmal pain, stupor.	Three abscesses in the right lobe of cerebellum.	
26	Male.	28	For two years, discharge from right ear.	Paralysis of muscles of face after walk in the rain. Pain on right side of head, vertigo, chills, nausea, vomiting, coma, death.	Substance of right half of cerebellum destroyed to depth of three-quarters of an inch. Roof of tympanum bare but not carious. Tympanic cavity full of purulent matter.	Twenty-four days. Cases 26, 27, were reported by J. Orne Green, Transactions American Otological Society, 1871.
27	Male.	22	Acute purulent inflammation right tympanum. Recovery. Lay on the damp grass, and inflammation recurred. Polypus removed. Renewed exposure and inflammation.	Lancinating pain in the ear. Difficulty in swallowing, and headache. Pus discharging from meatus; vertigo. Paralysis of right hypoglossal nerve.	Severe meningitis. Granulations from arachnoid caries of inner table of skull. Tympanic cavity full of pus. Cochlea and semi-circular canals filled with solid red mass.	Sixty-seven days.
28	Female.	36	Three months inflammation of left ear. Discharge from ear.	Pain in ear, and left half of the head. Vertigo; delirium.	Abscess in left cerebral hemisphere. Caries of roof of tympanic cavity.	Twenty-nine days. Reported by Dr Farwick, Archiv für Ohr., Bd. VI., p. 113.

29	Female.	18	Chronic suppuration in left middle ear since three years old.	Pain in the ear; chills. Region of left jugular sensitive. Pain in swallowing; nausea; uvula œdematous; vomiting; singultus. Left side of the neck œdematous, and painful on pressure; slight convulsive movements of left arm.	Clots in superior longitudinal and superior petrosal sinus. Old thrombus in left lateral sinus. No caries.	Fifteen days.
						Cases 29, 30, 31, reported by H. Schwartze, Archiv für Ohrenheilkunde, Bd. VI., p. 221.
30	Male.	3½	Scarlatina. Otitis media purulenta.	Symptoms of meningitis.	Œdema of pia mater. Left lateral sinus contained a thrombus. Carious bone in left auditory canal. Hemorrhagic infraction of right lung. Suppurative pleuritis.	Thirty-three days.
31	Female.	54	Discharge from right ear since thirteen years old.	Eight days before death severe pain in ear and head; vomiting, vertigo, coma; ptosis of right side.	Hyperæmia of membranes of brain. Œdema of pia mater. Thrombus in right superior petrosal sinus, filling it up to mouth of jugular vein.	Eight days.
32	Male.	53	Inflammation of left ear for fifteen years. Polypus.	Pain in left ear and head; coma; very small perforation of drum-head.	Abscess in left middle cerebral lobe, communicating with petrous bone.	Nineteen days.
33	Male.	24	Old suppurative inflammation in the ear.	Pain in the chest. Brain symptoms. Simulating uræmia.	Carious perforation of roof of tympanum. Abscess of left inferior cerebral lobe.	Cases 32, 33, 34, reported by Von Tröltsch, Archiv für Ohr., Bd. IV., p. 108. Five days.
34	Female.	21	Chronic discharge from right ear for three years.	Daily chill; increased infrequency. Œdema in vicinity of the ear. Swelling of submaxillary glands. Delirium. Dilatation of right pupil. Coma. No convulsions.	Thrombus in right lateral sinus. Metastatic abscesses in lungs. Caries of roof of cavity of tympanum.	Eighteen days.

No.	Sex.	Age	Cause.	Symptoms.	Seat of Abscess or Disease.	How long before Death acute symptoms set in.
35	Female.	20	Chronic suppuration of left middle ear for ten years.	Headache; vomiting. Pain in left ear and occiput. Coma; delirium.	Abscess in left cerebellum, and in left inferior cerebral lobe.	Eight days.
36	Male.	35	Discharge from ear for six years.	Pain in the ear.	Sinuses congested. Right lateral sinus filled with a clot. No caries. Pus in the internal (middle?) ear.	Cases 36 and 37 reported by Dr. Thos. F. Cock, American Journal of the Medical Sciences, vol. xxiv., 1852, p. 37.
37		20	Discharge from ear for eight or nine years.		Caries; phlebitis. Lateral sinus filled with pus. Gangrene of brain.	
38	Female.	4	For months profuse discharge from right ear. Fistula of mastoid. Paralysis of facial nerve.	Brain symptoms.,	Meningitis basilaris. Abscess in right middle lobe of cerebrum. Left cavity of tympanum full of pus, but no perforation of drum-head. Caries.	Cases 38, 39, and 40, reported by H. Schwartze, Archiv für Ohrenheilkunde, Bd. IV., p. 244.
39	Female.	34	Discharge of pus from right ear.	Chills; vomiting. Pain in right side of head. Facial and pharyngeal paralysis.	Fistula of mastoid. Abscess in right middle lobe of cerebrum. Segment tympani discolored and soft. Caries of mastoid cells.	Death in eleven days.
40	Child.	8 mo	For six weeks discharge from left ear. Fistula of mastoid.	Vomiting for nearly a month; inanition; pneumonia; general convulsions.	Exostosis of petrous bone. Caries of tympanic cavity and mastoid. Connective tissue growths in vestibule.	Eight months.

PART III.

THE INTERNAL EAR.

CHAPTER XVIII.

ANATOMY OF THE INTERNAL EAR.

GALEN named the internal ear the labyrinth, although he did not attempt to describe its various parts. This name it continues to bear, although so much labor has been given to its exploration, that we now have the thread to guide us through its devious passages. Yet in our own time, a part of this internal ear—the cochlea—is still the subject of vigorous research and heated discussion, and different views are yet entertained by competent authorities as to the true description of its component parts. I shall attempt to give the student such an account of its anatomy as shall serve as a basis for the study of its physiology and diseases, without entering into the discussion of the points still unsettled.*

The internal ear may be conveniently studied by dividing it into the following parts :

1. The vestibule.
2. The semicircular canals.
3. The cochlea.
4. The auditory nerve.

We shall first study the osseous envelope of these parts, and then consider their contents ; the latter being, of course, far more important.

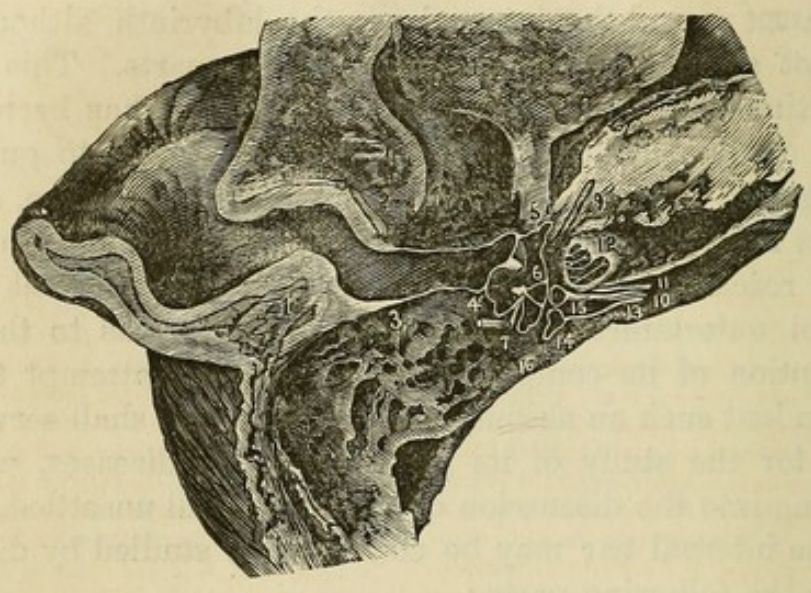
THE VESTIBULE.

The vestibule is considered the essential part of the internal ear by all authorities. A part answering to the vestibule

* In compiling this anatomical sketch, the author has been at times compelled, in order to avoid inaccuracy of statement, to use the exact words of the writer whose work he has used. He has not inserted the quotation marks, but the authorities he has consulted will be found at the end of the chapter. The text-book of Henle has formed the basis of the description of the microscopic anatomy of the labyrinth.

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, soon to be described. 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.

FIG. 89.



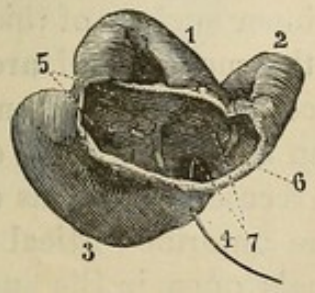
Horizontal Section through the Lower Half of the Left Ear. After a Photograph—Rüdinger. Made from a preparation softened by hydrochloric acid and then hardened in alcohol.

1. *Cartilaginous portion of the auditory canal, having a great anterior convexity. At figure* 1 *the posterior wall presses well into the canal, so that it is the narrowest at this point.* 2. *Cartilages of the anterior wall of the canal.* 3. *The osseous part of the canal.* 4. *Membrana tympani.* 5. *Cavity of the tympanum.* 6. *Stapes bone.* 7. *Stapedius muscle.* 8. *Section of facial nerve.* 9. *Tensor tympani muscle.* 10. *Auditory nerve.* 11. *Nerve of the cochlea.* 12. *Section of the cochlea.* 13. *Inferior nerve of the ampullæ.* 14. *Section of the sacculus hemillipticus.* 15. *Sacculus hemisphæricus.* 16. *Section of membranous semicircular canal.*

The vestibule is an irregularly-shaped osseous cavity, the diameter of which from above downwards, as also from behind forwards, is about one-fifth of an inch. It is about one-tenth of an inch between its inner and outer wall. The semicircular canals open into it by five orifices behind the cochlea, by a single one in front. The fenestra ovalis is on its outer wall; 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.

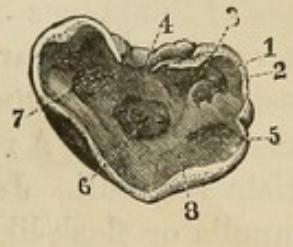
FIG. 90.



The Left Vestibule, with the Semicircular Canals, from an Adult, seen from within.—Rüdinger.

1. *The horizontal semicircular canal.* 2. *The upper semicircular canal.* 3. *The posterior semicircular 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 semicircular canals.* 6. *The opening of the lower ampulla of the posterior semicircular 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 semicircular canals.*

FIG. 91.



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 semicircular canals.*

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 only to be seen 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 semicircular canals. The nerve fibres to the posterior semicircular

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 lateral 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 medial wall are two depressions, called respectively the recessus sphæricus and the recessus ellipticus. A minute elevation between them is called the crista vestibuli. Just above the recessus ellipticus opens the ampulla or flask-like orifice of the anterior vertical semicircular canal. The two vertical canals open in the angle of the posterior and medial wall. On the same line, but a little higher in the middle of the posterior wall, is the posterior opening of the horizontal semicircular canal. The lower opening of the posterior vertical canal is in the angle formed by the posterior, lower, and medial wall of the vestibule. The anterior ampulla of the horizontal canal lies on the lateral wall between the fenestra ovalis and the ampulla of the anterior vertical semicircular canal.

THE SEMICIRCULAR CANALS.

The semicircular 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 posterior vertical semicircular canals 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.

There are considerable variations in different individuals, according to Henle, in the length and curvature of the semicircular 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 20 millimetres ; that of the posterior is 22mm., of the horizon-

Fig. 92.



Osseous Cochlea and Semicircular Canals, with Stapes Bone. Left Ear of Adult. —After Rüdinger.

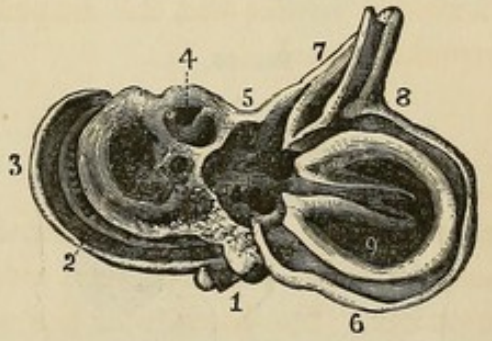
Fig. 93.



Right Osseous Vestibule, Semicircular Canals, Cochlea, and Ossicula Auditus of Newly-born.—After Rüdinger.

tal 5mm. The part common (canalis communis) to the two vertical canals is from 2 to 3 millimetres in length. The diameter in a grown man varies from 1.3 to 1.7 millimetres. Wharton Jones makes their caliber about one-twentieth of an inch in a direction from the concavity to the convexity of their curve.

Fig. 94.



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 semicircular canal.* 7. *The upper semicircular canal.* 9. *Horizontal semicircular canal.*

Since the semicircular 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.

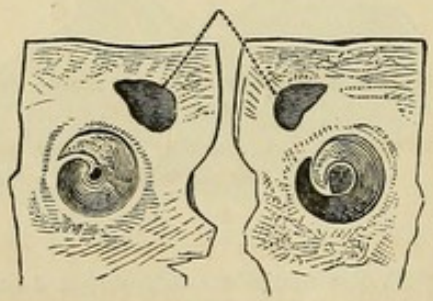
According to Henle,* in the later years of life the semicircular canals increase in length; the horizontal canal increases the most, and the anterior vertical the least. The canals also increase very slightly in width; about 0.7mm. according to Hyrtl.

The functions of the semicircular canals, according to the experiments of Flourens† and Goltz,‡ are to preserve the equilibrium of the head, and consequently of the body. Goltz believes that the semicircular canals are not, so to speak, essential to the function of hearing.

THE COCHLEA.

This part of the internal ear is so named from its resemblance to a common snail; a resemblance which is very marked. It is one of the most remarkable instances in the

FIG. 95.



Section through the Apex of the Right Osseous Cochlea, parallel with the base.

a. *Lower surface of the section.* b. *Upper surface of the section.* c, *. *Canal of facial nerve.*

whole body of the compact packing of very important parts. Wharton Jones§ remarks of its function, that the presence of a cochlea is evidence of a very advanced condition of the organ

* Lehrbuch, p. 762.

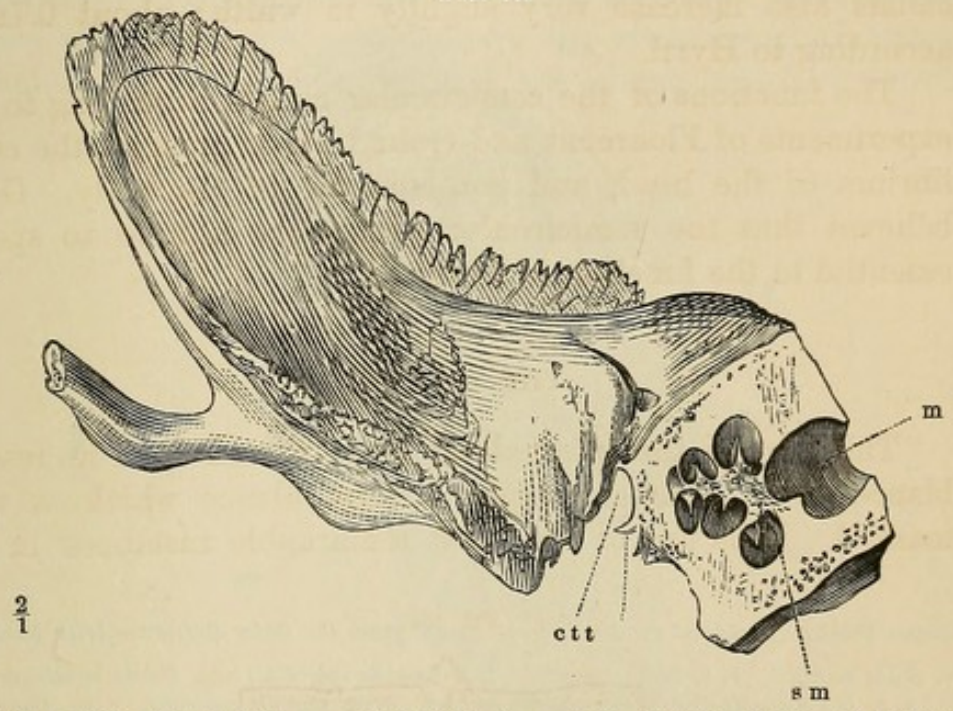
† Von Tröltsch, second American edition, p. 505.

‡ Knapp, Archives of Ophthalmology and Otology, vol. ii., No. 1. Brunner, ibid., l. c.

§ Cyclopedia of Anatomy and Physiology, p. 569.

of hearing; "beyond this we can arrive at no definite conclusion in the present state of our knowledge." Recent investigations, however, render it safe to say that one of the functions of the cochlea is to discriminate between tones. The fibres of Corti connected to the cells that are to be described, being the keys of an instrument of more than a thousand strings.

FIG. 96.



Section of the Temporal Bone, vertical to its Long Axis—Posterior Surface of the Section. —After Henle.

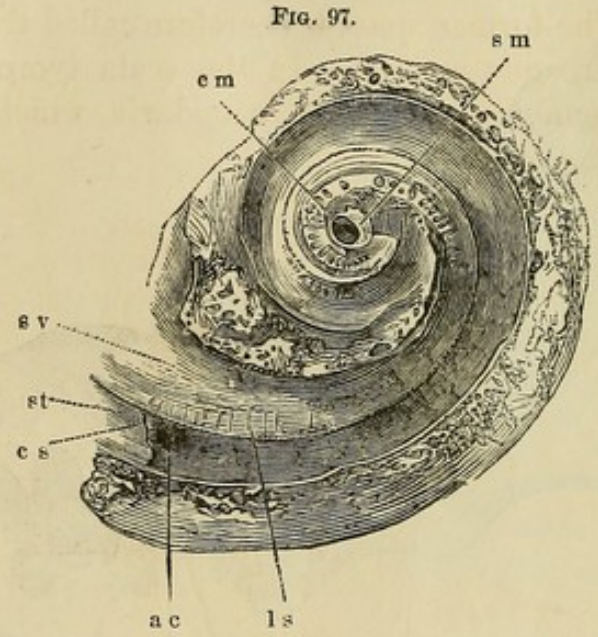
m. *Meatus auditorius internus.* c, t, t. *Canal of the tensor tympani muscle.* s. m. *Canalis spiralis modioli.*

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 towards the tympanic cavity. Inwards it strikes upon the blind end of the internal auditory canal. The cochlea is aptly compared to a tube tapering towards 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 turns and a half turn, in a direction from below upwards, from left to right in the right ear, and from right to left in the left ear. The apex of the coil is directed forwards and outwards. 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. 97.



$\frac{6}{1}$

Osseous Cochlea (Right) of the Newly-born, opened from the Outer Surface.—After Henle.

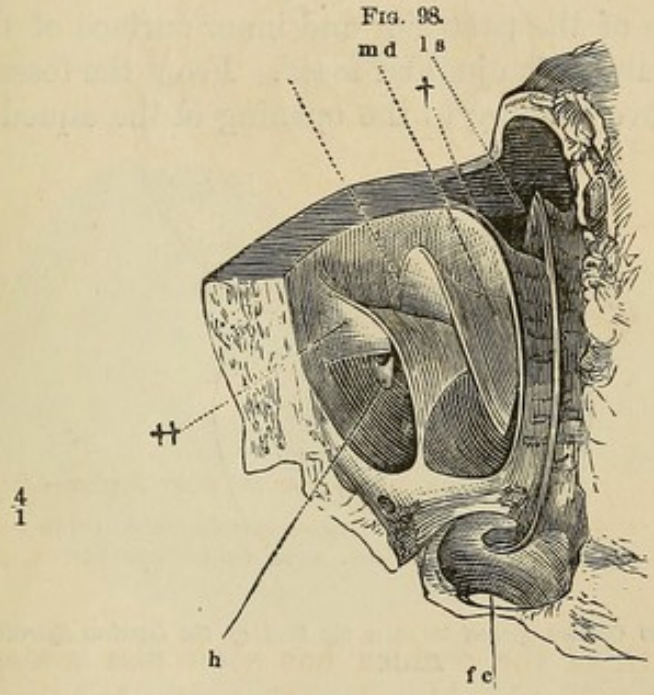
s, v. *Scala vestibuli.* s, t. *Scala tympani.* l, s. *Lamina spiralis.* c, s. *Crista semilunaris.* a, c. *Inner opening of the aqueductus cochleæ.* c, m. *Canalis centralis.* s, m. *Canalis spiralis modioli.*

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*). Wharton Jones compares the appearance of the axis of the cochlea after the outer walls have been removed,

to the ordinary pictorial representations of the tower of Babel.

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 the fenestra rotunda, the upper with the recessus hemisphæricus (see Fig. 94, of the vestibule). The former space is therefore called the *scala tympani*, the latter, *scala vestibuli*. In the scala tympani, exactly behind the membrana tympani secondaria, which closes the

FIG. 98.



Right Osseous Cochlea, opened anteriorly.

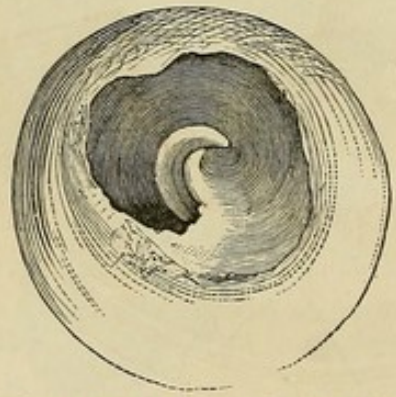
m. *Modiolus.* l. s. *Lamina spiralis.* h. *Hamulus.* f. c. *Fenestra cochleæ.* †. *Section of the middle wall of the cochlea.* ††. *Its upper extremity.* m. d. *Modiolus.*

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. One opens into

the vestibule, and has already been alluded to, and is called the aqueductus vestibuli; the other enters into the tympanic scala of the cochlea, and is called the aqueductus cochleæ. The length of the aqueduct of the vestibule is about one-third of an inch; that of the aqueduct of the cochlea is about one-quarter of an inch. The aqueduct of the vestibule begins by a groove immediately below and in front of the opening common to the two vertical semicircular canals. From this the aqueduct turns itself around the inner wall of the common canal, and runs downwards and backwards. It gradually widens and opens under a thin osseous projection, seen a little behind the middle of the posterior and inner surface of the petrous bone, just above the jugular fossa. From the fossa there is a narrow groove running to the opening of the aqueduct.

Fig. 99.



Apex of the Left Osseous Cochlea opened to show the End of the Lamina Spiralis. After Henle.

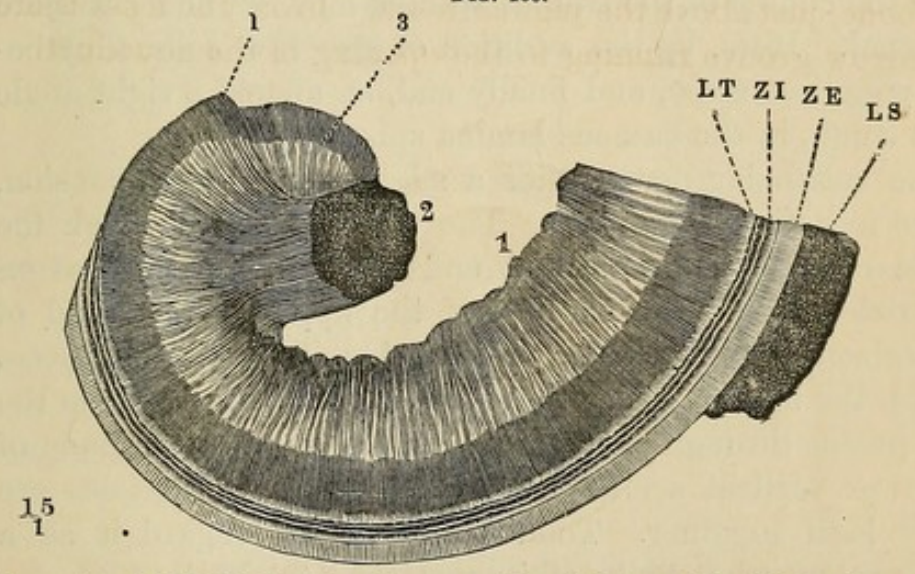
The aqueduct of the cochlea begins by a very small opening in the lower wall of the scala tympani, immediately above the fenestra rotunda. It passes downwards, inwards, and forwards in the inner wall of the jugular fossa, and opens at the bottom of a triangular depression, situated towards the middle of the edge which limits the inner and inferior surfaces of the petrous bone, and below the internal auditory canal.

THE MEMBRANOUS LABYRINTH.

The Auditory Nerve (*Nervus acusticus*).—The auditory nerve, or *portio mollis* (soft part of the 7th nerve), is the

nerve of the sense of hearing, and is distributed exclusively to the internal ear. The auditory nerve arises from numerous white lines, or striæ (linæ transversæ), which come from the posterior median fissure in the anterior wall, or floor of the fourth ventricle. It is also connected with the gray matter of the medulla. 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

FIG. 100.



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.*

crus cerebelli, in the 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 in company with the facial nerve. At the bottom of the internal auditory passage, in the petrous portion of the temporal bone, it divides into two branches, which are distributed to the cochlea, vestibule, and semicircular canals, and are called the cochlear and vestibular branches.

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.

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 becomes 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. The upper passes through the macula cribrosa superior, and ends with three branches on the utricle, and on the ampulla of the upper vertical and of the horizontal semicircular canal. A middle branch passes through the middle macula cribrosa to the saccule, while the lower passes through its own osseous canal to the ampulla of the lower vertical semicircular canal, and its fascicles are loosely held together. Todd and Bowman regard it as a direct prolongation of the white matter of the brain.

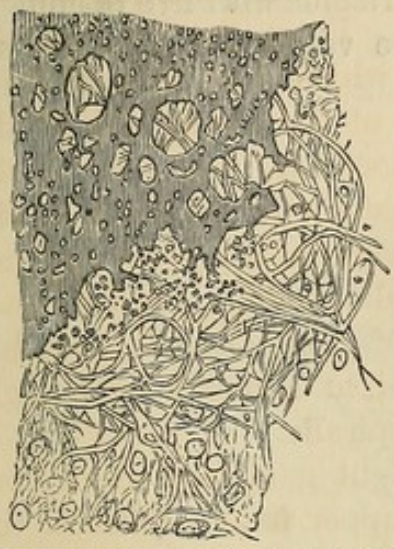
In the internal auditory canal, the portio mollis forms a connection with the portio dura by means of a few fascicles of fibres, which constitute what Wrisberg called the "portio intermedia." It is not decided whether the connecting link proceeds from the auditory to the facial nerve, or from the latter to the former. Todd and Bowman believe it probable that the facial nerve sends some filaments to the blood-vessels of the labyrinth and the muscular structure of the internal ear.

PERIOSTEUM OF THE LABYRINTH.

The periosteum that covers the walls of the osseous canal is, with the exception of that on the outer wall of the cochlea,

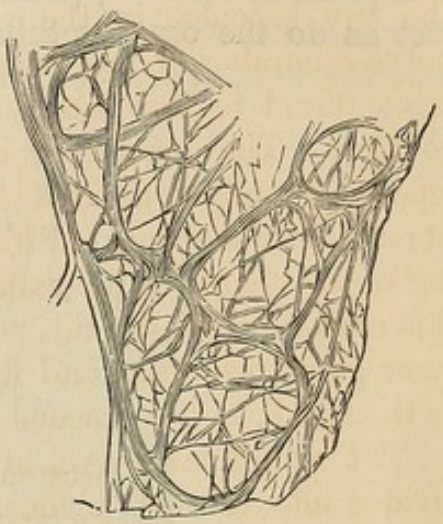
very delicate. Henle* compares the periosteum of the labyrinth to one of the parts of the choroid, because it is strewn with nucleated pigment cells. There are also calcareous deposits. It is very difficult, according to Henle, to separate

Fig. 101.



Periosteum of the Labyrinth. After Henle.

Fig. 102.



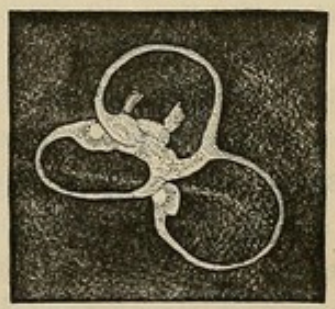
Periosteum of the Outer Wall of the Cochlea. After Henle.

the periosteum of the labyrinth, without also detaching bits of bone. The periosteum is abundantly supplied with blood-vessels.

UTRICLE AND MEMBRANOUS SEMICIRCULAR CANALS.

The utricle is an elliptical tube, situated on the median wall of the vestibule. Its longest diameter corresponds to the

Fig. 103.



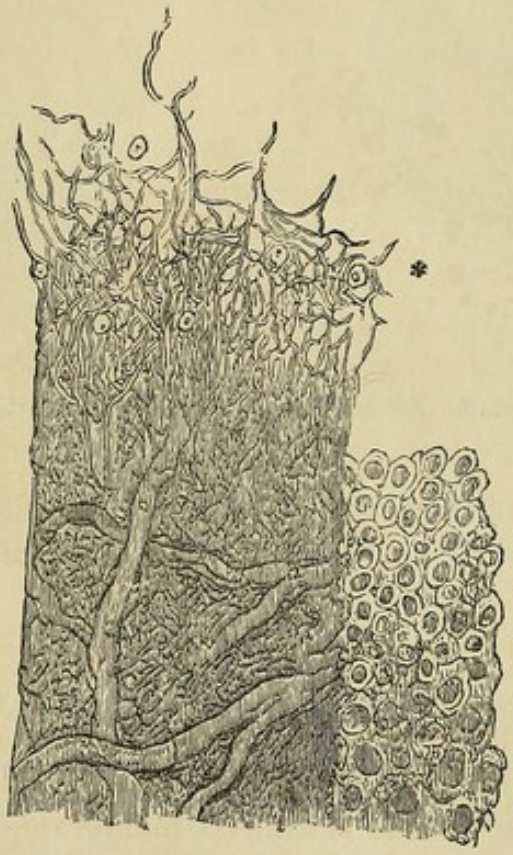
Utricle and Membranous Semicircular Canals of the Left Side.

* Lehrbuch, p. 774.

height of the vestibule. By means of a fine vascular and nervous network, and a very delicate connective tissue, it is fastened to the recessus ellipticus of the vestibule.

The membranous semicircular 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 am-

Fig. 104.



Wall of Membranous Semicircular Canals.

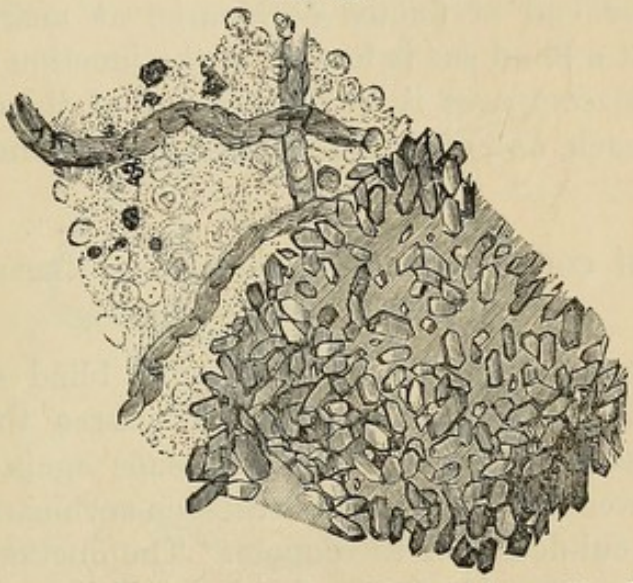
1. *Membrana propria, artificially separated edge.* 2. *Epithelium.*

pulla 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 acustica by Max Schultze. It comprises about one-third of the wall of the ampulla. It is sometimes surrounded by a pigmented line.

The wall of the membranous semicircular canals is from 0.02mm. to 0.03mm. in thickness, and is composed of various layers.

FIG. 105.



A Piece of the Wall of the Utricle, with the Otoliths. After Henle.

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 mentioned, 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. The powder consists of crystals of varying shape and size. The largest are only 0.012mm. long and 0.008mm. broad. They are too small to allow the

crystal form to be recognized. The material of which otoliths is composed is carbonate of lime. Henle says it is unknown how the otolith is fastened on to the wall of the utricle.

SACCULE AND DUCTUS COCHLEARIS.

The saccule is of the shape of a broad flask with a narrow neck. It lies in the recessus sphæricus of the vestibule. The neck of this bottle or flask proceeds from the lower wall, downwards and backwards, and sinks into the upper wall of the vestibular end of 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 cœcum.

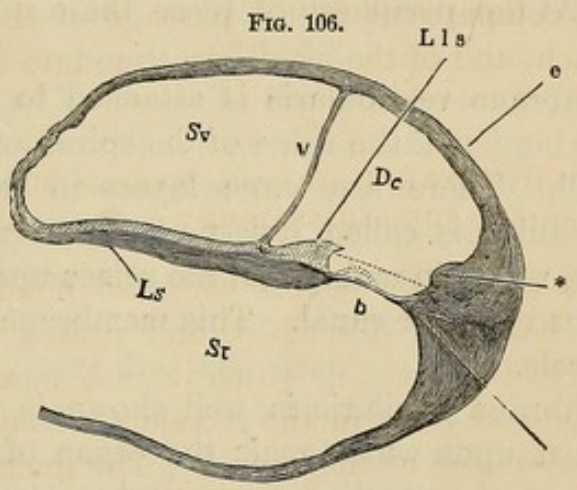
THE DUCTUS COCHLEARIS. (Lamina Spiralis Membranacea of the old anatomists.)

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 to which the insertion of the two others is made. The lower wall of the ductus cochlearis, which is turned towards 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 towards the caliber of the ductus cochlearis. It is called by Henle the limbus laminæ spiralis. (See Fig. 106.) 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 vestibular; 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.

FIG. 106.



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 v. *Ligamentum spirale.* V. *Membrana vestibularis.* b. *Membrana basilaris.* e. *Outer wall of ductus cochlearis.* *. *Bulging of membrana basilaris.*

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 2,500. 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 the nerve fibres fasten between them, and then unite beyond it in a sharp border, from which the *membrana basilaris* proceeds. This membrana basilaris, 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 Fig. 106, 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 0.17mm.; 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 is found the structures making up what is known as Corti's organ, from their discoverer, Marchese Corti.* The outer zone is rather broader than the inner.

* Corti was formerly prosector to Professor Joseph Hyrtl, and made the first exact microscopic examination of the lamina spiralis ossea, and membranacea.

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 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. (See Fig. 106.) 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, but 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 covering it.

TERMINAL AUDITORY APPARATUS.

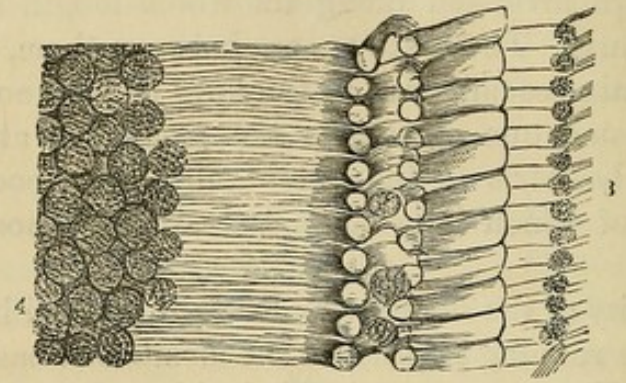
Henle terms the important structures of the lower chamber of the ductus cochlearis the terminal auditory apparatus. They consist of rod-like bodies, a perforated membrane, and nuclear cells of various shapes. A fourth part, whose existence Henle thinks is doubtful, are fibres, in which connective tissue and the ultimate fibres of the auditory nerve are found.

AUDITORY RODS.

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. It is probably their vibrations that cause us to perceive what we call tones. There

FIG. 107.

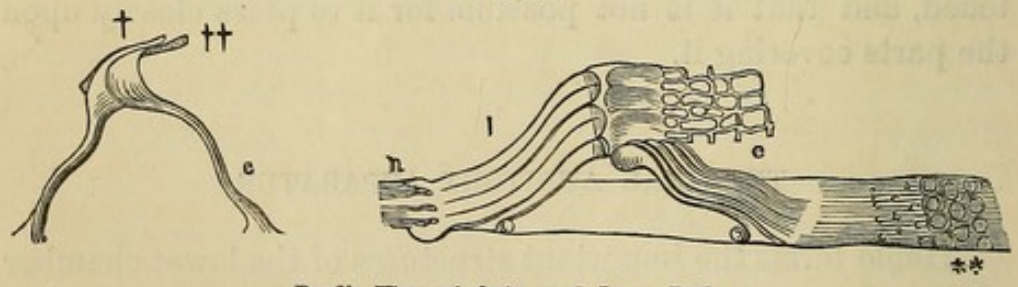


From the Terminal Auditory Apparatus of a Cat. After Henle.

i. *Outer ends of the inner fibres.* e. *Outer fibres.* 3. *Outer covering cells.* 4. *Epithelial cells.*

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, towards the membrana tectoria, without, however, being united to the latter. The outer rods or fibres join, with their inner extrem-

FIG. 108.



Profile View of Outer and Inner Rods.

B. *Membrana basilaris* (b), *with the terminal nerve fibres* (n) *and the inner and outer rods,* i, e. 1. *Inner.* 2. *Outer floor cells.* 4. *Attachment of the roof cells.* ††. *Epithelium.*

ities, 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. They have

a tortuous course sometimes, like the letter S. 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 0.1mm. 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.

MEMBRANA RETICULARIS.

This 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 CELLS.

These are cylindrical and spherical elements which are called cells, because they contain nuclei. They may be considered, according to Henle, as epithelial or ganglion cells. Some of these cells are called hair cells, stachel cells, and in them are probably the terminal filaments of the cochlear nerve.

Henle divides these cells which are not epithelial into two classes: the roof-cells (deck-zellen), and floor-cells (boden-zellen). Gottstein calls these hair cells. The roof-cells are found on the convex side of the roof formed by the union of the two rows of arches.

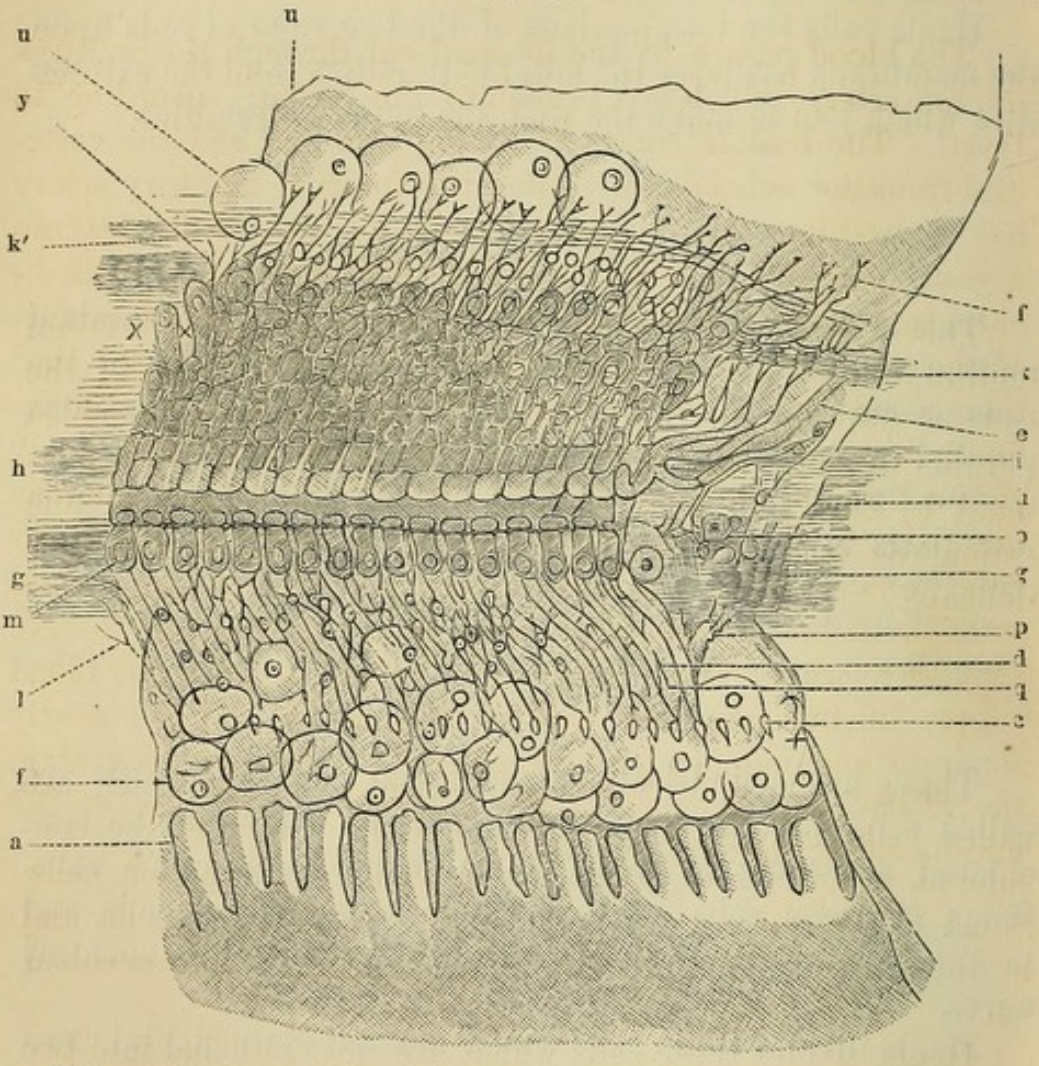
The floor cells are found at the angle which the base of each rod makes with the membrana basilaris.

Henle divides the floor cells into three varieties: an inner, an outer, and a lower outer.

After the exit of the nerve fibres from the canals of the

labium tympanicum, the bundles of nerve fibres take two different directions. One part maintains the original radiate direction, the other proceeds spirally. These fibres take different directions with reference to the fibres of Corti; at the

FIG. 109.



Diagrammatic Representation of the Terminal Auditory Apparatus. After Henle.

a. *Teeth of the labium vestibulare.* b. *Epithelial cells of the labium tympanicum.* c. *Openings of these cells.* d. *Inner rods.* e. *Outer rods.* f. *Connecting fibres.* g, h, i, k, k'. *First to fourth bundle of spiral nerve fibres.* l. *Radiate bundles.* m. *Upper nerve roof cells.* n. *Epithelial cells.* o. *Supporting fibres of rods.* p. *Radiate nerve fibres upon membrana basilaris.* q. *Nerve fibre running above rods.* u. *Membrana basilaris.* x. *Upper outer roof cells.* y. *Lower and outer roof cells.*

apex of the cochlea they decrease in number. They do not lie directly upon the membrana basilaris, but at a certain height above it. The nerve fibres are probably connected

with the cells at the base of the rods, the so-called floor cells of Henle. It is possible that they are also connected to the lower sharp extremities of the upper and outer roof cells.

BLOOD-VESSELS.

The blood passes to the internal ear through the auditiva interna 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 foraminulentus 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 semicircular canals. The stylo-mastoid artery is said to give several small branches to the labyrinth. It is important to observe the fact to which Von Tröltsch calls attention—that the blood supply of the labyrinth and of the middle ear are nearly 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.

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* The best bibliography of the Anatomy of the internal ear, is found in Waldeyer's article.

CHAPTER XIX.

DISEASES OF THE INTERNAL EAR.

Nervous deafness may be defined to be a primary affection of the auditory nerve or labyrinth, or of both. It should be carefully distinguished from other forms of impaired hearing that are accompanied by symptoms of general nervous disease, or by evidences of secondary affections of the labyrinth, such as vertigo and tinnitus aurium.

Primary and independent affections of the labyrinth or internal ear are happily the most infrequent of aural diseases. We know very little of the nature of these affections, and we have as yet absolutely no means of treatment for them that can be said to be at all successful. The gaps in our knowledge on this subject are yet to be filled up by the patient comparison of symptoms with post-mortem appearances. Of fifteen hundred cases of aural disease observed by the author in private practice, but fifty-seven could be fairly considered to be cases of primary disease of the internal ear. The statistics of most other writers, and the reports of public institutions show about the same proportions; Voltolini,* however, believes that affections of the labyrinth are more common than is usually believed, but his opinions are as yet not supported by the only reliable evidence, that which has been just alluded to, the confirmation on the post-mortem table of symptoms observed during life.

It has been already said in this volume, that it is quite a common view that nervous affections of the ear are very frequently met with. The kind of nervous affection that is meant by the laity and those members of the profession who

* Von Tröltsch, Translation, 2d American Edition, p. 498.

entertain this notion is quite different, however, from the diseases of the nerve apparatus now under discussion. 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. It is quite doubtful, however, if in such cases the nerves of the ear are 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 the auditory nerve make the subjects deaf, and sometimes cause them to stagger in their gait, but they do not render them nervous or unsteady in the ordinary acceptation of that term. 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. On this point Mr. Hinton* says, that it is difficult for him to accept *debility*, nervous or other, as a cause of nervous deafness. He has not found that the cases of deafness which appear to him as properly classed among the nervous ones, occur specially in the debilitated. I am thus detailed upon this subject of nervous deafness, because there is so much error in the understanding of what nervous deafness really is, and because this error leads to a confusion of that common affection, chronic non-suppurative affection of the middle ear, with the comparatively rare affection, disease of the labyrinth. It is probable, however, that secondary disease of the labyrinth—that is, disease extending to this part from the middle ear—is quite frequent. We know at least that affections of the fenestra ovalis, or undue pressure of the chain of bones upon this opening into the vestibule, will cause vertigo, nausea, and other head symptoms. Post-mortem examinations also show that changes in the labyrinth are apt to occur in connection with chronic diseases of the middle ear, even when there is no suppuration or caries, when, as we have seen, the labyrinth is sometimes necrosed and exfoliated. Young children who suffer from acute inflammations of the middle ear, in consequence

* Nervous Deafness. Reprint from Guy's Hospital Reports, 1867.

of the exanthemata, very readily develop head symptoms, which undoubtedly depend upon extension of the middle ear disease through the very delicate partition walls separating the cavity of the tympanum from the brain, or through the wall that separates it from the expansion of the cerebrum that we call the internal ear; but these cases of secondary affection of the labyrinth are reached by treatment of the primary affection of the middle ear, and it will not be proper to include them in this chapter.

Voltolini is quite positive that there is a primary affection of the labyrinth that is sometimes mistaken for cerebro-spinal meningitis, and he has written several papers,* illustrated by cases, to sustain his position. Although his ideas have been rejected by some other writers, I do not think the question can 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, the suspicion is at least a strong one in my mind that Voltolini is 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. Unfortunately—although we have had an epidemic of cerebro-spinal meningitis in New York—I have as yet had no opportunity of studying this disease except from its clinical history, when the victims were brought to me deaf or blind.

After these general observations as to the nature of so-called nervous deafness, or of what should be termed diseases of the internal ear, we may enter upon the consideration of the symptoms, causes, pathology and treatment of affections of the auditory nerve and its expansions in the labyrinth.

Symptoms.—There is but one symptom that is absolutely pathognomonic of disease of the auditory nerve, and that is *absolute deafness.* 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

* Monatsschrift für Ohrenheilkunde, Bd. I. and VI.

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, and actual 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. Other symptoms of nerve deafness, such as vertigo, nausea, vomiting, tinnitus aurium, are also seen in affections of the middle ear, although very few cases of nausea or vomiting occur, unless the nerve expansion in the labyrinth is involved. A staggering gait, or loss of equilibrium, is also a symptom of nerve deafness; at least patients who recover from cerebro-spinal meningitis, with deafness, exhibit this symptom, and the same is true of those who become profoundly deaf in an instant, and whose history shows that they have had a primary affection of the labyrinth.

After these symptoms have been considered, the tuning-fork becomes very valuable as a means of diagnosis in suspected nerve deafness. As we have seen in Chapter II., the tuning-fork is heard more distinctly if the ears be stopped with the finger or the like, while the handle is placed upon the forehead or teeth. If a person be affected with nerve deafness, it is a clinical fact that such a stoppage of the meatus does not usually at all intensify the sound of the tuning-fork. Of course there are no appearances upon the drum-head or in the Eustachian tube, that give evidence of disease of the labyrinth. We may have a normal membrana tympani in cases where we feel sure from other evidences that the auditory nerve is the seat of the disease; and we may, as I have often had occasion to observe, especially in deafness from cerebro-spinal meningitis, find a sunken drum-head and other marks of chronic processes in the middle ear, which have occurred secondarily to, or in connection with, an affection of the labyrinth. The one prominent symptom, however, in most cases of true disease of the auditory nerve, is sudden and complete deafness. Yet it must not

be supposed that the deafness is always absolute. I lately saw a case which has led me to the belief that we may have an affection of the labyrinth, as sudden in its origin as those in which the patients awake, as they sometimes do, to find themselves totally deaf of one ear, and yet the hearing be merely impaired. I confess, however, that it is hard to conceive of a sudden effusion into the semicircular canals and cochlea, which should be so circumscribed as to make the patient but partially deaf. The case in question is as follows: A physician, æt. 33, states that while a student, in 1869, he was one day studying in a recumbent position upon a lounge, and when he got up he was dizzy and fell down at once. He did not become unconscious, but he found that he had a ringing in his left ear. He tested his hearing by means of the watch, and found that it was greatly impaired. From that time to this he has always had a ringing in his ear, with impairment of hearing. The tuning-fork was heard better in the sound ear. The hearing distance was—Right ear, $\frac{18}{48}$; left ear, $\frac{20}{48}$. The drum-head was a little sunken, and the light spot was small. Air entered both Eustachian tubes. There was no improvement after inflation of the ears. The patient, who was a careful physician, was confident that he never before had any disease of the ears. He stated also that he became much worse, as to the ringing, when overworked or fatigued from any cause. I am not ready to affirm that this is a true case of primary affection of the labyrinth; but it seems to me that this is probably the case.

Deafness to certain tones must of necessity be 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 and hyperæmia of the cochlea. Indeed, double hearing, or the hearing of the last

tones or syllables repeated or echoed, is usually a secondary symptom of middle-ear disease. It has been observed by Sir Everard Home,* Gruber,† Moos,‡ and Knapp.§ In Knapp's case, which occurred in a patient suffering from acute aural catarrh, the patient heard all sounds of the three upper octaves double. Both ears of this patient were affected with this double hearing. This trouble increased until "all musical sounds appeared to him perverse, and music in general, which he had liked passionately, became a perfect horror to him."

The explanation of these cases, as has been already intimated, is to be found in a change in the pressure upon the fluid in the labyrinth, and thus the ends of the nerve fibres are incorrectly tuned. It is hardly necessary to more than allude to the symptom 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. We may then believe that the function of the nerve is completely destroyed.

Pain is not usually a symptom of disease of the nerve, except in the form which Voltolini calls inflammation of the membranous labyrinth. In these cases it may exist. 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.

The symptoms of inflammation of 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‖ unites with me in believing that such a disease may occur. If we find a child suddenly taken with severe vomiting, followed by stupor or delirium, who never has any paralysis, but slight opisthotonos, such as chil-

* Transactions of Royal Society, 1800.
† Lehrbuch, p. 626.
‡ Klinik der Ohrenkrankheiten, p. 319.
§ Transactions of the American Otological Society, 1871.
‖ Lehrbuch, p. 552.

dren have with acute otitis media, and if we see this child recover in a few days from every symptom except the one of absolute deafness and a staggering gait, I think 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.

Having seen many cases in which such a history was clearly given, I must believe in a primary acute inflammation of the labyrinth, and I trust the attention of physicians will be directed to the differential diagnosis between this affection and cerebro-spinal meningitis.

The late Dr. P. Ménière, of Paris, published several observations of cases of loss of equilibrium accompanied by deafness, which have very improperly led to the classification of a large class of different forms of disease of the labyrinth under the head of Ménière's disease. These cases have the usual history of what we may suppose to be effusion into the labyrinth—that is, nausea, vomiting, vertigo, and inability to walk straight, with sudden deafness. There was an autopsy in one case, which has been repeatedly quoted. This case, however, was not a true specimen of the cases from the clinical history of which Ménière made his diagnoses. It was that of a young woman who, while menstruating, caught cold and became suddenly deaf. Her chief symptoms were vertigo and frequent vomiting. Dr. Ménière examined the ears and found all the parts healthy except the semicircular canals, which were filled with a reddish plastic substance replacing the labyrinth fluid. The vestibule also exhibited traces of this exudation, but the cochlea, brain, and spinal cord were normal. The subject of the occurrence of these symptoms and the cases reported by Ménière, especially the one accompanied by a post-mortem, are indeed important, but it seems to me a mistake to classify symptoms of effusions into the labyrinth, from whatever cause, under such a name as Ménière's disease, and to infer that lesion of the semicircular canals only is to be found in such cases.

In recapitulation, it may be said that the chief symptoms of labyrinth disease are—

Deafness, usually nearly absolute, and occurring suddenly.

Vertigo.

Nausea and vomiting.

Loss of equilibrium.

Inability to hear the tuning-fork more distinctly in the affected ear.

ELECTRICITY IN THE DIAGNOSIS OF DISEASE OF THE AUDITORY NERVE.

Electricity has been much used in the diagnosis of disease of the auditory nerve, and some authorities believe that we have a positive means of diagnosis in the employment of the galvanic current. My friend, Dr. Roger S. Tracy, has taken the pains to go over the literature which I have collected upon this subject for me, with a view to the determination of the side on which lays the weight of evidence as to the reaction of the auditory nerve under galvanism. The method of using the current should be first described.

The galvanic current is applied to the middle and internal ear by means of an electrode insulated to the end, introduced into the external auditory canal (which has been previously filled with warm water), until it touches the membrana tympanum, or is firmly pressed against the tragus, the other electrode being held in the hand of the opposite side. The second electrode may also be introduced, through a catheter, into the Eustachian tube, and even into the cavity of the tympanum, as by Wreden, of St. Petersburg.

When the galvanic current is passed through the ear in this manner, certain sounds are heard by the patient, described as hissing, roaring, ringing, etc., which have been formulated by Brenner, who, after a long series of careful observations, has established a formula for the reaction in the normal ear, which he claims to be constant. He has also determined formulæ for some diseased conditions. Brenner and his followers hold that these acoustic phenomena are all due to a direct irritation of the auditory nerve by the current, while others have considered the irritation to be reflex, through the medium of the trigeminus. It is not claimed that the *faradic* (induced) current produces these effects, or at least not to the same degree as the galvanic current.

Dr. Hagen, of Leipsic, in an able monograph,* takes strong ground in support of Brenner, and thinks the following points may be considered established :

1st. That the auditory nerve reacts to the galvanic current.

2d. Through the galvanic irritation of this nerve, we can learn its condition, which we cannot learn in any other way.

3d. With this assistance we can with certainty diagnosticate a perforation of the drum-head.

4th. The passage of the current through a diseased ear informs us whether, in addition to visible changes in the organ, the nerves are also affected.

5th. That when, with subjective symptoms of tinnitus, etc., the galvanic reaction indicates hyperæsthesia of the nerve, it is in some cases possible to abolish these sensations permanently, or for a time.

Dr. Wreden, of St. Petersburg,† on the other hand, by a series of carefully conducted experiments upon sound and unsound ears, claims to have established the fact that the sounds heard in the ear during the passage of the electrical current, are due to the contraction of the small muscles of the middle ear, and *not* to the direct or reflex irritation of the auditory nerve, as Brenner and others have asserted.

He has used for these observations small sounds, one of which, for what he calls *tubal electrization*, is introduced, through the catheter, the whole length of the Eustachian tube, and the other, for *middle ear electrization*, projects two millimetres into the cavity of the tympanum, being insulated throughout the portion lying in the tube. These electrodes, for greater accuracy in their introduction, have each three marks upon them ; one indicating the exact length of the catheter through which the electrode is introduced, the second, 24 millimetres from the first, the length of the cartilaginous portion of the Eustachian tube, and the third, 11 millimetres from the second, the situation of the tympanic extremity of the tube in adults.

By *tubal electrization* he claims to irritate the fifth nerve,

* Praktische Beiträge zur Ohrenheilkunde. Leipsic, 1866.

† Beiträge zur Begründung einer Lehre über die electrische Reizung der Binnenmuskeln des Ohres.

and produce contractions of the *tensor tympani*, and by *middle ear electrization*, the seventh, or facial nerve, with consequent contractions of the *stapedius*.

In view of the importance of his researches, it may be well to give here some of the proofs which he adduces in support of his position.

1st. During the passage of the galvanic or faradic current, by means of *tubal electrization*, an inspection of the membrana tympani will show a decided drawing inwards of the membrane, at the opening and closing of the circuit. This motion of the drum-head is accompanied by a sound readily appreciable by the otoscope.

2d. At the same time with these objective phenomena, the patient feels an evident contraction in the ear, which an educated person always refers to the membrana tympani.

3d. By the second method of electrization, an insulated electrode in the middle ear, a sensation as of a powerful blow is felt in the ear, accompanied by giddiness and faintness.

4th. He has observed a case of clonic spasm of the *stapedius* muscle, in which every muscular contraction was accompanied by sensations and sounds precisely similar to those produced during the passage of the electrical current.

5th. Even the adherents of the theory of direct irritation of the auditory nerve acknowledge that no current will produce sounds in healthy ears, unless it is strong enough to excite contractions of the muscles supplied by the facial nerve. In this *conditio sinè quâ non* is included, of course, the contraction of the *stapedius*.

6th. He has repeatedly had opportunity to observe, that in cases of complete facial paralysis, in which a simultaneous paralysis of the auditory nerve could be excluded, even the strongest currents failed to produce any sensation of sound, either by tubal electrization or by the external meatus. This complete absence of result in such cases is inexplicable upon the theory of irritation of the auditory nerve.

7th. The well-known fact of the absence of sounds during the passage of the current, in some persons whose ears are diseased, but whose auditory and facial nerves are healthy, can be explained by immobility of the *stapes* (from anchylo-

sis or other cause), while on Brenner's theory it is inexplicable.

8th. The absence of all sensations of sound during tubal electrization, where the membrana tympani is destroyed, and both *incus* and *malleus* gone, as in a case reported by Wreden,* is likewise difficult to explain on Brenner's theory.

Drs. Erb and Moos, of Heidelberg, adhere to the theory of Brenner, and the former has written a monograph in its support.†

Schwartze, of Halle, and others equally eminent as observers, dispute Brenner's conclusions.

The questions at issue cannot yet be considered settled, though the stronger arguments at present appear to favor the theory of muscular contraction.

I beg to refer those who are interested in Brenner's formula to the article upon aural disease in Beard and Rockwell's treatise on electricity.‡

Dr. C. J. Blake,§ who is a believer in the theory that the auditory nerve is actually excited by galvanization after the method of Brenner, has sought some other means of demonstration of the condition of the auditory nerve, than the ability to obtain a certain formula, which, as even the advocates of Brenner's theories admit, sometimes does not exist. He finds that "the passage of the galvanic current increases not only the limit of perception of musical tones, but also the intensity of perception, the degree of increase in intensity of perception being a measure of the degree in which the auditory nerve responds to the stimulus." The following case, given by Dr. Blake in the article from which I have quoted, will give his views as to the value of this method of determining the state of the auditory nerve.

"A man thirty-two years of age, first noticed diminution of hearing and a rushing sound in both ears, ten years before the date of his application for treatment. His general health had been good with exception of occasional attacks of malarial fever, for relief from which he had used quinine in large

* Op. cit., p. 33.

† Archives of Ophthalmology and Otology, vol. I., No. 1, 1869.

‡ Medical and Surgical Uses of Electricity, p. 546.

§ Brown-Séquard's Archives, June, 1873.

quantity. The hearing had so far diminished that the watch was not heard when pressed upon the auricle, and the tuning-fork held between the teeth, was heard only in the left ear. In the right ear, however, a tone of 50,000 v. s. was distinctly heard, and in the left ear a tone of 45,000 v. s. The membrana tympani of both ears was transparent and apparently normal, except that it was quite concave. The hearing was not improved by the use of either Politzer's air-douche, or the catheter. No formula of reaction could be obtained, but the use of the cathode increased the perception for high musical tones to 60,000 v. s., and for duration of hearing of the tuning-fork, from twenty seconds to thirty-five seconds." *

"This increase in the perception for musical tones persisted but a short time after the application of the current; the duration of perception of the tuning-fork, however, continued to increase, but never reached the normal standard, and the improvement in the general hearing was, on the whole, so very slight, that the use of the current was finally abandoned. This case presented several points of interest. So far as could be determined, the middle ear was in a healthy condition, with exception of such changes as were evidenced by the concavity of the membrana tympani. Assuming the auditory nerve to be in a normal state, we should expect an increase in the limit of perception for high musical tones, as was the case on account of the increased tension of the membrana tympani; the same condition would tend to diminish the hearing for lower tones, as was the case in the test with the tuning-fork, and in the hearing for the voice. The use of the cathode increased the hearing for the voice, and for the watch, slightly and decidedly increased the perception for high musical tones, and also the duration of the perception of the tuning-fork; and an excision of a portion of the membrana tympani, which operation was subsequently performed, had no appreciable effect upon the hearing whatever.†"

Causes.—Instead of attempting to divide the diseases of the labyrinth into numerous forms, I have thought it would better accord with the present state of our knowledge, if the causes that are known to produce primary disease of the internal ear were tabulated and discussed. We shall then at least see the gaps in our knowledge, which is, after all, the best view for the scientific student to take.

I will venture to tabulate the causes of disease of the internal ear as follows:

* "The tuning-fork, a 562 v. s., being struck by the spring-hammer with a force equivalent to one pound falling one inch, the normal duration of hearing is from 55 to 60 seconds."

† "In the majority of cases in which this latter operation is performed, the perception for high musical tones is immediately increased; in one case in which the experiment was made, the patient heard a tone of 100,000 v. s. distinctly, after the operation, the extreme limit before the operation having been only a tone of 35,000 v. s."

Proximate causes—

Injuries.
Hemorrhages and effusions.
Inflammation of the membranous labyrinth.
Internal administration of quinine.
Concussion of the nerve, and its expansion.

Remote causes—

Syphilis.
Cerebro-spinal meningitis.
Fevers.
The exanthemata.
Mumps.
Cerebral tumors.
Aneurism of the basilar artery.

INJURIES.

It is readily seen that a fracture of the petrous portion of the temporal bone, attended, as it must necessarily be, by laceration of the tissues of the membranous labyrinth, with unstringing of the fibres that make up Corti's organ, must produce great impairment, if not total loss of the functions of the auditory nerve. Such an injury may be accompanied by hemorrhage through the membrana tympani; but a case of Zaufal's, quoted by Politzer,* shows that a hemorrhage may occur from the ear after an injury when the drum-head is intact. In this case a fracture occurred through the upper wall of the pyramid and the opposite wall of the tympanic cavity, and extended to the upper wall of the osseous part of the auditory canal, without having injured the membrana tympani.

A serous discharge from the ear, after a fracture of the base of the skull, is a symptom that is spoken of by most surgical authorities. The fluid that escapes is usually cerebro-spinal fluid, but Politzer† quotes a case from Fedi, in which the fluid must have come from the labyrinth, for there was no trace of a fracture of the skull found in the post-mortem ex-

* Läsion des Labyrinthes. Archiv für Ohrenheilkunde, Bd. II.
† L. c.

amination, made three years after the injury, although the stapes was fractured, and there was a free communication between the cavity of the tympanum and the vestibule. Hyrtl, after removing the fluid from the canal of the spinal cord in the cadaver of a child, once found that the injecting material forced into it passed into the cavities of the labyrinth. He is of the opinion that the labyrinth fluid in this case, was connected with that of the cerebro-spinal cavity by holes which existed in the meatus auditorius externus, near the entering fibres of the auditory nerve. It is therefore conceivable, as Politzer suggests, that the cerebro-spinal fluid may, in some cases, flow from the ear, after an accident, without a fracture of the base of the skull. The question as to whether the cavity of the spinal column and the labyrinth are normally in communication with each other in the adult subject is not yet settled. In fœtal life such a communication exists. It is unnecessary to dwell upon the kind of injuries that may produce injuries to the labyrinth. The text-books on general surgery are the proper sources of information of this kind, and to them I may be permitted to refer the reader for a fuller account of such injuries.

HEMORRHAGE OR EFFUSION.

I think we have a right to conclude, from the clinical history of certain cases, that a hemorrhage or effusion of serum into the membranous labyrinth may occur without any well-defined cause. Of course, in atheromatous degeneration of other blood-vessels of the body, we may also suppose that such a hemorrhage sometimes occurs. The following case is a fair type of what is meant by hemorrhage 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 of 22, consulted me at the instance of Dr. Howard Pinkney, and 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 his body; he could lift his head, his arms, 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.

I think there is no reasonable doubt that this was a case of hemorrhage into the semicircular canals and the cochlea. I have seen several such, and some where no vomiting occurred, but 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 the labyrinth disease, we have not the same facilities for clearing up a diagnosis that we have in fatal affections.

The following case was furnished me by Dr. R. S. Tracy, who observed it while house physician in Bellevue Hospital. It seems to be one of inflammatory effusion into the labyrinth, and to fairly belong to this group of cases, although both Dr. Tracy and myself agree that the evidence is not quite positive.

Syphilitic Periostitis of Internal Auditory Canal, or of the Periosteum of the Labyrinth.

Patrick Freely, æt. 40, native of Ireland, laborer. Admitted to Bellevue Hospital, March 27, 1868.

The patient was first seen in the evening, at about six o'clock. He was then seated on a stool beside his bed, with his head between his hands, and elbows on his knees, rocking himself from side to side, with frequent groans, as if in considerable pain. On my approach he looked up, and, when spoken to, replied that he was unable to hear a word, that he had acute pain in his head, shooting through from ear to ear, and that he felt giddy, so that he stag-

gered in walking like a drunken man. This was all the history that could be obtained from him, as he could not hear the loudest shouts uttered close to his ear, and he was found to be unable to read or write. All doubt as to his actual deafness was dispelled by his manner of speaking. His voice was very loud, and badly modulated. He was given one-half grain of morphine, to relieve his pain, and left till morning.

The next day he had less pain, and remarked that it was always worse at night. He was found to have enlarged post-cervical ganglia, and a copper-colored, non-inflammatory papular eruption over the whole body. A cicatrix was also found upon the glans penis.

From the evidence of syphilis present, the nocturnal exacerbations of the pain in his head, the fact that his deafness was of recent occurrence (a fact learned from his friends), its symmetrical character, and the absence of other cerebral symptoms than deafness and a certain degree of giddiness, the diagnosis was made of syphilitic periostitis of the internal auditory canal, and he was given iodide of potassium, in ten-grain doses, three times a day.

He continued in much the same condition, excepting that his pain was somewhat alleviated, until the morning of April 1st, when he was found to have marked facial paralysis on the left side. The face was considerably distorted whenever he talked or laughed.

April 5th.—Eruption fading rapidly. Facial paralysis also improving. No lesion of sensation or motion in any other part of the body.

April 6th.—Facial paralysis almost gone. On the evening of this day, when spoken to in a loud voice, he heard what was said to him—the first indication of a returning sense of hearing.

April 10th.—Pain in the head entirely gone. Hearing somewhat further improved. Eruption stationary.

April 11th.—Patient hears now when addressed in a tone but little louder than ordinary conversation. But it has been noticed for several days, since he began to regain his hearing, that after conversing for a short time his hearing becomes blunted, perhaps from local congestion.

April 13th.—Hearing still further improved. Still complains of dizziness, and his gait is unsteady. Eruption disappearing.

April 14th.—Facial paralysis gone. Hears when conversed with in an ordinary tone.

April 21st.—Continued improvement. Still staggers in walking, and complains of noises in his ears. Eruption gone.

May 11th.—Patient continued to improve steadily, his gait becoming more natural, and his dizziness less and less, until to-day, when he was discharged at his own request, not perfectly relieved, but in pretty good condition.

This case is, I think, another hint at the truth of Voltolini's idea of a true inflammation of the membranous labyrinth, although it is not a pure case of this disease. It was, perhaps, one of effusion about the trunk of the auditory and facial nerves.

INFLAMMATION OF MEMBRANOUS LABYRINTH.

Inflammation of the membranous labyrinth, suppurative or exudative in character, is, as I have already said, a disease, which I unite with the author just alluded to, in believing may exist, and that it may be and is mistaken for cerebro-spinal meningitis. I would ask those who see a great deal of diseases of children, to accurately note the symptoms of doubtful cases of cerebro-spinal meningitis, and see if we may not have a primary inflammation of the labyrinth, as well as one of the membranes of the brain and the medulla oblongata. The symptoms of epidemic cerebro-spinal meningitis, as given by Clymer,* 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." Dr. Clymer's definition is so comprehensive and guarded that it would be difficult to say, that the symptoms of labyrinth disease as given by Voltolini, may not accord with those of cerebro-spinal meningitis. I am inclined to think that Dr. Clymer has made his definition very comprehensive, in order to take in the sporadic cases. Voltolini regards these as affections of the labyrinth. Voltolini says,† "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 sometimes 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 lays particular stress upon the absence of facial paralysis in these supposed cases of cerebro-spinal meningitis,

* Reprint from the American edition of Aitken's Science and Practice of Medicine, 1872.

† Monatsschrift für Ohrenheilkunde, Jahrgang I., No. 1.

and he asks 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. Dr. H. Knapp cannot agree with Voltolini in his idea of primary inflammation of the membranous labyrinth, and has discussed the subject quite fully in a "clinical analysis of inflammatory affections of the middle ear."* Knapp's argument against Voltolini's view is embraced in 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 ocular affection on the cerebro-spinal disease may be demonstrated?" Voltolini went too far in thinking that there was no such disease as cerebro-spinal meningitis, which causes deafness; but because so-called "spotted fever" does exist, and transmits disease to the auditory and optic nerves, this fact furnishes no evidence that primary affections of the nerve-trunks, or of their expansions, may not occur, just as we may have primary neuritis optica. But here, also, gaps in our knowledge are to be filled, a task that must be performed by the post-mortem examinations of the practitioners of the present or future.

Severe Headache and Vomiting—Partial Delirium—Deafness in a few days—No Paralysis—Recovery of all symptoms but Deafness.

Sally A., æt. 13, May 3, 1873. Three months ago this child was attacked with vomiting and pains in the head. She became only slightly delirious. There was no paralysis of any kind. The hearing was found to be impaired in a very few days, and she became deaf soon, and has remained so. She was taken sick on Saturday, and on Wednesday she heard as badly as now. She is now perfectly deaf, but concussions hurt her ears. She walks with difficulty, that is, the gait is staggering.

The practitioner will judge for himself as to how much inflammation of the spinal cord, or membranes of the brain, there is in such cases as the above.

* Archives of Ophthalmology and Otology, vol. ii., No. 1.

CONCUSSIONS.

Workmen employed in hammering large iron plates, such as are used in making the boilers of steam-engines, are very apt to lose much of their hearing power. I am informed by the superintendents and workmen of some such factories, that a large proportion of the men who have been long in the horrid din of a boiler shop, become deaf. So many of these cases were found, 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 me that the lesion causing the impairment of hearing and deafness, must be sought for in the labyrinth, and that is probably due to concussion of the fibres of the nerve in the cochlea and semicircular canals.

Concussions of the labyrinth, from cannonading, such as are sometimes experienced by soldiers, and sailors also, belong to this class of labyrinth affections. Deafness from such concussions, without an affection of the tympanic cavity, is very rare however.

QUININE.

There is no doubt but that large doses of quinine may cause temporary affections of the labyrinth, which are made known by tinnitus aurium and impairment of hearing. Yet I am inclined to think that such a congestion is not peculiar to the membranous labyrinth, but that it may also occur in the tympanic cavity and in the auditory canal, from the administration of quinine. 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, as is the case with most other persons in our country, have taken some 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 of such patients have never taken quinine enough to cause, or even to cure any disease. I have grown suspicious of quinine, however, in aural disease, in

any considerable doses; for I have been convinced by experience that it has a peculiar power of congesting the auditory apparatus. The case on page 155 is an evidence of this fact.

REMOTE CAUSES—SYPHILIS.

Among the remote causes of disease of the internal ear, syphilis is especially prominent. Yet it should not be forgotten that syphilitic affections of the middle ear, are more common than those of the labyrinth. It should also be remembered that the inflammations of the ear that may occur in the course of syphilis, have no pathognomonic symptoms. There are no marks by which we can distinguish them from other affections of the same nature, in which there is no syphilitic diathesis. It is only by other evidences of the existence of the poison in the system that we can be assured of the syphilitic nature of a given case of aural disease. Where, for example, in the course of constitutional syphilis, we have paralysis of the facial of the seventh pair of nerves and at the same time the hearing begins to be impaired, we have good reason to suspect—if the pharynx and Eustachian tubes do not show positive evidences of disease—that we have also an affection of the portio mollis of this pair. The tuning-fork will then aid us in making a differential diagnosis. It is probable, however, that the middle ear is usually also affected in the cases of impairment of hearing that occur in the course of syphilitic disease. The pathology of syphilitic aural disease is not exactly known; but we have good reason for believing that we may have periostitis of the labyrinth as well as gummata. Besides, we may have a lesion of the meatus auditorius internus, and of the nerve-trunk itself.

Mr. Hutchinson* is of the opinion that all of the cases which he inspected, of aural disease occurring in the course of inherited syphilis, are "due either to disease of the nerve itself or to some change in non-accessible parts of the auditory apparatus." I fear that Mr. Hutchinson has not attached enough importance to the throat symptoms in his cases, and

* A Clinical Memoir on certain Diseases of the Eye and Ear, consequent on Inherited Syphilis. London, 1863.

that thus he has been led to give diseases of the labyrinth an undue preponderance in aural affections resulting from syphilis. The fact that the Eustachian tubes are pervious, goes but a very little way to sustain the theory of labyrinth disease, and Mr. Hutchinson admits that his cases showed changes in the membrana tympani, but not "adequate" ones. The following case illustrates the difficulty of making a positive differential diagnosis between middle ear and labyrinth disease in the existence of a syphilitic diathesis:

Acute Pain in right side of Head along the course of the Seventh Nerve, followed by impairment of Hearing and Tinnitus Aurium—Gradual loss of Hearing more marked on the right side—Primary Syphilis one year since, followed by Mucous Patches and Erythema.

Mr. X., æt. 29, May 26, 1873, was sent to me for advice, by Dr. R. Hubbard, of Bridgeport, Conn. The following history was given by Dr. Hubbard and the patient: One year ago he had a chancre in the urethra, followed by mucous patches and erythema. He was treated by the use of mercury and iodide of potassium, and recovered very rapidly from those symptoms. About five weeks ago the patient was seized with a severe pain in the track of the facial nerve, with tinnitus aurium. The tinnitus was compared by the patient to the peep of a chicken, although this variety of noise was not the only one observed. There was no pain in the ear itself. The general health is excellent. The hearing had gradually diminished in the right ear since the pain and tinnitus occurred. The pain subsided in a short time; the tinnitus still continues. The hearing distance is—R., $\frac{\text{Pressed}}{4\ 8}$; L., $\frac{12}{48}$. The tuning-fork is heard more distinctly in the better ear. When the right ear is closed by the finger, however, the tuning-fork is heard better in that ear. The membranæ tympani of both sides are sunken, that of the left more so. The light spot is nearly obliterated on the right side. There is a small one on the left. Inflation of the ears by Politzer's method improves the hearing a very little on each side. The pharynx is secreting excessively.

I suppose this to be a case of sub-acute catarrh of the middle ear, with a secondary affection of the labyrinth. The affection of the facial may have occurred during its passage through the tympanic cavity, or possibly at its cerebral origin. The tuning-fork indicates that there is labyrinth disease, and yet the test is not positive, because when the right ear was closed, the sound of the fork was intensified on the side of the closed ear. The appearances of the drum-head, and of the pharynx, as well as the results from the employment of Polit-

zer's method, are, however, positive proofs that some catarrh of the middle ear exists. The patient is under treatment both constitutional and local.

Mr. Hutchinson speaks only of hereditary syphilis in his book, but there is the same tendency to catarrh of the pharynx and Eustachian tubes in inherited syphilis as in any other form.

The prognosis in disease of the labyrinth, occurring in the course of syphilis, is very unfavorable. I have never seen a case of recovery.

MENINGITIS—CEREBRO-SPINAL MENINGITIS.

Meningitis and cerebro-spinal meningitis lead to disease of the labyrinth by direct transition of the inflammatory action. Disease of the middle ear also results from those affections, and I have seen many cases where the two parts of the ear were simultaneously affected. The deafness is not usually observed until the patient is aroused from the stupor, when, if the labyrinth be affected, the deafness is profound. and there is apt to be unsteadiness of the gait. Knapp* speaks of some cases, however, where the deafness occurred during convalescence. This is a state of things that we sometimes see in labyrinth disease from scarlet fever, where, after a slight catarrhal inflammation of the middle ear the labyrinth becomes suddenly invaded, probably from the middle ear, and secondary, incurable disease of the internal ear occurs. Fortunately, in scarlet fever and in the other exanthemata, middle ear and not labyrinth disease, is the variety of aural affection usually found. In cerebro-spinal meningitis, however, the labyrinth is the part of the ear that usually is attacked; at least, even if the middle ear be diseased, the labyrinth is also. The nature of the lesion in deafness from cerebro-spinal meningitis, is not yet fully made out. Suppuration of the membranous labyrinth has been found in some of the very few post-mortem examinations that have been made.† It is probable that the seat of the lesion is to be found in the

* Medical Record, vol. vii., No. 15, p. 340.

† Knapp, Archives of Ophthalmology and Otology, vol. ii., No. 1, p. 47.

labyrinth proper, and not in the auditory nerve-trunk, for the facial nerve is seldom affected.

Von Tröltsch* says that a few post-mortem examinations show that the morbid changes causing deafness in cerebro-spinal meningitis, are sometimes found in the fourth ventricle. It is as yet an assumption to say that *suppuration* of the labyrinth is the usual lesion.

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. Griesenger 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. Van Tröltsch states that a constant sensation of knocking, in the back of the head, is also a suspicious symptom.

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† 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 intercranial tumor, or other adventitious product, unless the auditory nerve is actually involved or pressed upon.

Pathology.—In passing over the subject of the causes of

* Von Tröltsch, second American edition, p. 511.

† Royal London Ophthalmic Hospital Reports, vol. iv., part iv., p. 420.

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
Hemorrhage upon,	2
Thickened membranous labyrinth,	11
Atrophy of membranous labyrinth,	22
Congestion,	1
Suppuration of membranous labyrinth,	2
Serum in labyrinth,	3
Opaque fluid in labyrinth,	3
Black pigment cells too abundant,	1
Distension of blood-vessels of cochlea,	3
Black pigment very abundant,	4
Fluid, opaque,	4
Pus in cochlea,	1
Thickened lamina spiralis,	1
Osseous wall of semicircular canals incomplete,	3
Pus in canals,	1
Calcareous matter in canals,	1
Hemorrhage into canals,	1*
Hyperæmia of cochlea and semicircular canals,†	
Ecchymoses in vestibule and cochlea, seen by Politzer‡ accompanied by ecchymoses of the tympanic cavity and osseous tube,	
Hemorrhage into the whole labyrinth, after the action of the poisons of gout, typhus fever, scarlatina, measles, or mumps, observed by Toynbee,§	

* The above cases are taken from the tabulated index of Toynbee's catalogue. Many of them are secondary changes, but they show what may occur in the labyrinth.

† Voltolini, Virchow's Archiv, Bd. XVII.; Schwartze, Archiv für Ohrenheilkunde, Bd. I., p. 206. Schwartze's case was one of acute catarrh of the tympanic cavity after typhoid fever.

‡ Moos, Klinik der Ohrenkrankheiten, p. 311.

§ Diseases of the Ear, American reprint, p. 377.

Fibro-muscular tumor in the infundibulum of the cochlea was found by Voltolini,*	
Phosphate of lime on lining of the meatus auditorius internus, Boettcher,†	
Atrophy of membranous labyrinth,	16
Soft and swollen,	10
Fatty,	2
Endolymph opaque or red,	17
Labyrinth containing pus,	1
Labyrinth containing cholestearine,	1
Bony degeneration of saccule,	1
Thickened lamina spiralis,	1
Fibrous mass in cochlea,	1
Excess of pigment,	3
Extravasation of blood,	2
Bony deposit in meatus auditorius internus,	2
Atrophy of fibres of auditory nerve,	3‡

It must be observed that suppuration in the membranous labyrinth is, as yet, among the rarest of pathological changes that has been found in the internal ear, although it is assumed by some authorities that this is the lesion that usually results from cerebro-spinal meningitis.

Treatment.—Only general remarks can be made in reference to the treatment of disease of the labyrinth. Each case must be studied by itself, and treated according to the symptoms. If we have to deal with a case of true inflammation of the labyrinth, cold applications to the head and the use of quinine should be avoided, and our reliance must be on leeches and counter-irritation, pedeluvia and purgatives. Chronic affections of the labyrinth are, so far as my experience goes, utterly hopeless. The effusions in the labyrinths due to syphilis are less amenable to treatment than any other form of secondary venereal disease. Electricity has a much-vaunted reputation among inexact observers, for its cures of nerve-deafness; but there are no authentic cases on record of a cure of a true inflammatory affection of the labyrinth by this agent. The only seeming exception to this rule is a case reported by

* Moos, l. c., p. 316.

† Von Tröltsch, translation, p. 499.

‡ Hinton, Nervous Deafness, reprint from Guy's Hospital Reports, 1867.

Moos,* which he entitles "Recovery of Complete Nervous Deafness." The constant current was used successfully in what seems to me to have been a case of impairment of hearing occurring in the course of an hysterical affection. The patient had acute articular rheumatism, and in the fifth week hysterical symptoms appeared. There was great sensitiveness of the ear, such as occurs in other parts of the body in hysterical women, and increased hearing power. The patient lay for nine days without moving on the right side, and thus an ulcer of the concha was caused. She took large doses of quinine for these nine days, when impairment of hearing occurred, and continued to increase until the patient was communicated with in writing. In the eleventh week tetanic spasms occurred. The galvanic current was then employed, twelve elements being used. The symptoms, except the deafness, soon subsided, and a thorough course of galvanization of the ear restored the power of the right one perfectly, and of the left in all respects, except the inability to distinguish the highest note of the seven-octave piano.

I confess I do not feel the enthusiasm over this case which is exhibited by Professor Moos, which, according to his hopes, is to "toll the knell for all the opponents of the therapeutic value of electricity in aural disease." It has, to say the least, so strong an hysterical element, as to make it doubtful what pathological process was at the basis of the deafness, and yet it is an interesting and important case.

Beard and Rockwell† give their views as to the value of electricity in the treatment of diseases of the auditory nerve and labyrinth in the following cautious language: "Cases of nervous deafness, or of deafness resulting from various pathological conditions, with which a morbid condition of the auditory nerve is complicated, and all cases of tinnitus aurium, whatever may be their supposed pathology, should only be regarded as hopeless after the failure of persevering and varied treatment by electricity, although perfect or approximate cures will be obtained only in a small percentage of the cases. The treatment of opacity and thickening of the drum, and of

* Archives of Ophthalmology and Otology, Bd. I., No. 2.

† A Practical Treatise on Medical and Surgical Electricity, pp. 571–2.

chronic inflammation (with the consequent adhesions and other morbid changes) of the middle ear and Eustachian tube, offers a fair and important field for electrical experiment."

Dr. Knapp says:* "I have tried it (electricity) in nearly all reported cases, *but without a shade of improvement.*"

Dr. S. Sexton, of this city, Surgeon to the New York Ear Dispensary, writes me that he has experimented with electricity in aural disease for two years, both in private and public practice. He is convinced of the correctness of Brenner's formula; but in all his cases, Dr. Sexton says "there was no marked improvement in the hearing." "In a few cases of impaired hearing, where there were the accompanying symptoms of dizziness or nervous headache, the advantages of the treatment were decided."

My own experience has been purely negative. I have never seen any improvement, in any forms of nerve deafness, from the use of electricity in any form. I fear that 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.

OTALGIA.

The subject of otalgia belongs, strictly speaking, to the middle ear; but I have followed the custom of other text-books, and insert a brief notice of this affection at this point.

True otalgia may occur as a consequence of malarial poisoning, of syphilis, or of carious teeth. The chief point in the differential diagnosis is the absence of swelling or redness of the visible parts of the ear, and the non-impairment of the hearing. I do not remember to have seen but two cases. One of these seemed to have been the result of malaria; the other, of syphilis.† Dr. R. F. Weir, of this city, has seen two cases, the result of decayed teeth. The ear, especially the tympanic

* Archives of Ophthalmology and Otology, vol. ii., No. 1.

† The author would be very glad of opportunities to examine the labyrinth in fatal cases of cerebro-spinal meningitis. The petrous bones may be placed in Müller's fluid. R. Bichromate of potash, 2½ grammes; sulphate of soda, 1 gramme; distilled water, 100 grammes. M.

cavity, is so richly supplied with nerves, that it is surprising that so few cases of otalgia have been observed. Bonnafont* says that the disease rarely attacks both ears at once, but that it readily passes from one to the other, in consequence of the sympathy between the two sides of the fifth pair. There is apt, according to the same author, to be injection of the conjunctiva and lachrymation, in connection with otalgia.

The seat of otalgia may be, according to Bonnafont, in the auditory nerve, the chorda tympani, or the nerve supply of the tympanic cavity. Bonnafont advises instillation into the ear of a concentrated decoction of poppy-heads and cataplasms, or blisters on the auricle and mastoid process.

Gruber† reports a case of typical otalgia cured by the use of iodide of potassium. Quinine was tried, but proved of no service.

Gruber thinks it possible that there was an exudation pressing upon the nerve in this case. The symptoms were spasmodic contraction of the left side of the head, with pain in the ear occurring at irregular intervals; the longest intermissions were a few days. The hearing power was normal, and there were no pathological objective symptoms.

The following case, which I have as yet seen but once, is a fair representation of pure otalgia:

Otalgia of Right Side, probably from Syphilitic Exudation on the Seventh Nerve.

A. X., æt. 27. May 23, 1873.—This patient, who is a physician, says that he has suffered from more or less acute pain in the right ear and the mastoid process for three months. Within the last ten days it has been more severe. The hearing is not impaired. On examination the hearing distance is found to be normal, but the tuning-fork is heard better on the right side. The membrana tympani and mastoid process are in a normal condition. The pain seems to follow the course of the seventh nerve. The patient has had primary syphilis, and also some secondary symptoms. He has never had any malarial disease.

I supposed this to be a case of otalgia from exudation upon the seventh nerve in its course through the tympanic cavity, and advised the employment of anti-syphilitic treatment.

* Traité theoretique et pratique des Maladies de l'Oreille. Paris, 1873.

† Monatsschrift für Ohrenheilkunde, Jahrgang III., No. 9.

PART IV.

DEAF-MUTEISM AND HEARING TRUMPETS.

CHAPTER XX.

DEAF-MUTEISM—HEARING TRUMPETS.

DEAF-MUTEISM is caused by diseases of the middle and internal ears. 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.

I.—The acquired cases, or those in whom the disease of the ear has occurred after birth, from some traceable cause.

II.—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. Dr. George M. Beard and myself* 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 our examination was, that about sixty-one per cent. of these cases

* American Journal of the Medical Sciences, vol. liii., p. 401.

were probably congenital, and that the remaining thirty-nine per cent. were acquired. Wilde's statistics show that about fifty per cent. are of the acquired form. 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.

Wilde* says that children appear to be conscious of sounds during the third month, while at the fourth they show an appreciation of particular sounds, such as chirping, whistling and the like. He believes that from the fourth to the sixth month is perhaps the earliest period at which an opinion can be formed as to the hearing of an infant. 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 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 Wilde's proportion, in which he gives fifty per cent. as the proper one for acquired deaf-muteism, is too low a one. I am inclined to think that many more children become deaf after birth than those who are born so.

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. I have seen two or three cases of children who were being educated in deaf and dumb asylums, who could hear words spoken into their ears in a very loud tone. In one case the parents found it too much trouble, inasmuch as no physician could be found who would treat the suppurating ear, to teach

* Aural Surgery, English edition, p. 461.

their child to speak. He was consequently losing his speech, and also having his life placed in peril by the neglect of the ulcers in his ears.

Causes.—The causes of deaf-muteism are very graphically set down in the reports of deaf and dumb asylums, but unfortunately these assigned causes are usually incorrect. Thus, "colic," "a burn," "a fall," "fits," "mother marked,"* etc., figure in such tables as causes of deaf-muteism. Many of the so-called facts in such 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, etc., 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 disease, 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 myself, in only 22 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 tonsilitis. It is thus seen that the middle ear was usually the seat of the lesion that caused the deafness. Of the 114 acquired cases, the membrana tympani was perforated in twenty-nine 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 membrani tympani had once been perforated and had healed. In Blake's statistics,† forty per cent. of those examined, forty-one in number, were classed by him as acquired cases. In twelve of these acquired cases the membrana tympani was perforated or destroyed on one or both sides. In thirteen of the seventeen cases, the deafness was traceable to the pharyngitis of scarlet fever or measles.

* On the Etiology of Acquired Deaf-Muteism, by Clarence J. Blake. Reprint from Boston Medical and Surgical Journal.

† Reprint from Boston Medical and Surgical Journal.

The remote causes, or the causes that tend to produce disease of the ears in intra-uterine or infantile life, form a very interesting study, but we have as yet no very accurate data upon which to discuss them. It is an open question, perhaps, whether intermarriage tends to produce disease of the ear in young subjects or not, or 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. I was informed at Hartford, 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 that I saw, 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, etc.

Voltolini's inflammation of the membranous labyrinth is probably one of the proximate causes of acquired deaf-muteism. Von Tröltsch showed that a purulent process is a very common appearance in the tympanic cavities of half-starved foundlings. I suppose that the mal-nutrition of parents may be traced as remote causes for such affections of the middle ear. We may sum up the causes of deaf-muteism, as developed in clinical histories and in examinations on the dead subject, as follows:

1. Inflammation of the middle ear, resulting in suppuration, or adhesions, anchylosis of the ossicula auditus, etc.

2. Inflammation of the nerve or labyrinth, resulting in suppuration or thickening of the membranous labyrinth, deposits in it, etc.

3. Arrested development of some parts of the essential part of the auditory apparatus, for example, absence of the semicircular canals, or of the cochlea.

These are the causes which are shown in the table given by Moos,* in his account collected from various authorities, of

* Klinik der Ohrenkrankheiten, p. 341.

sections of the ears of sixty deaf-mutes, and they agree well with the clinical examinations and histories.

Treatment.—There is certainly no peculiar treatment necessary for the deafness of young children, which renders them mute, because they cannot learn to imitate speech; but I cannot refrain from alluding to the lingering remains of the barbarism of the past centuries, which neglects the care of the ulcerated membrana tympani, and the swollen 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 sadly neglected in the asylums and schools of our country. It was not until the seventh century that deaf-mutes were thought worthy of an education. The twentieth century will probably arrive before every school or asylum for these unfortunates has 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. I refer, of course, more particularly to the suppurative forms of disease.

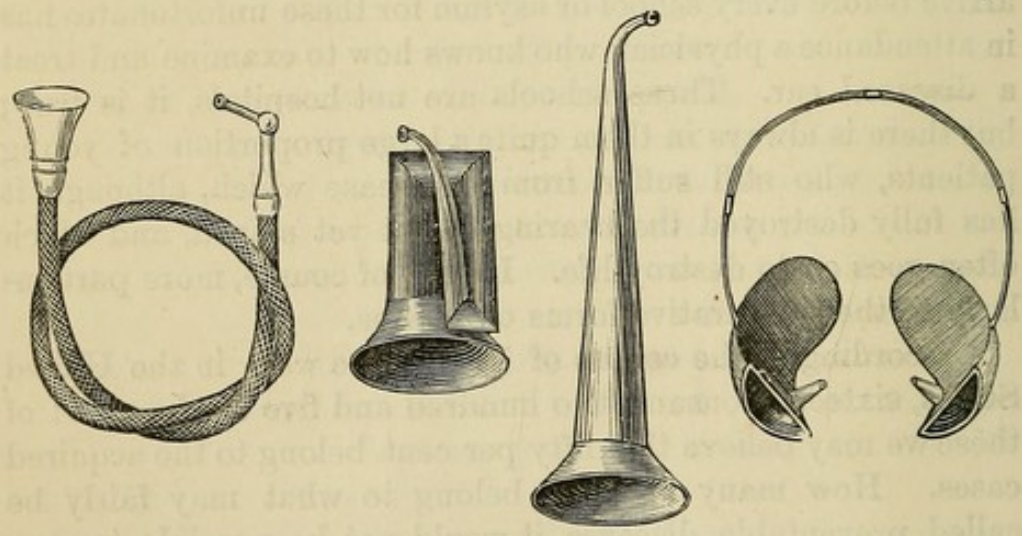
According to the census of 1870, there were in the United States, sixteen thousand two hundred and five deaf-mutes: of these we may believe that fifty per cent. belong to the acquired cases. How many of these belong to what may fairly be called preventable diseases, it would not be possible to say; but certain it is, that if diseases of the ear had always rejoiced in the same attentive treatment as many of the less essential parts of the body have received, the number of these unfortunate mutes would have been greatly lessened.

HEARING TRUMPETS.

We have not, as yet, been furnished with an apparatus for conducting the undulations of sound to the ear, which is at the same time efficient and unconspicuous. This is the great desideratum of most patients who are affected with incurable

impairment of hearing, for nearly all deaf persons would like to conceal their infirmity. It is possible that the development of the science of acoustics will yet furnish us with a sound lens, that will refract and focus rays of sound upon the drum-head and assist the hearing power; but in the very nature of things it is not likely that we shall ever have an apparatus so well adapted to the pathological changes in a diseased ear, as are convex lenses to the physiological process of thickening of the crystalline lens and rigidity of the ciliary muscle, which we term presbyopia. The physician can only therefore advise his patients to use one of the simple conductors of sound that are here delineated, as being all that science, as yet, offers to the hopelessly deaf.

FIG. 110.



Hearing Trumpets.

It will be seen that the first is a flexible speaking tube, which is very convenient for conversation, and is in fact called a conversation tube. The second and third figures represent the ordinary metallic trumpets which aid many persons with impaired hearing to hear addresses, sermons, and so forth. In many churches long flexible tubes run from beneath the pulpit to the seats of those whose hearing is impaired, and are used as is the conversation tube. I am very much in doubt as to the value of the so-called auricles, represented in the fourth figure. The most different accounts are given as to

their value as assistance to the hearing power. They are, of course, worn over the head and fit into the meatus.

The simpler apparatus are usually the best. It is sometimes of advantage to use little clamps which hold up the auricle, as deaf people do with their hands, in order to catch all the waves of sound. The small "*invisible*" tubes, placed in the auditory canal, are wholly useless. There is, in fact, no apparatus as yet invented that is better than the various forms of curved tubes.

DESCRIPTION OF THE CHROMO-LITHOGRAPHS.

FIG. 1.—Normal membrana tympani.

It is impossible to exactly render the normal tint of this beautiful structure, but this lithograph seems to me to approximate this to a very satisfactory degree.

FIG. 2.*—In this case, that of a man thirty-two years of age, a purulent inflammation of the middle ear had existed for nearly two years. There was a perforation in front of the malleus, which finally healed under the application of nitrate of silver, forming the cicatrix shown in the drawing, and also a small circular opening through the "pars flaccida"—the space within the opening, and around the malleus-incus articulation being filled with small granulations. After the closure of the lower perforation, these were treated by application of saturated solution of arg. nit., on a cotton-tipped probe, with good result. The outer layer of the membrana tympani, above and behind the processus brevis, was much thickened and congested, and this condition (as shown in the drawing) continued after the closure of the inferior perforation. This plate is of value, as exhibiting a comparatively rare form and position of perforation of the membrana tympani, and one not readily amenable to treatment.

FIG. 3 represents a small perforation, the consequence of purulent otitis media, occurring in a boy twelve years of age, and of one year's duration. There were no granulations at the time when the drawing was made, and the perforation was in process of healing, as is shown by the congested blood-vessels extending from the periphery towards the perforation. This drawing exhibits the want of clearness of the outline of the malleus, as the result of thickening of the outer layer of the membrana tympani, and also the prominence of the processus brevis and of the posterior fold, in consequence of the concavity of the membrana tympani. Through the perforation is seen the congested mucous membrane of the middle ear.

* The cases here described were treated by Drs. C. J. Blake and H. L. Shaw, of Boston.

FIG. 4.—A case of purulent otitis media, in a boy twelve years of age. This drawing represents faithfully the granulations occurring on the membrana tympani, and also the thickening of the membrana tympani, subsequent to the perforation, and during the continuance of the purulent inflammation. This case was convalescent at the time the drawing was made, under the application of astringents to the middle ear, and the granulations were rapidly diminishing under the application of arg. nit. In this drawing, also, is shown the peculiar arrangement of the blood-vessels passing from the superior wall of the meatus into the membrana tympani, to assist in forming the manubrial plexus, and which are congested in consequence of the diseased condition of the tympanum and membrana tympani.

FIG. 5 represents a case of chronic catarrhal inflammation of the middle ear, accompanied by great concavity of the membrana tympani. The processus brevis is very prominent, and both anterior and posterior folds of the membrana tympani are consequently elongated. The handle of the malleus is much foreshortened, and the lower end nearly in contact with the promontorium, as is shown by the lighter color of the membrana tympani at this point, the light rays being reflected directly from the white surface of the promontorium. The concavity of the membrana tympani is further evidenced by the character of the light reflection, which, instead of being a perfect cone, as represented in Fig. 1, is represented by two small points of light, one close to the end of the malleus, and one at the periphery; the intermediate space representing a surface of such degree of concavity that the light thrown upon it from the mirror is focussed at a point within the meatus.

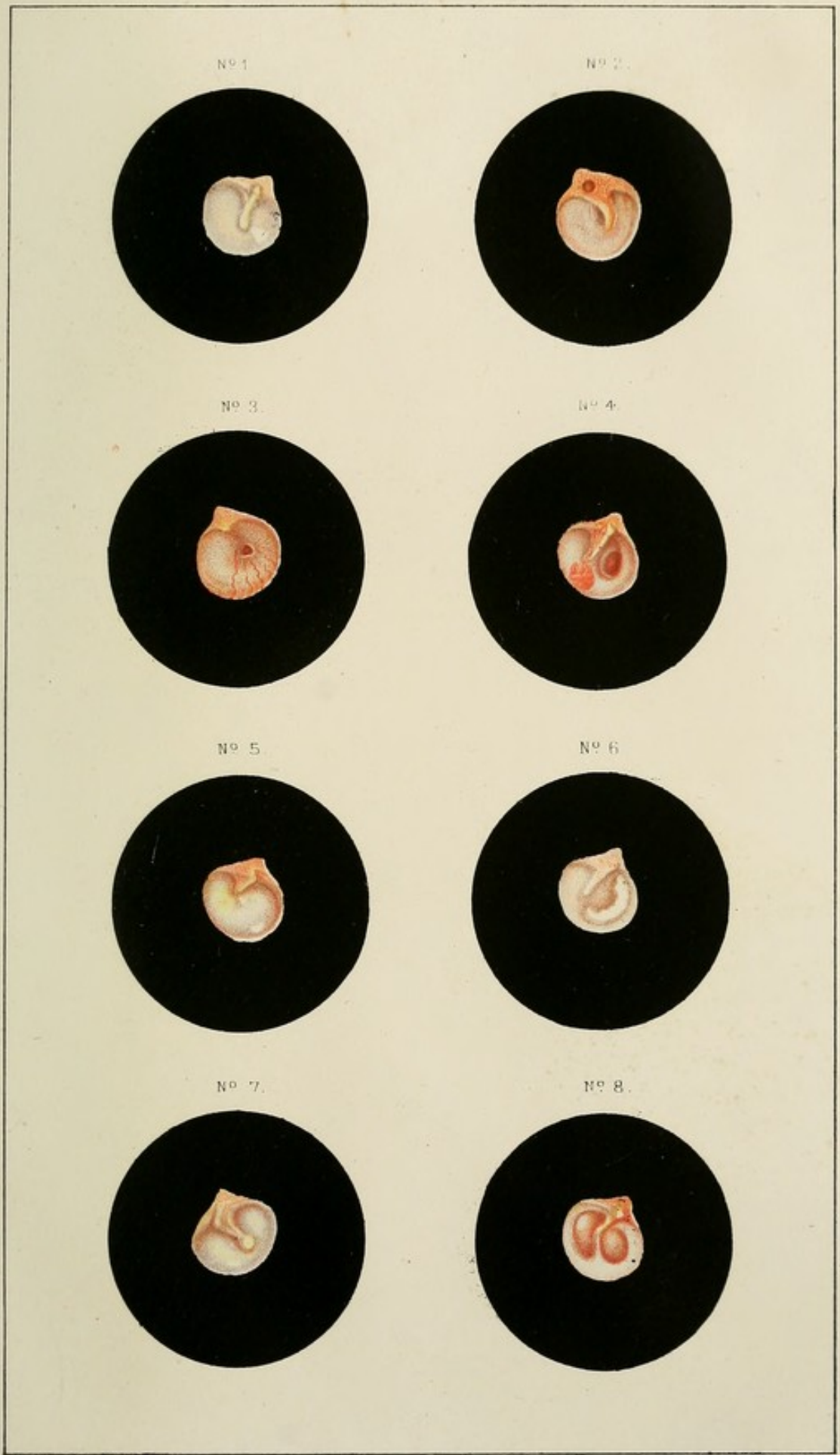
FIG. 6 is a type of cases of chronic catarrhal inflammation of the middle ear, of long standing, in which the mucous coat of the membrana tympani has become uniformly thickened, with but a slight degree of concavity of the membrana tympani; the latter condition in this case is principally evidenced by the prominence of the manubrium and processus brevis, and of the posterior fold. The same dull gray color is found, as a result of thickening of the mucous coat of the membrana tympani, following acute inflammation of the middle ear.

This drawing exhibits also the appearance characteristic of, and the form peculiar to, large calcareous deposits. The light reflex is wanting, in consequence of the presence of the calcareous deposit at the point at which this appearance is found in the normal membrana tympani.

FIG. 7 represents a condition common to chronic catarrhal inflammation of

the middle ear. In this case the malleus is in contact with the promontorium, and the continuance of the atmospheric pressure from without has carried the membrana tympani inwards, rendering the malleus exceedingly prominent. The light color of the central portion of the membrana tympani is due to the reflection of light from the inner wall of the tympanum, and not to thickening of the mucous coat. This condition is found where the trouble has been confined principally to the mucous membrane of the Eustachian tube and anterior portion of the tympanum, without the thickening of the inner coat of the membrana tympani, which is shown in Figs. 5 and 6.

FIG. 8 exhibits the result of purulent inflammation of the middle ear of long standing, in a boy ten years of age. At the time of the drawing the discharge had ceased, under treatment with dry cotton packing applied daily, and the mucous membrane was returning to a normal condition. There were two large perforations, divided by a narrow bridge of thickened membrana tympani. The short process of the malleus was very prominent, and the manubrium in contact with the promontory. The remainder of the membrana tympani was much thickened. The slight congestion about the short process, and along the manubrium, was due to the pressure of the cotton plug, as there was no evidence of a process of repair about the edges of the perforation.



DISEASES OF THE EAR.

D.R.ST.JOHN ROOSA.

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