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# THE DISEASES OF THE EAR

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# A PRACTICAL TREATISE

ON THE

# DISEASES OF THE EAR

INCLUDING

## *A SKETCH OF AURAL ANATOMY AND PHYSIOLOGY*

BY

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SEVENTH REVISED EDITION

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TO MY FRIEND

**Edward Talbot Ely, M.D.**

IN REMEMBRANCE OF OUR YEARS OF INTIMATE PROFESSIONAL AND SOCIAL RELATIONS, THIS BOOK IS AFFECTIONATELY DEDICATED

## PREFATORY NOTE TO THE SEVENTH EDITION.

In this edition, certain changes and additions have been made, which it is hoped will increase the value of the book. Such additions will be especially observed, in the discussion of the relation of diseases of the nose and throat to the ear, the value of operations upon the drum-head and ossicles, as well as in the history and practice of operations upon the mastoid. Minor changes have also been made in many parts of the book, and a new and more complete index has been made by Dr. Frank N. Lewis. The last edition was translated into German by Dr. Ludwig Weiss, and published in Berlin by August Hirschwald. The author sincerely hopes that his book may continue to find readers, not only among students of medicine, but among practitioners as well, for, although otology has made great strides in the last decade, it still lags behind many departments of our science and art, in the estimation and knowledge of the profession at large. Even among specialists, who are devoted to otology and fields not remote from it, a wider knowledge of what has been done for diseases of the ear, would sometimes be of service in lessening the quantity of literature upon well discussed themes. I therefore hope that this book may not be anywhere considered as an elementary work, suitable only for undergraduates in medicine. In many parts it consists rather of a series of monographs intended for specialists as well as for general practitioners.

New York, August 22, 1891.

# PREFACE TO THE SIXTH EDITION.

It is now eleven years since the first edition of this work was published. The manner in which it has been received by the profession of this country and of Great Britain and Ireland, has been a source of great gratification to me. I offer my hearty thanks to my brethren for having given my labors in otology such a kind appreciation. In revising this book, while perhaps no page has escaped alteration, and many pages have been added, pains have been taken to preserve the original plan. It was written for three classes of readers. First, it is intended to be a means by which advanced medical students may acquire a knowledge of the diseases and anatomy of the ear. Second, it is designed for general practitioners, to whom it may be a guide for the diagnosis and treatment of cases actually in hand. Third, I also hope, that professional men who interest themselves largely or exclusively in otology, may in the future as in the past, find in it something of interest and profit to them.

The larger part of the work is essentially a digest of my own experience in the treatment of diseases of the ear, now extending over more than twelve thousand cases for which I have had the personal responsibiiity. The nomenclature of this book has been accepted quite generally in the profession, and some of the views which were set forth for the first time in the first edition, have been recognized as true, and have taken their place in the great structure of human knowledge.

In this edition, it will be found that I have endeavored to

make deductions from my clinical experience in certain novel directions. Time will eventually establish the truth, or expose the incorrectness of the conclusions which I have drawn from my cases. If any of them are wrong, the facts at least will remain, I trust, a substantial contribution to a department of medicine to which I have given some of the best years of my life.

I wish to express my thanks to my valued friend, Dr. Charles E. Hackley, for his aid and advice in correcting the proofs, also to Dr. J. B. Emerson for the preparation of the index, and much other assistance.

Many of the anatomical illustrations were prepared expressly for this edition, and most of these are from the museum of my distinguished colleague, Professor William Darling. While engaged upon this work, Dr. John L. Vandervoort has extended to me great courtesy in his official position as Librarian of the New York Hospital. Many of the engravings of instruments were furnished me by Messrs. John Reynders & Co.

New York, November 1, 1884.

# PREFACE TO THE FIRST EDITION.

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.[1]

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 in-

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[1] "Arbores seret diligens agricola quarum adspiciet baccam ipse nunquam."

debted, 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 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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A TREATISE ON

# THE DISEASES OF THE EAR.

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## CHAPTER I.

### A SKETCH OF THE PROGRESS OF OTOLOGY WITH A BIBLIOGRAPHY.

Vastness of Otological Literature.—Apathy in regard to Diseases of the Ear.—Wilde the Reformer of the Science.—Carl Gustav Lincke and his Handbook.—Papyrus Ebers.—Hippocrates and his Knowledge of the Ear. Alcmæon the Discoverer of the Eustachian Tube.—Rufus of Ephesus.—Aristotle.—Discoveries in the Time of the Ptolemys.—Galen and the Want of Progress in his Time.—Achillini and Berengario describe the Ossicles.—Vesalius the most accurate Anatomist of his Day.—Ingrassia, Columbo, and Eustachius each claim Discovery of Stapes —Fallopius and his Career.—Anatomical Writings of Eustachius.—First Monograph on Anatomy of the Ear.—Constant Varolius.—Fabricius of Aquapendente.—Valsalva —Casserius, a Pupil and Rival of Fabricius.—Stenon describes Ceruminous Glands.—Discovery of Helicotrema.—Du Verney and his Plates —Cotugno and the Aqueducts.—Meckel —Rivinian Foramen.—Hyrtl and Bochdalek upon its Existence.—Ruysch. —Brendel and Zinn.—Scarpa upon the Internal Ear. —Saunders, Todd, and others. —Monro's Claim to have first traced the Nerves into the Cochlea, Vestibule, and Semicircular Canals.—Everard Home's Account of the Membrana Tympani.—Soemmering. —Shrapnell.—Thomas Buchanan on the Importance of Cerumen.—Wharton Jones.—Discoveries of Toynbee.—Tröltsch, Politzer, Lucæ, and others. —The Organ of Corti and its Discoverer.—Pathological Anatomy of the Ear.—Progress in Treatment of Aural Disease.—Herodotus on Specialists.—The Remedies suggested by Hippocrates.—Celsus.—Archigenes on Venesection and Foreign Bodies.—Galen on Noise.—Peculiar Method of removing Foreign Body from Ear. —Paulus Ægineta, his Classification and Operation.—Arabians, their Knowledge of Otology.—Paracelsus burning Books of his Predecessors —Capivacci on Differential Diagnosis —Ambroise Paré first uses a Syringe for the Ear.—The Education of Deaf Mutes.—Old Method of detecting Inspissated Cerumen.—Lusitanus on cutting off Ears of Thieves.—Fabricius of Hilden.—Thomas Willis, his Observations on Hearing in a Noise.—The Therapeutical Work of Valsalva.—Petit on Caries of the Mastoid.—The Discovery of the Eustachian Catheter.—Guyot, Cleland.—Perforation of the Membrana Tympani.—Trephining the Mastoid.—Sir Astley Cooper. —Saunders on Perforation of the Membrana Tympani.—First Infirmary for Dis-

eases of the Ear.—Saissy, Itard, Beck.—Sketch of Kramer's Career.—Discovery of Artificial Membrana Tympani.—Yearsley.—Wilde and his great Work in Otology.—The Text-books of Toynbee, Tröltsch, Erhard.—Modern Text-books and Journals.—Bibliography.

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.

Hundreds and perhaps thousands of volumes have been written on the anatomy, physiology, and diseases of the ear, 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 generally incorrect and superficial. Even after the investigations of the famous Italian, investigations which occupied 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, aural medicine and surgery is more generally regarded from the standpoint of the errorists of the dark ages, than is any other department of our science and art. It is to be feared, that even now, many wise and skilful practitioners 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,[1] 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 philoso-

[1] Aural Surgery, English edition, p. 7.

pher of Cos, until the seventeenth century, that I attempt an historical sketch of our progress up to our present position. I have neither the time nor the facilities for such a task ; but an endeavor will be made to sketch the history of otology, from the sources to which I have access, in such a manner as to show the obstacles which, until twenty years ago, have prevented the satisfactory progress of the science.

I must first of all, make especial acknowledgment of my indebtedness for a large part of my material, to that valuable compendium, "Lincke's Handbuch der Ohrenheilkunde."[1] 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.

For the convenience of the reader, I have given the titles of the works consulted, both at the foot of the page, and in the formal bibliography.

In the Astor Library in the city of New York, is a fac-simile copy of one of the oldest medical treatises that is known to exist. The original is a papyrus book in the Royal Saxon Library of Leipsic. It is called the "Papyrus Ebers," it having been obtained by the celebrated Egyptologist, George Ebers, while in Thebes, from a certain native, who is said to have taken it, about the year 1861, from among the bones of an Egyptian who had been buried more than thirty-four hundred years. This book is entitled "The Hermetic Book of the Medicines of the Ancient Egyptians."[2] It is written upon papyrus, three-fourths of a meter wide and twenty meters long. It is one of the six medical works named by Clement of Alexandria.

Among other subjects treated of in this large volume, is a monograph upon "medicines for ears hard of hearing," and "for ears from which there is a putrid discharge." Inasmuch as the translation of the hieroglyphic language of the manuscript only extends, as yet, to the table of contents, we cannot know whether the Egyptian priests had a better knowledge of the proper treatment of the ear, than was possessed by their Greek and Roman successors many centuries later.

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[1] Carl Gustav Lincke was a teacher of otology in the University of Leipsic from Easter, 1837, to Easter, 1840. His name appears in the catalogue of that University in the sessions of 1845–46 for the last time.

[2] Papyrus Ebers. Das Hermetische Buch über die Arzneimittel der alten Aegypten. Leipzig, 1875.

A papyrus of later date is in the Berlin Museum. This has been translated by Dr. G. Brugsh,[1] and there are also similar manuscripts in the museums in Leyden, London, and Turin.

## PROGRESS IN THE ANATOMY OF THE EAR.

Hippocrates probably knew very little of the anatomy of the ear, although one passage is found in his works which indicates that the membrana tympani was not unknown to him.[2]

Alcmæon, a disciple of Pythagoras (570–504 B.C.), is said to have had a knowledge of the art of dissecting the human body, to have known the construction of the ear, and to have anticipated Eustachius in the discovery of the passage leading from the tympanic cavity to the pharynx. Lincke thinks that this much cannot be conceded to Alcmæon, since it rests only upon his assertion, brought forth and denied by Aristotle, that goats breathed through their ears. This statement of Alcmæon is said to have rested upon other grounds than the existence of what we call the Eustachian tube. Plutarch says, however, that Empedocles discovered a snail-shaped cartilage in the ear (κοχλιώδης χονδρος), which he considered the real organ of hearing, and that the vibrations of the air caused it to give forth a tone which was then perceived by the soul.

The knowledge of Aristotle (384–322 B.C.) as to the anatomy of the ear did not go beyond the membrana tympani. But Aristotle made numerous dissections of animals and many important discoveries in anatomy. There are indications that he had an indefinite idea of the Eustachian tube.

In the time of the Ptolemys in Egypt, when dissections of the human body were instituted, Erasistratus made the discovery that the nerves originate in the brain, and he traced them so exactly to their origin that we find the acoustic nerve properly indicated in his representations.

Rufus of Ephesus (A.D. 98–117), who was the first medical lexicographer, and who lived in the age of Pliny,[3] used the names helix, lobe, tragus, and anti-tragus, which are still employed to describe the different parts of the auricle. He probably obtained them from Herophilus, a contemporary of Erasistratus.

Marinus, the preceptor of Galen, and whom Galen named

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[1] Hartmann : Lehrbuch, Einleitung.

[2] Τὸ δερμα τὸ πρὸς τῇ ακοῃ
πρὸς τῶ ὐστεω τω σκληρω λεπτὸν
ἐστιν ὥσ ερ αραχνιον. ξηροτα τον
τοῦ αλλου δερματος.

[3] History of Medicine (Dunglison), p. 166

the restorer of anatomy, called the acoustic and facial nerves one, under the name of the fifth pair.

Galen (A.D. 130–200) 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 and polemic 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. As 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.[1] 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 standstill.

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*, 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. He believed that the external auditory canal extended to the dura mater and touched the auditory nerve.

There is no record of the *ossicula auditus* until the fifteenth century. An Italian anatomist, Alexander Achillini, generally has the credit of discovering the little bones, but it is probable that he and Jacob Berengario first described them, although they did not discover them. This is the opinion of the great anatomist, Bartholomeo Eustachio. The discovery of the *ossicula auditus* did not at first include the third and last of the chain.

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 in the acoustic nerve or the meninges of the brain.

Andreas Vesalius (1514–1564), who is said to have been the most accurate anatomist of his day,[2] described the long process of the malleus, the Eustachian tube, the vestibule, and the semicircular canals. He was a reformer in anatomical learning, he

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[1] Chambers's Encyclopædia, American edition. Article, Galenus or Galen.

[2] Dunglison: History of Medicine.

boldly attacked the views of Galen, showing the errors in his teachings. His anatomical plates were made from drawings by the best masters. They were published in a folio edition at Basle in 1542.

The honor of the discovery of the stapes bone is claimed by no less than three anatomists, viz. : Ingrassia, Columbo, and the renowned Bartholomeus Eustachius (1604). The first named wrote commentaries upon Galen's works, that were published long after his death. He claims to have shown the bone to his scholars in 1546, at Naples. Fallopio, or Fallopius, at one time claimed to have had a part in the discovery of the ossicle, but in view of his own greater discoveries he finally relinquished his claim in favor of Ingrassia, after one of the latter's pupils had assured him, that Ingrassia had actually discovered and named the bone. The weight of evidence, in spite of the opinion of Eustachius, seems to lean toward the side of Ingrassia as having the honor of the discovery. Anatomical and geographical science were about this time in an embarrassed position from the claims of priority of their discoverers. Fallopius did good service, in the study of the anatomy of the ear, in describing the tympanic cavity more accurately, the two fenestræ, and their communication with the vestibule and the cochlea respectively.

The anatomical writings of Eustachius were published in 1563, before his death, but the *Tabulæ Anatomicæ* did not appear until 1714, a century and a half afterward. He was probably unable to publish these on account of his poverty. Of posthumous fame he has had a large share. His anatomical plates were reproduced with Dutch and German commentaries—in the latter language as late as 1800. The Venetian edition of his works is a beautiful specimen of printing. The part referring to the ear occupies only seventeen pages—yet his fame now rests chiefly upon his description of the Eustachian tube.[1]

Gabriel Fallopius (1523–1562), of Modena, died in the bloom of youth, at thirty-nine years of age,[2] 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 the facial nerve runs in its passage through the cavity of the tympanum—*acquæductus Fallopii.*[3]

The great Cuvier regarded Vesalius, Eustachius, and Fallo-

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[1] Bartholomæi Eustachii : Opuscula Anatomica Anatomica, MDLXIII.

[2] Chambers's Encyclopædia, p. 233.

[3] Gabrielis Falloppii : Opera Omnia. Francfurti, MDC.

pius as the three anatomists of the sixteenth century, to whom belongs the honor of having restored this science.

Bartholomeo Eustachio (1500–1574) described the tensor tympani as well as the stapedius muscle. He 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. He described the modiolus of the cochlea, and gave a good representation of the membranous zone. He also recognized the three portions of the facial nerve.

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

Constant Varolius (1543–1573),[1] 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.

Lincke does not think that the famous Fabricius of Aquapendente (1537–1619) 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.

The folio edition of his works, published in 1600,[2] contains a very systematic and clear account of the anatomy of the ear as then understood. He gives the name myrinx, as well as *myringa*—whence our myringitis—to the membrana tympani. Fabricius ascribes the discovery of the Eustachian tube to an earlier date than that which assigns it to Eustachius. According to him Aristotle knew of it.

Julius Casserius (1593–1609), 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 describe the two and a half turns of the cochlea and the membranous zone.

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[1] Biographie Médicale Paris

[2] Heronymi Fabricii ab Aquapendente. De Visione, Voce, Auditu. Venetiis, 1600.

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

Lincke ascribes to Du Verney the greatest reputation of any of the anatomists of the seventeenth century who devoted any attention to the ear. He threw new light upon many dark subjects. He was the first to give good representations of the ceruminous glands, the Eustachian tubes, and the semicircular canals with their five openings in the vestibule.[1] His plates are particularly clear.

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.[2] 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 opens 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 semi-circular canals.

Morgagni (1682–1771), himself an original investigator, the founder of pathological anatomy, 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. Valsalva had a rival, whose name the lapse of time has well nigh effaced, Raymond Vieussens (1714), 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.

Rivinus (1717), professor in Leipsic, observed an opening in the membrana tympani, which he believed to be a constant anatomical condition. This supposed discovery excited the warm-

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[1] Tractatus de Organo Auditus. par Dr. du Verney. Norembergæ, 1684.

[2] Tractatus de Aure Humana. Lugdunum Batavorum, 1742. Also, the same. Trajecti ad Rhenum, 1717.

est discussion among such anatomists as Walther, Ruysch, Morgagni, Cassebohm, and Valsalva. Hyrtl, until recently the distinguished anatomical teacher of Vienna, thought that it was a rent in a macerated membrane ; but his predecessor, Berres, believed in its existence and described it minutely.[1]

Professor Bochdalek, of Prague, has revived the question,[2] 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,[3] Professors von Patruban, Gruber, and Politzer unite in affirming its existence, thus confirming Bochdalek's statement.

The famous Ruysch (1718) (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.

Cassebohm (1730) (Joan. Frid.) published a monograph upon the ear, in six parts, which Lincke calls "a monument to German industry and German spirit of inquiry." "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.

Brendel and Zinn (1747–1753), 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.

Brendel discovered the opening uniting the two scalæ, the helicotrema of Breschet. Zinn describes the opening through which the auditory nerve enters the cochlea.

It is claimed, in an inaugural thesis published in Erlangen in 1754, that Casimir Christopher Schmiedel, discovered the so-called Jacobson's nerve.

Dominic Cotugno (1761), the discoverer of the fluid 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 sound. He described two canals, one opening in the vesti-

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[1] Prager Viertel. Jahrschrift, 1866, I.

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

[3] Monatsschrift für Ohrenheilkunde, Jahrgang III., No. I.

bule, the other in the cochlea, and both communicating with the cerebral cavity. They were named in his honor.

Phil Friederich Meckel confirmed and corrected the observations of Cotugno by injections of quicksilver.

Antonio Scarpa (1747–1832), nearly thirty years after the publication of Cotugno's writings, 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. His beautiful copper-plate representations of the ossicles *in situ*, are somewhat diagrammatic, but they are almost as instructive as the accurate photographs of Rudinger of our own day. Those of the semi-circular canals remain in some respects unsurpassed.

Saunders, Van der Hoeven, Alex. Fischer, Teole, and David Todd (1806), also contributed essentially to complete our knowledge of the anatomy of the ear.

Alexander Monro[1] (1797), "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 semi-circular 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 semi-circular 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 and with greater minuteness than Scarpa, and he appears to have been correct in his comparative anatomy.

Sir Everard Home (1800) wrote an excellent, and, for its time, exact account of the membrana tympani in a paper for the Royal

[1] Three treatises on the Brain, the Eye, and the Ear. Edinburgh and London, 1797.

Society.[1] 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.

Samuel Thomas Soemmering (1806), a great name in anatomical science, contributed to otology by a series of plates of the anatomy of the ear,[2] which are almost as well worth study today as they were seventy years ago.

Henry Jones Shrapnell (1832) contributed a series of papers to the London *Medical Gazette*.[3] 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.

Thomas Buchanan (1832), 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."[4]

The distinguished English surgeon, T. Wharton Jones, Esq. (1836–39), 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.[5]

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, Arnold, Schlemn, Johannes Müller, Breschet, Bonnafont, and Toynbee (1824–51).

Huschke, and especially Breschet, examined the labyrinth more thoroughly. Breschet called attention to much that was incorrect in anatomical nomenclature. Bock, Jacobson, Arnold, Schlemn, and Müller greatly increased our knowledge of the different nerve-tracts. The anatomical and physiological textbooks of Breschet, J. F. Meckel, Weber, Cloquet, and others, added much to the common stock of anatomical knowledge.

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[1] Philosophical Transactions, 1800. The Croonian Lecture.

[2] Samuelis Thomæ Soemmering : Icones Organi Auditus Humani. Francofurti ad Mœnum, 1806.

[3] Vol. x., 1832.

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

[5] Cyclopædia of Anatomy and Physiology. Edited by Robert B. Todd.

These authors grouped and assimilated facts that the centuries had produced, and added not a few, as the result of their own labors.[1]

Toynbee[2] (1851) 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 that it had obtained in anatomy, by the labors we have enumerated.

Toynbee's statements, that the Eustachian tube was usually a closed canal, that muscular action was required to open it, and that swallowing was a simple way of effecting this, 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.

Von Tröltsch (1856) 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 described two peculiar constant formations on the inner side of the membrana tympani, (pockets) which had only been mentioned by Arnold, as folds of mucous membrane. In the course of some investigations of the cavity of the tympanum of the fœtus, he also 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.

Gerlach[3] (1858) followed Toynbee in the investigation of the fibrous layer of the membrana tympani, and showed that in the extreme periphery the circular fibres were wanting.

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

Politzer and Lucæ (1862) published the results of experiments, which were supplementary to those of Müller, 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. Politzer also made valuable experiments upon intra-auricular pressure, proving that in the Valsalvian method of inflating

[1] Lincke: Band I., p. 27. [2] Diseases of the Ear. English edition.
[3] Schwartze, Archiv für Ohrenheilkunde. Bd. I.

the ear, not only were the tympanic cavity and the membranes of the fenestræ of the labyrinth with the membrana tympani, placed under an abnormal pressure, but also the contents of the labyrinth—the labyrinthine fluid, the membranous labyrinth, and the termination of the acoustic nerve.

Lucæ[1] showed that a vibrating tuning-fork placed on the mastoid process set the membrana tympani and ossicula auditus in vibrations which could be represented.

Corti[2] (1851), an Italian anatomist, reviewed the work of his countrymen who studied the cochlea in preceding centuries, and divided the lamina spiralis membranacea into two different broad zones—an inner one, *Zona denticulata;* and an outer, *Zona pectinata.* He described a regular arrangement of pillars or rods like the strings of a miniature harp, parts now known as Corti's pillars, and for some time supposed to contain the termination of the acoustic nerve.

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

Hyrtl (1858), an anatomist of great industry and reputation, made an important discovery of the frequency of a thin and porous bony covering to the cavity of the tympanum, and thus explained how readily, in certain cases, an otitis may become a meningitis.

The pathological anatomy of the ear, which may be said to have been first accurately studied by Toynbee, has received large additions since his time at the hands of German, English, and American writers, among whom are Hinton, Ménière, Voltolini, Tröltsch and Schwartze. Many contributions upon pathological subjects have been made of late to the various otological journals. Moos and Steinbrugge, especially have begun to furnish accounts of the pathology of the cochlea, which are steps toward the clearing up of a dark chapter in aural pathology.

The chief advances in aural patholgy, since the above was written are in the investigation of mastoid abscesses and their relation to diseases of the brain. The connection between suppurations of the tympanum and of the mastoid, is beginning to be more clearly understood. The surgeon has become more anxious to secure free drainage from the tympanum, in order to prevent transferrence of the suppuration to the cerebrum, with its inevitably fatal results. Besides, he does not even hesitate to attack the brain substance itself when he has good reason to believe that pus has formed in it.

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[1] Virchow's Archiv. Bd. XXV., Hefte 3 und 4.

[2] A Manual of Histology. Stricker, p. 1054 (Translation).

PROGRESS IN AURAL THERAPEUTICS.—TEXT-BOOKS, DISPENSARIES, AND HOSPITALS.

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[1] says that there were specialists in Egypt, a particular 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 pains in the ear connected with high fever as a very dangerous disease, and he states that 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 a very simple application, which is often thought to be a suggestion of our own day; that is, the instillation of warm water. The great physician advises the water to be poured in 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 language, if we may believe that the following passage was not, as Lincke insinuates, interpolated:[2] "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,

[1] Herodotus, translated by Cary. Euterpe, p. 125.

[2] Lincke's Handbuch, Bd. II., p. 5.

and hold it before the ear, in order to 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."

Hippocrates laid considerable stress upon certain aural symptoms in constitutional disease. For example, he considered the presence of sweet ear-wax as a bad symptom, while that of the bitter was not. He noted that acute aural disease, sometimes led to a fatal result on the third day after its occurrence. This indicates his perfect appreciation of the serious character of such a form of disease. He says that deafness following a fever is sometimes cured by nasal hemorrhage or diarrhœa, and so forth.

Heraclides of Tarent, advises caustics made of verdigris, copper filings, and honey, for the removal of granulations arising from abscesses in the ear, and for hemorrhages from the ear, the juice of white horehound, quince, and gall-nuts mixed with vinegar. Galen quotes much from Apollonius in regard to remedies for various affections of the ear. A famous remedy for earache was burned opium and castoreum. Apollonius recommended the oil of bitter almonds for fleas and maggots in the ear. He removed foreign bodies by means of ear-spoons, little hooks, and probes, which were wound about with wool and dipped in turpentine. Hardened cerumen he softened with a solution of saltpetre in vinegar, and then cleaned the ear with lukewarm water or oil.

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 afterward added.

Aulus Cornelius Celsus (B.C 44–A.D. 19) 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 should strike with a hammer upon the table, in

order to dislodge the foreign body by the concussion. Celsus also recommends plastic operations for the restoration of lost or disfigured auricles, unless the subjects be unhealthy and cachectic.

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.

Galen (A.D. 130–201) recognized the importance of the ear, inasmuch as it lies so close to the head. Although his classifications of disease are very minute, we do not 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 remedies, 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 too 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 were usually extremely composite and correspondingly dangerous.

Galen makes some very sensible remarks about the various

kinds of sounds that are pleasant or otherwise to the ear. The soft and slow tones of the human voice, in his opinion, are much the pleasantest to the human ear. A rough and quick voice is distressing. Fine ears tolerate only a weak, soft voice, diseased ears, only a very gentle and weak tone, sometimes even absolute silence. If Galen had lived in the nineteenth century, and in New York with its uneven pavements, boiler shops, locomotive whistles, elevated railways, and Wagner music, he might have added largely to his category of sounds unpleasant to tired and morbid ears. Galen's classification was a subjective one; for example: 1, Otalgia; 2, hardness of hearing; 3, cophosis; 4, paracusis; 5, paracousmata, or hallucinations of hearing; but it was not without value.

For earache from a cold, he recommends the warming method by means of wolf's milk or pepper mixed with old oil. For "inflammatory earache" fatty or oily substances are recommended, the fat of geese and hens; and if the pain be very severe, a mixture of opium, musk, and the white of an egg, with or without the addition of castoreum, or a solution of opium in thickly cooked juice of fruit. All these substances were poured while warm into the ear.

Dioscorides and Plinius, recommend a host of remedies for aural disease. Among others, the latter advises the excrement of pigeons and the ashes of horses' dung.

Cælius 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.

About this time we read of the materia medica of Marcellus, who gives us a glimpse of the popular remedies of the day. Frog's 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 forth. We see a great deal in the ancient literature, concerning 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.

The famous surgeon and obstetrician, Paulus Ægineta (600 A.D.), 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.

Paulus Ægineta made a good classification of cases of closure of the external auditory canal: 1, congenital; 2, from ulceration; 3, superficial or deep. He gives sound advice as to the removal of aural polypi, divides deafness into congenital and acquired, and seems altogether to have been a man in advance of his time. His surgical writings are said to abound in novel and ingenious views. He suggested the operation of detachment of the auricle for the removal of foreign bodies situated in the tympanic cavity or deep in the external auditory canal. This operation was again advised by Tröltsch and was performed (1871) by the author of this volume, and by Orne Green (1881), and Buck (1882), and in spite of theoretical objections urged against it, has proved itself a practical operation in certain cases. Hippocrates, also, is said to have recommended this procedure.

Guido Guidi (1595) about this time, in his recapitulation of the works of Hippocrates, Celsus, Galen, Paul of Ægina, and others, gives the sensible advice to keep the ear uncovered, and the meatus unstopped, in order, as he says, that sound may enter it properly and the ear-wax run out freely. For congestion of the ear, he advises leeches placed in the nostrils.

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 earache in children, and he gives the important caution, that the milk must be that of a woman who is nursing a female infant, if it be a boy, who is affected.

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 ignorance 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 all the morbid material of the ear, by means of a tube placed in the meatus externus; 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.[1]

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

Johannes Arcularius (1560) 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 is 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.

Alexander Benedetti (1560) 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.

Gabriel Fallopius (1523–1562), professor of anatomy, surgery, and botany in Ferrara and Padua 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 was gravely repeated by some of his legitimate successors for more than three hundred 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.

The great revolutionist in medicine, Paracelsus (1490–1544), who began his lectures at Basle, by burning the books of his predecessors, and who afterward boasted of having read no books for ten years, seems to have paid very little attention to the treatment of diseases of the ear. Deafness he considered to be incurable, "for what nature had once taken away a physician could by no means restore." He had, however, like all the ancients, his remedy for worms in the ear, and one for each kind of worm.

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 which his successors, three hundred years after him, find true of a large proportion of cases. 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, such as a zither. 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.

In the seventeenth century, we hear of De Vigo (1600), body-surgeon to Pope Julius II., curing his Holiness of a very 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. De Vigo was opposed to the removal of foreign bodies by means of the detachment of the auricle, because this part was too sensitive for an operation, and *quia natura sagax raro vel nunquam deficit in orsis bonis operationibus.*

Peter Forest, who may 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 cure deafness with water that had been 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.

The great Frenchman, the father of modern surgery, Ambroise Paré (1510–1590), figures in otological history as the first one to employ a syringe for cleansing the ear. He also recommended artificial auricles of *papier maché* or leather.

It was in the latter half of the sixteenth century, that zeal for the education of deaf mutes first began to exhibit itself. It

is probable that the Greeks and Romans made no efforts in this direction, for they had decided that nothing reached the intellect except through the hearing, that there could be no intellectual process without hearing, and they had given over deaf mutes as they did idiots and insane people. Although isolated instances had been noted of instruction for the deaf mute—instances like that of the dumb youth taught by one of the early English bishops, St. John of Beverley—they were generally considered as supernatural occurrences. Rodolphus Agricola, of Gröningen, born in 1442, stated that he knew of a deaf mute who had been taught to write and note down his thoughts. Fifty years afterward this was denied, on the ground that no one could be instructed who could not be taught through the ear.

Jerome Cardan, who was born in Pavia in 1501, is said to be the man who showed that written characters and ideas may be connected together without the use of sounds. This fact, now universally accepted and assumed, was a new idea in the sixteenth century. Benedictine monks in Spain, first put Cardan's principles into practice, and from that country they gradually spread throughout the civilized world, until now in every nation the deaf mute, like his more fortunate fellows, has an opportunity for education. The reader has seen what a great debt the scientific world owes to Italy, and nowhere is this more apparent that in what was promulgated by Cardan.[1]

Caspar Tagliacottzi (1597), 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, that of a Benedictine monk, for which he had done this with success.

Although the aural speculum had been used a hundred years before, we find a certain Johann Hartman (1690), a disciple of Paracelsus, very unwilling to use it; for he advised 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

[1] Encyclopædia Britannica, Vol. VII. Article, Deaf and Dumb.

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 semen, which was generated in the head, 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.

Marcus Banze (1640) gives us the first idea of an artificial membrana tympani, by proposing to place a tube of ivory, the end of which is covered by a bit of pig's bladder, in the auditory canal, as a protection to the exposed ear, when the membrana tympani was lost by ulceration. He did not, however, propose this as an improvement to the hearing power.

The renowned surgeon, Fabricius of Hilden (1646), 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. This instrument consisted of a large tube which was introduced into the auditory canal down to the foreign body ; of a smaller tube with a toothed extremity placed inside of this, and in this again a trephine, which was turned in an opposite direction from the second tube containing the teeth. He also wrote of the removal of aural polypi.

In the latter half of the seventeenth century, Thomas Willis[1] 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. The most interesting one is 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. These observations will be found in full in the latter part of this book.

Du Verney (1683), known by his labors in the anatomy of the

[1] Opera Omnia Amsterædamia apud Henricum Wetsteiñum. Pars physiologica. Cap. xiv., p. 67.

ear, and his work on its diseases, 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 discharge 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 and fenestra rotunda, before it could get into the external auditory canal.

Du Verney modified the suggestion of Hippocrates 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.[1]

In the works upon the ear that appear in this century, we still continue to hear much of the presence of worms, or living larvæ—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 cause deafness only.

John Wallis, an Englishman, was perhaps the first to instruct a deaf-mute to speak—and he instructed him so that he spoke very well. The case was one of acquired deaf-muteism, the patient having lost his hearing at eight years of age ; but he became able to read the Bible aloud, and to converse with some fluency.

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[1] Diseases of the Ear. English translation, p. 488.

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 ear, 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 proved that there were 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 anchylosis 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.[1] He also showed that closure of the Eustachian tube is often a cause of impairment of hearing. This is certainly a refreshing catalogue after we have been wading through the disgusting empiricism of the centuries before.

He reports the case of a man who suffered from a nasal polypus, which gradually by its growth closed the pharyngeal orifice of the Eustachian tube, and caused deafness. He also relates the case of a man, who suddenly lost his hearing while suffering from a pharyngeal ulcer in the neighborhood of the tube, when a tent was placed in the ulcer, but who immediately regained it when the tent was removed. 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.

J. L. Petit (1774), 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 trepanned

[1] As I have elsewhere shown, this case was for a long time supposed to be one of perforation of the mastoid by a surgical operation. See chapter on the diseases of the mastoid.

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 means of treatment.[1]

We then come to the famous postmaster of Versailles, Guyot (1724), 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 relieved the impairment of hearing.

Beck[2] (1735), 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 even this is a very valuable means of treatment. I regret very much that I cannot find Guyot's original report to the French Academy, in any of our New York libraries.

Archibald Cleland (1741), an English army surgeon, advised injections of the Eustachian tube with warm water, by means of a syringe joined to a flexible silver tube introduced through the nose into the oval opening of the duct, at the posterior opening of the nares, toward the arch of the palate. A sheep's ureter was fastened to the silver tube, to the other end of which the syringe was fastened. His contemporaries seem to have paid little attention to his suggestions, for Van Swieten recommends catheterization of the tubes 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. Cleland also used probes of the same size of the catheter to explore the tube. He does not allude to Guyot's suggestions to the French Academy, but, unfortunately for poor human nature, this is by no means proof that he did not know of them. Certain it is, however, as Wilde states, that the English surgeon was the first one to introduce the catheter through the nose, the only proper way of performing the operation; and he says that Guyot never practised the operation

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

[2] Die Krankheiten des Gehoerorganes, 1827, p. 21.

which he recommended, and that it was on this ground rejected by the French Academy, as "he wanted the recommendation of facts to support and enforce it."

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.

Julian Busson (1748) 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.

Jonathan Wathan (1755), 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.

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. It is probable that the use of the Eustachian catheter fell into disrepute, because it was used in chronic cases in which the prognosis should have been pronounced bad or hopeless from the beginning. The want of success in such cases must have been disheartening. It contributed much to the opprobrium attached to the practice of aural surgery, which exists in our own day. The necessity for greater exactness in the diagnosis and course of disease, exists now as then. If we achieve it, otology will be on as sure a foundation as any part of our science and art.

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 that lukewarm milk, or a linseed-meal mixture, or the like, should be drawn into the nostrils a day before the instrument was introduced, so as to make the parts more pliable.

The operation of perforation or trephining the mastoid process also fell into great disrepute, because a Danish surgeon, Berger (1792), 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 patient 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 through the efforts of German and American surgeons.

Everard Home [1] (1800), 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 [2] 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 in value. 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 paracentesis 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 [3]: "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. The book is very deficient in its treatment of the Eustachian tube and middle ear. Thus early do we find, in spite of Cleland's and

[1] Philosophical Transactions, 1800.

[2] The Anatomy of the Human Ear, etc. Edited by Wm. Price, M.D., Philadelphia, 1827.

[3] Loc. cit., p. 59.

Wathan's teachings, the English prejudice against the use of the catheter, a prejudice which has only lately been overcome.

Saunders was the first to establish an infirmary for the treatment of diseases of the ear. It was also an eye infirmary, and was opened in March, 1805. At a later date it was limited to the treatment of the diseases of the eye. In 1816 John Harrison Curtis established the "Royal Dispensary for Diseases of the Ear," in London. The work of Curtis[1] adds nothing to our knowledge, being a feeble imitation of the book by Saunders.

J. A. Saissy (1819), 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.[2]

I. M. G. Itard (1821), Physician to the Royal Deaf and Dumb Institution in Paris, also publishes a treatise, which was translated into German,[3] 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.

Thomas Buchanan (1823), of Hull, published a work on the ear, which is highly spoken of by Sir William Wilde, especially as to his remarks upon catheterization of the Eustachian tube and puncturing the membrana tympani. He had, however, fallacious views with regard to the physiology and diseases of the external auditory canal.

Karl Joseph Beck (1827), of Freiburg, published a "Handbook of the Diseases of the Ear."[4] 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 that the names of English authors are very often misspelled.

Wilhelm Kramer (1833), of Berlin, an author who died in 1874 at a ripe old age, brought out a work which was animated by the true scientific spirit, and which greatly simplified the practice of otology. After this he published a number of volumes. He introduced a valvular-handled speculum, that was an improvement upon the very clumsy ones hitherto in use. He also gave us the air-press, by which air or vapors could be introduced through the Eustachian tube into the middle ear.

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[1] A Treatise on the Physiology and Diseases of the Ear, by John Harrison Curtis, Esq. Third edition. London, 1823.

[2] An Essay on the Diseases of the Internal Ear. Baltimore, 1829.

[3] Die Krankheiten des Ohres und des Gehörs.

[4] Die Krankheiten des Gehoerorganes. Heidelberg und Leipzig, 1827.

In discussing the practices of his predecessors, the intolerance of Kramer's spirit is seen—an intolerance which is painfully manifest in his later works.[1] 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,[2] which was essentially a review in a very unfriendly spirit of the labors of Toynbee, Wilde, 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, was overshadowed by his subsequent writings. In spite of what I am almost inclined to call common sense, he persisted 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 continued to use the handled bi-valved speculum, with sunlight as the only source of illumination, and on cloudy days sent away patients without examination up to his last days of practice; and because Toynbee made post-mortem examinations of many ears of persons whom he had not seen during life, Kramer rejected all pathological investigations, except experiments conducted upon a dead body or a glass model. He described 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 called Toynbee, in his work published in 1867,[3] and this after Toynbee had lost his life in experiments as to the effect of chloroform and hydrocyanic acid, "a wretched 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 accomplished anything for aural pathology and therapeutics in any other way than by the employment of *his* catheters, *his* bougies, and *his* valvular-handled speculum.

Yet Kramer did much for the advance of otological science. If he had possessed an unprejudiced and receptive spirit, he would have accomplished much more. The author well remembers him in his pleasant consulting room in Berlin, in 1862, disdainfully declining to use the simple method of examination just recommended by Tröltsch, but sending away his patients who

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[1] Ohrenheilkunde der Gegenwart, 1860. Berlin, 1861.

[2] Ohrenkrankheiten und Ohrenärtze in England and Deutschland.

[3] Handbuch der Ohrenheilkunde, p. 44. Berlin, 1867.

needed examinations on dark days, to wait until the sun should shine. He frequently visited England, and had quite a large consultation practice there. He unwittingly did much to deepen the general distrust of the treatment of aural disease.

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, acquired the reputation of a safe guide and leader in this part of the field of medicine.

Joseph Williams[1] (1839) obtained a gold medal from the University of Edinburgh for a monograph upon the anatomy, physiology, and pathology of the ear. It is an excellent compilation of the knowledge of his time, written in a pleasant style, apparently by a writer with very little or no experience of his own.

George Pilcher (1841) 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 auditory canal is full of warning interest. There is, however, very little of the author's own experience in the volume.[2]

The text-book of Wilhelm Rau[3] is written in an attractive style and scientific spirit, but unfortunately for its permanent hold upon the profession, it does not anticipate the real advance so soon to be made by Tröltsch in giving us a simple method of examining the drum-head, the stand-point for modern otology, just as much as Sims's speculum is for gynæcology, and it has a place among books written from the knowledge of the ancients.

The work of James Yearsley,[4] although having some unscientific characteristics, as its title would indicate, is a valuable book, especially for its sound doctrine with regard to the origin of most cases of impaired hearing in the mucous membrane lining the throat, nose, and ear, and for its account of the discovery of the artificial membrana tympani.

The profession has of late become more alive to the value of Yearsley's artificial drum-head, which, as is well known, is formed of cotton, by the papers of American, German, and English otologists, but nothing essentially new has been added to the original statements of its inventor. The history of the man-

[1] Treatise on the Ear. London: Churchill, 1840.

[2] Treatise on the Structure, Economy, and Diseases of the Ear. American edition, 1843.

[3] Lehrbuch der Ohrenheilkunde. Berlin, 1856.

[4] Deafness, Practically Illustrated. Sixth edition. London, 1863.

ner in which the value of an artificial membrana tympani was suggested to Yearsley is interesting.

In 1841 a gentleman from New York consulted Dr. Yearsley, in 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 upon the remains of the membrana tympani."[1]

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, by 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 means of treatment, and is in constant use by many of those who treat suppurations of the middle ear.[2] Of late years, the use of the artificial drumhead has assumed great importance in the minds of the laity, by its recommendation for all diseases of the ear, by interested advertisers, who describe it as a new invention, and sell it for a very large price.

The work of Dr. Frank,[3] already alluded to, will be found a valuable work of reference, although it lacks individuality. Hoffman'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.

The work of William R. Wilde[4] (1843), 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 Val-

[1] Loc. cit., p. 221.

[2] Frank, p. 293.

[3] Practische Anleitung zur Erkenntniss und Behandlung der Ohrenkrankheiten. Erlanger, 1845.

[4] Practical Observations on Aural Surgery. London, 1853.

salva. This work was founded on the observations of a careful observer, who had acquired fine habits of study as a skilful ophthalmologist. It was not, as the works of Lincke and Frank, a cyclopædia of what had been written on otology, nor did it contain 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 something different from any other part of the body, 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 —afterward 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 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 true nature of aural disease was inflammatory in a large proportion of cases. With this as a standpoint, he inaugurated a successful system of antiphlogistic treatment by means of incisions in tense tissue, local blood-letting, blisters, the administration of mercury, and so forth. This system, although modified and enlarged, still obtains with our wisest practitioners, and is an everlasting monument to the genius of its promulgator. He displaced the fanciful and theoretical notions of Kramer, which were having wide credence, to the great detriment of the scientific knowledge of the nature and treatment of diseases of the ear. He was the first author to place aural surgery upon a rational basis. Wilde deserves the title of the Father of Modern Otology.

Then came Toynbee's book [1] (1860), 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, however, materially improved Toynbee's treatise.

Dr. Anton von Tröltsch (1861), of Würzburg, published a monograph [2] upon the anatomy of the ear, in 1861, which he entitled

[1] The Diseases of the Ear: their Nature, Diagnosis, and Treatment. Reprint. Philadelphia, 1860. The same, with a supplement, by James Hinton, F.R.S. London, 1868.

[2] Die Anatomie des Ohres. Würzburg, 1861.

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. Tröltsch showed himself to be a disciple of Wilde and Toynbee. He built upon the foundations which the clinical skill of the Irish, and the pathological 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.

This work on the anatomy of the ear was soon followed by a text-book upon its diseases,[1] 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 favor, having passed through two editions, and it has given tone to all the otological literature and investigations of its day. Tröltsch improved and brought into general use the method of examination of the canal and drum-head first proposed by Dr. Hoffman, of Westphalia—which had been entirely forgotten by the profession—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 air into the middle ear, the so-called inflation. 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, of large experience in aural disease, 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 even adults, who have suffered but a short time from impairment of the hearing, from disease of the middle ear, are often wonderful.

Toynbee just missed making the discovery of this method of inflating the ear, in his physiological investigations as to the potency of the Eustachian tube, and especially when he proved that it was opened by the act of swallowing. Politzer evidently followed Toynbee's investigations very carefully, and with rare

[1] Die Krankheiten des Ohres.

wisdom availed himself of them to make an invaluable addition to our means of treating the ear.

The late Dr. Julius Erhard (1863) published a work upon the diseases of the ear,[1] which is a peculiar mixture of truth with error. Most of its theories are based upon imperfect observations and are misleading in the extreme. It has little or no practical value.

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. This monograph was the first serious study of the drum-head, and holds a high place in otological literature.

In October, 1867, the first number of the *Monatsschrift für 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. This journal is still continued, with the addition of a department devoted to diseases of the throat. 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.

Dr. S. Moos,[2] of Heidelberg, issued a practical treatise on aural disease in 1866, and Dr. Gruber,[3] 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 thirteen 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.

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[1] Klinische Otiatrie. Berlin.

[2] Klinik der Ohrenkrankheiten.

[3] Lehrbuch der Ohrenheilkunde.

No outline of what has been done in the last twenty years for otology would be complete without a reference to the writings of the late Professor Edward H. Clarke, of Harvard University. Dr. Clarke published a paper on perforations of the membrana tympani,[1] its causes and treatment, which was probably the best that had been written on this subject. It received a full recognition among foreign authorities. This article contains a very important sentence, quoted by Tröltsch in his textbook, 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 also published a monograph upon polypus 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. In 1879 these publications were separated, and the author of the present work became associated with Drs. Knapp and Moos in the publication of the journal devoted to otology.

In 1872, Dr. Laurence Turnbull issued a "Clinical Manual of the Diseases of the Ear." In 1873, the first edition of the present treatise on the ear was published. In the same year Mr. W. B. Dalby, of London, published a volume of lectures upon the ear, which is of permanent value. The work of Dr. A. D. Williams, of St. Louis, was also published in this year, and contains many original observations.

Dr. Weber Liel's[2] (1873) work upon the nature and curability of progressive impairment of hearing, is a monograph which has been subjected to close analysis and criticism on the one hand, and from which much has been borrowed on the other. It is an ingenious and interesting work, but, in the opinion of the author of this work, its theories have not been substantiated.

In Italian, the work of Dr. De Rossi[3] (1871) is written in the

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[1] American Journal of the Medical Sciences, January, 1858.

[2] Ueber das Wesen und die Heilbarkeit der häufigsten form progressiver Schwehörigkeit.

[3] Le Mallattie dell' Orecchio.

spirit of the modern German school, and forms a reliable guide to those reading that language.

One of the most valuable works that has ever been published upon diseases of the ear is the one entitled "The Questions of Aural Surgery," by the late James Hinton (1874). It is written in a purely scientific spirit, and is full of valuable facts and wise observations, while it suggests much for more thorough investigation. It was accompanied by an atlas of the membrana tympani, consisting of one hundred and fifty pictures of the drum-head in water-color. Literature must be searched very carefully to find a scientific work upon any subject so essentially honest and impartial as the volume entitled "Questions in Aural Surgery."

The lectures on aural catarrh, by the late Dr. Peter Allen (1870), are valuable in many points. The second edition passed through the press in 1874, during the author's last illness. The death of Dr. Allen was a loss to our profession of a hard-working and ingenious student in otology.

Mr. George P. Field (1876), the successor of Toynbee as Aural Surgeon to St. Mary's Hospital, published a small octavo upon the ear, which has some unique features, especially in the illustrations of the various forms of diseases of the membrana tympani, as seen through the speculum. The book contains many valuable cases, and is altogether a positive contribution to aural medicine and surgery, and has passed into the second edition.

Among the most valuable of the text-books on the ear of the present day is that of Dr. Charles H. Burnett (1877). The part upon anatomy and physiology is particularly well presented.

The monograph upon "Deafness, Giddiness, and Noises in the Head," by Dr. Edward Woakes (1879), of London, hardly assumes to be a text-book. Its peculiar views are chiefly those of Weber Liel of Berlin, and will be alluded to in certain discussions in this volume. The author is enthusiastic in the promulgation of his views of the causes of aural affections. His work has passed to a second edition, and he has adherents in this country.

The work of Dr. H. Macnaughton Jones (1881), of Cork, also lays great stress upon Weber Liel's views as to paretic deafness, and operations upon the tensor tympani, without, however, any claim like that made by Woakes, to have been coeval with the latter author in his views upon these subjects.

The work on the ear by Dr. Albert H. Buck (1880), of New York, contains a vast amount of valuable research in otology. The author's experience has been large, and every one interested in otology will find its pages very interesting and instructive.

Especially to be mentioned are the sketch of the physiology of the ear, the chapter upon the mastoid process, and the one upon fractures of the temporal bone.

Of text-books upon the ear in the French language there is very little to be said. Modern otology finds very little comfort in such works as those of Miot and Bonnafont, although the latter-named author has laid the profession under obligations by his contributions to the subject of exostosis.

Among the recent works in the German language are those of Urbantschitsch, of Vienna, Hartmann, of Berlin, and Politzer. The work of the first-named author is an elaborate cyclopædia, with scarcely a trace of personal coloring, dreary in the extreme, but valuable as a work of reference. Politzer's work upon the ear is worthy of the expectations raised by the renown of its author. It has been translated into excellent English by Dr. Patterson Cassells, of Edinburgh, and is accessible through an American publisher.

In 1879, *The American Journal of Otology*, a quarterly, was founded by Dr. Clarence J. Blake in conjunction with a number of eminent aural surgeons and physicists. The journal was established in order "to afford a medium for the publication of original communications on subjects coming within the scope of the two departments to which it was devoted," acoustics and aural surgery. This journal was ably conducted, but the publication ceased with the fourth volume in 1882.

There is also a French journal[1] devoted to diseases of the ear, in conjunction with those of the larynx, which furnishes many original articles as well as a fair digest of foreign literature.

The latest work on the ear that has appeared up to the time of the writing of this chapter, is that by Dr. Oren D. Pomeroy, long and favorably known to the profession as an original and industrious worker in otology. His volume contains the result of the author's large experience, with a compendium of that of others, written in a judicial spirit.

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

[1] Annales des Maladies de l'Oreille et du Larynx.

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 2,800 aural cases. In the Manhattan Eye and Ear Hospital, New York, 1,809 aural cases were examined in the last year; in the Ophthalmic and Aural Institute, 1,579; and in the Brooklyn Eye and Ear Hospital, 1,731. These facts indicate that due scientific attention is being at last given to the ear.

In New York City, there are five special hospitals for the treatment of aural diseases, in conjunction with diseases of the eye—a union which seems to find favor chiefly in the United States, Ireland, and Canada.

The marked distrust with which the profession at large regarded the theories of the nature and treatment of aural disease, did not begin to give way until the views of Wilde became generally known and accepted. It was not, however, until a simple and practical means of examining the auditory canal and membrana tympani had been suggested and accepted, that otology became an inviting field of professional labor.

The next step was to recognize the pharynx as the starting-point of the diseases of the middle ear, and to separate these from the less frequently occurring cases of diseases of the external ear. With this came a simple means of opening and treating the Eustachian tube and the tympanic cavity. If now, we can succeed as I believe we are about to succeed, in separating affections of the nerve from those of the middle ear, that is to say, diseases of the perceptive apparatus from those of the parts devoted to the conduction of sound, otology will take rank with ophthalmology for exactness in diagnosis and prognosis.

If any cause remain for looking askance at the claims of otology, it is to be found in the attitude of those otologists who, in a spirit quite out of keeping with true medical philosophy, devote too much of their energy to the explication of the causes and treatment of incurable aural diseases, and who lay too little stress upon recent affections and the hygienic knowledge which may prevent insidious and incurable diseases of the ear, and who reject all attempts at an exact diagnosis of affections of the labyrinth, declaring themselves agnostics, at a time when faith and works may bring to us a knowledge of what they declare to be beyond human ken.

In concluding this introductory chapter, I beg that the reader will bear in mind that I have 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 endeavored 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 those who are interested in this department of medicine.

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# CHAPTER II.

## THE EXAMINATION OF AURAL PATIENTS.

History.—Power of Hearing Conversation.—Test Sentences.—Tick of a Watch.—Tuning-fork.—Aërial and Bone Conduction.—Malingering.—Angular Forceps.—Specula.—Tröltsch's Otoscope.—Examination of Pharynx.—Rhinoscopy.—Use of Eustachian Catheter.—Politzer's Method and its so-called Modifications.—Bougies.—Valsalva's Method.

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 "earache," 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 hear-

ing 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 had any kind of 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 large granulations existed. These conditions of course accounted for the 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 power of hearing.

The tests of the hearing power usually employed are:

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

Many attempts have been made to produce an instrument that will so accurately test the hearing power as to supersede the imperfect tests that even all these three constitute. As yet success has not been attained. Politzer,[1] after admitting that the instruments as yet invented are useless for the precise estimation of the degree of impairment of hearing, describes his own acoumeter. In this instrument the tone is produced by the striking of a hammer upon a steel cylinder, which is connected by a screw with a perpendicular vulcanite column. I have tested it thoroughly, but I see no advantage in it over a watch, if the latter be carefully tested, so that the average distance at which it can be heard by persons with good hearing power is known.

The power of hearing conversation, perhaps tells the most about a person's practical hearing power, and yet it is difficult to test it. About the best test of the hearing power that we

[1] Text-book. English translation, p. 163.

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 and 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 noting 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.

Dr. A. H. Buck [1] has made an attempt to furnish test sentences so that all the members of any one group or class should be as nearly as possible equal in value in penetrating power. Examples of such equivalent test sentences are given by Dr. Buck, as follows :

1. Pour oil on the waters of Lake Erie.
2. All hail ! thou hero of fourteen wars.

Each of these sentences contains eight long vowel sounds and are equally free from non-resonant, consonant, or short vowel sounds.

Dr. Buck [2] has found, however, that the objections to these test sentences are practically insurmountable, and he does not think they can be made available to any extent ; yet in a rude way, I think we may make them of use. I come more and more to the use of this test of words spoken as near as may be in an ordinary tone, as being the one that conveys the best idea of the hearing power. On the other hand, I am more and more distrustful of the watch as a means of testing the hearing. This remark applies also to the acoumeter. I shall long remember the critical remark of a boy once under my care for impaired hearing, who after submitting for some time with patience to a test of his power of hearing a watch tick, finally exclaimed : "I don't care to hear the watch ; what I want to hear is what people say to me." Since this incident, I have endeavored to learn the capability of the patient to hear conversation under ordinary circumstances by a test of the hearing power, and when I wish to demonstrate an improvement, I induce a

[1] Report of the First International Otological Society. New York: Appleton, 1877.
[2] Treatise on the Ear, p. 18.

friend of the patient to converse with him, under conditions the same as those that existed before the improvement took place.

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 hearing power is sometimes tested by placing the watch where it can be certainly heard and then withdrawing it to the furthest limit at which its sound can be perceived. This is a fallacious test, for the sound once perceived, it is easy for a defective ear to follow it until it reaches a distance far beyond its normal range of hearing. The ear which is not being tested should be closed by the hand during the examination. It is not possible 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, many 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.

The discrepancy in the power of hearing the watch and ordinary conversation, as was shown by the author in a paper published in the *American Journal of the Medical Sciences*, is so marked as to render the tick of a watch almost useless for determining the hearer's power in many cases. Such cases as these, I have since learned, are invariably due to disease of the internal ear, in some of its parts, and not to an affection of the middle ear. This discrepancy is one of the means of differential diagnosis between affections of the middle and internal ear.

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.

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:[1] "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.; 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 the 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."

Dr. Prout's method is now universally employed. If a watch can be heard by a person with good hearing power at least 48 inches, and we wish to express the hearing power of a person who hears that watch one inch, we 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, $\frac{0}{48}$; if on the mastoid, $\frac{M}{48}$.

The objects to be gained by testing the hearing power are, of

[1] Boston Medical and Surgical Journal, February 29, 1872.

course, to learn when a patient is first seen how much his hearing power is impaired, and as he continues under treatment whether or not any improvement has taken place. If the watch alone be used for this purpose, there are many opportunities for error in opinion. For example, some patients, especially children, readily imagine they hear the ticking of a watch when they do not. Adults who are very much troubled by tinnitus aurium also fall into this kind of error. In testing one ear with the watch we should be careful to exclude the other, for sound readily passes through the bones of the head, or the air, or both, to the other ear. Especially is this the case when one ear is so much affected that it is only heard when pressed upon the mastoid process ($\frac{r}{48}$), or not at all ($\frac{o}{48}$). I think it is true that patients affected with certain forms of disease of the acoustic nerve, hear a watch relatively much worse than they do conversation.

*Table showing the Disproportion between the Power of Hearing the Tick of a Watch and the Human Voice.*[1]

| No. | Sex and age. | Hearing distance for the watch. | Hearing distance for conversation, the patient being with the back to the speaker. |
|---|---|---|---|
| 1 | Female, 17. | R. $\frac{laid}{40}$, L. $\frac{0}{40}$. | Words spoken loudly at 10 feet with difficulty. |
| | | R. $\frac{4}{40}$, L. $\frac{0}{40}$. | Loud conversation at 20 feet. |
| 2 | Male, 45. | R. $\frac{0}{40}$, L. $\frac{8}{40}$. | Voice at 30 feet; cannot tell the direction from which sound comes. |
| 3 | Female, 28. | R. $\frac{7}{40}$, L. $\frac{4}{40}$. | Conversation at 20 feet. |
| 4 | Male, 56. | R. laid, L. laid. | Conversation at 20 feet. |
| 5 | Male, 62. | R. pressed, L. pressed. | Loud conversation at 20 feet. |
| 6 | Female, 23. | R. $\frac{5}{40}$, L. $\frac{3}{40}$. | Loud conversation at 6 feet. |
| 7 | Male, 9½. | R. $\frac{1}{40}$, L. $\frac{3}{40}$. | Loud conversation at 30 feet. |
| 8 | Male, 16. | R. $\frac{laid}{40}$, L. $\frac{laid}{40}$. | Conversation at 20 feet. |
| 9 | Male, 18. | R. $\frac{40}{40}$, L. $\frac{30}{40}$. | Conversation at 12 feet. |
| | | R. $\frac{40}{40}$, L. $\frac{40}{40}$. | Conversation at 30 feet. |
| 10 | Female, 15. | R. $\frac{4}{40}$, L. $\frac{8}{40}$. | Conversation at 20 feet. |
| 11 | Male, 19. | R. $\frac{5}{40}$, L. $\frac{10}{40}$. | Conversation at 20 feet. |
| 12 | Female, 29. | R. $\frac{laid}{40}$, L. $\frac{laid}{40}$. | Conversation at 20 feet. |
| 13 | Male, 40. | H. D. R. $\frac{1}{40}$, L. $\frac{laid}{40}$. | Ordinary conversation with great ease at 30 feet. |
| 14 | Female, 25. | R. $\frac{12}{40}$, L. $\frac{6}{40}$. | Ordinary conversation with difficulty at 20 feet. |
| 15 | Male, 32. | R. $\frac{0}{40}$, L. $\frac{1}{40}$. | Conversation at 16 feet. |
| 16 | Male, 15. | R. $\frac{6}{40}$, L. mastoid. | Conversation at 20 feet. |
| 17 | Male, 41. | R. $\frac{8}{40}$, L. $\frac{0}{40}$. | Conversation with ease at 40 feet. |

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

*Table showing the Disproportion between the Power of Hearing the Tick of a Watch and the Human Voice.*—(Continued.)

| No. | Sex and age. | Hearing distance for the watch. | Hearing distance for conversation, the patient being with the back to the speaker. |
|---|---|---|---|
| 18 | Male, 45. | R. $\frac{4}{40}$, L. $\frac{\text{pressed}}{40}$. | Conversation at 40 feet. |
| 19 | Male, 54. | R. $\frac{4}{40}$, L. $\frac{\text{pressed}}{40}$. | Loud conversation at 45 feet. |
| 20 | Male, 70. | R. $\frac{\text{pressed}}{40}$, L. $\frac{\text{laid}}{40}$. | Conversation at 30 feet. |
| 21 | Female, 16. | R. $\frac{3}{40}$, L. $\frac{1}{40}$. | Voice with difficulty at 10 feet. |
| 22 | Male, 80. | R. $\frac{2}{40}$, L. $\frac{\text{laid}}{40}$. | Conversation at 40 feet. |
| 23 | Male, 32. | R. $\frac{0}{40}$, L. $\frac{6}{40}$. | Conversation at 30 feet. |
| 24 | Male, 36. | R. $\frac{\text{contact}}{40}$, L. $\frac{\text{mastoid}}{40}$. | Ordinary conversation at 18 feet. |
| 25 | Female, 24. | R. $\frac{3}{40}$, L. $\frac{4}{40}$. | Conversation at 10 feet. |
| 26 | Male, 74. | R. $\frac{\text{laid}}{40}$, L. $\frac{1}{40}$. | Conversation at 50 feet. |
| 27 | Female, 15. | R. $\frac{2}{40}$, L. $\frac{4}{40}$. | Ordinary conversation at 40 feet. |
| 28 | Male, 71. | R. $\frac{1}{40}$, L. $\frac{\text{pressed}}{40}$. | Conversation at 20 feet. |
| 29 | Male, 44. | R. $\frac{1}{40}$, L. $\frac{1}{40}$. | Conversation at 30 feet. |
| 30 | Female, 22. | R. $\frac{1}{40}$, L. $\frac{3}{40}$. | Conversation at 26 feet. |
| | | After removal of cerumen and inflation. | Conversation at 30 feet. |
| 31 | Male, 38. | R. $\frac{1}{4}$, L. pressed. | Conversation at 20 feet. |
| 32 | Male, 13. | R. $\frac{3}{40}$, L. $\frac{7}{40}$. | Conversation at 30 feet. |
| 33 | Male, 21. | R. $\frac{1}{40}$, L. $\frac{\text{pressed}}{40}$. | Loud conversation at 8 feet. |
| 34 | Male, 33. | R. $\frac{\text{laid}}{40}$, L. $\frac{1}{40}$. | Conversation at 50 feet; general conversation with ease; does not hear high notes well. |
| 35 | Female, 17. | R. $\frac{3}{30}$, L. $\frac{5}{40}$. | Conversation with some difficulty at 30 feet. |
| 36 | Female, 34. | R. $\frac{\text{pressed}}{40}$, L. $\frac{\text{laid}}{40}$. | Loud conversation at 6 feet. |
| 37 | Female, 37. | R. $\frac{1}{40}$, L. $\frac{\text{laid}}{40}$. | Distinct voice at 2 feet. |
| 38 | Female, 36. | R. $\frac{\text{laid}}{40}$, L. $\frac{\text{laid}}{40}$. | Voice at 34 feet after use of artificial membranæ tympanorum. |
| | | After use of artificial membranes, R. $\frac{3}{40}$, L. $\frac{\text{laid}}{40}$. | |

The *tick* of a watch is produced by the striking of a little hammer upon the apex or side of the tooth of a ratchet-wheel. It is therefore a simple unvarying tone, modified as to quality in different watches. Now the sounds produced by the vocal cords, reinforced by the resonating cavities of the nose and mouth, may pass through a range of musical notes, which, as in the case of the late Madame Parepa Rosa, may compass three full octaves. A mere regular sound, such as that of the watch, is certainly in no sense to be compared to the musical tones of that wonderful instrument the human larynx. If, however, the power of hearing the watch tick stood in any definite and fixed relation to the ability to hear ordinary conversation, it would serve very well as a test for registration. If, for example, we

were able to say that a person who has a hearing distance by the watch of $\frac{3}{40}$, has a degree of hearing sufficient for the duties of life, that it is as adequate as $\frac{3}{30}$ as tested by Snellen's test-types is for seeing, the statement would give us a definite idea of just how much the hearing power is impaired. But a reference to the table shows that the power of hearing the tick of a watch stands in no exact proportion to the power of hearing conversation. On the other hand, the test by the voice is also inadequate. When a person is waiting to hear a voice in a quiet room, his ability to hear this, when compared with what is demanded of an ear, is utterly inadequate as a test. As is well known, a healthy ear can appreciate from seven to eleven octaves. Probably the life we lead in large cities and towns requires such a power if we are to hear all that is demanded of us. How then can the tones of the larynx, capable at its greatest of reaching three octaves, form a sufficient test ?

Again, as will be shown in a subsequent chapter, a whole class of persons suffering from disease of the ears hear better in a noise, while another class hear best in quiet places. All these things must be taken into consideration in testing the hearing power or erroneous conclusions will often be reached. Unreliable as are the statements of patients as regards the history of their cases, their testimony as to their improvement or non-improvement is always of value in determining the true state of the hearing power, and better still are the statements of their relatives or friends, who, no matter how great their affection, are always annoyed by being obliged to make an effort to make them hear. They, at least, will gladly hail and note any greater ability to hear on the part of a person with whom they have been in the habit of conversing.

## THE TUNING-FORK.

The value of the tuning-fork in testing the hearing power is chiefly in the way of determining whether a given disease be in the middle or internal ear. Von Conta,[1] of Weimar, recommended it some years since, however, as a means of testing the hearing power. In his method, the vibrations from the tuning-fork are conducted to the ear through an elastic tube. The number of seconds during which the gradually decreasing vibrations are heard becomes the measure of the hearing power. This method never found any great favor, and so far as I know is not often employed.

[1] Archiv. für Ohrenheilkunde, Bd. I., p. 108.

Since then, however, the tuning-fork has been and continues to be widely employed in various ways for the purpose of differential diagnosis. I believe we now have in it, by a very simple method, a valuable aid to a knowledge of the situation of a given lesion. I shall, however, before describing the method I now employ to the exclusion of all others in the test with the tuning-fork, first give an account of the history of its use in aural diagnosis, with a statement of the methods in which it is generally used.

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 a tuning-fork placed upon the bones of the head 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, from a primary lesion, or secondarily, by disease which has extended from the middle 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 perhaps 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 in this manner that cannot be fully avoided. Patients who do not possess 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.

The following case illustrates the old method of using the tuning-fork as a means of diagnosis, and also the inadequacy of the watch as a test of hearing:

Dr. W——, aged thirty-three, consulted me 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 $\frac{4}{4}^{8}$, 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.

As has been previously intimated, I no longer employ the tuning-fork in this manner for the purpose of making a diagnosis, but I rely upon the statements of the patient as to whether the tuning-fork is heard more distinctly and for a longer time when its vibrations are conducted through the air or through the bones of the head. It is much easier for any person to determine whether he hears a tuning-fork when held in front of the ear better or worse than he does when it is placed on the mastoid process, than it is for him to say on which side of the head he hears it better. It is consequently a step toward an objective test, if not one itself, if the distinction which we ask the patient to make is one so easily made that even an ignorant person can make it. It is, I believe, perfectly easy for even a stupid person to determine which of two sounds is the louder if there be any appreciable difference between them. This is the whole problem to be solved in determining the difference between conduction by air and by bone. This subject will be more fully discussed in the chapter devoted to diseases of the in-

ternal ear. Here it will be sufficient to indicate the method of testing.

A tuning-fork "$C^2$" (according to Helmholtz $C^2=528$ vibrations) is heard better by persons with normal hearing when held while vibrating in front of the entrance to the external auditory canal—that is, it is heard louder. It is also heard longer. This is also true of other forks, but for the sake of clearness the remarks here made are confined to the $C^2$ tuning-fork. At my request, Dr. J. B. Emerson, Surgeon to the Manhattan Eye and Ear Hospital, undertook some experiments, which show these statements to be correct.[1]

Starting from such observations upon healthy ear, we find that in disease of the external or middle ear the intensity with which the tuning-fork is heard through the bones is increased. In other words, the natural relations between conduction through the air and through the bones is disturbed. The bone conduction is better than the aërial. It has also been ascertained by many

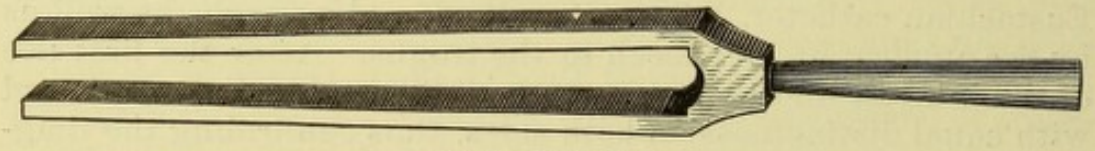

FIG. 1.—Tuning-fork.

examinations that the diagnosis of disease of the middle or external ear may always be made when the bone conduction is increased in intensity and relatively in duration. On the other hand, in a case of impaired hearing with a loss of bone conduction, while the conduction through the air—aërial conduction—remains, we know that we are dealing with an affection of the labyrinth or acoustic nerve. We may formulate the propositions as follows :

I. If the hearing be impaired, and we find the aërial conduction better than that through bone, we are dealing with disease of some part of the acoustic nerve, which may be either primary or secondary to disease of the middle ear.

II. If the conduction through the bone be intensified and last longer in time than the aërial conduction, our case is one of disease of the middle or external ear. Of course, if the case be one of impacted cerumen or other disease of the external ear, it is at once diagnosticated by an examination, and the test by the tuning-fork is practically useless, but it becomes very valuable in cases where we are in doubt as to whether disease of the middle

[1] Archives of Otology, vol. xv., No. 1.

or internal ear exists, if, as I believe, after much experience, it be one that can be depended upon. The method of making the test is extremely simple. The tuning-fork is placed in vibration by being struck on the knee of the examiner. It is then held in front of the meatus to test the vibrations through the air, and is again set in vibration and its handle placed on the mastoid process about in its centre to test the conduction by bone.

In testing the duration of the conduction by air (aërial conduction) or by bone, a stop-watch is essential for accuracy. The patient indicates the moment he ceases to hear the vibrations by lifting the hand. I am well aware of the criticisms made against this method of examination, that it is entirely subjective, that it leaves too much to the patient's intelligence and truthfulness, and so forth. To these and similar objections I can only answer that those who give this method of using the tuning-fork a fair trial will, I am sure, find that it is an extremely valuable test. In my opinion the test by aërial and bone conduction will, if tried, supersede all the methods of examination by the tuning-fork as yet known.

The tuning-fork is heard better through the bone in disease of the middle ear because of the increased resonating capacity of these parts when diseased by increase of tissue. When, on the other hand, there is disease of the acoustic nerve, the sound is heard most distinctly and longer when it passes through the best channel—that is, through the external auditory canal, the tympanic cavity, and the fenestra ovalis.

When an affection of the middle ear exists which cannot be detected by the watch or by conversation, although said to exist by the patient, it will be found that the tuning-fork will confirm the patient's statements that one ear "is not right;" that is, the bone conduction will be longer and more intense than the aërial; and a thorough inflation will often restore the normal relations. The objections that have been made as to the value of the tuning-fork as a means of assisting in a differential diagnosis, are chiefly against the old method of determining on which side the tuning-fork is heard better. Yet even when used in this way it is valuable, although as I trust, it is soon to be superseded by the simple tests of the intensity and duration of aërial and bone conduction.

According to Politzer,[1] 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

[1] Reprint from Wiener Medizinischen Wochenschrift.

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,[1] 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.

Even if we do not now employ the tuning-fork by determining on which side of the head it is heard better, the explanations as to the interesting phenomena revealed by such a test are not without value, and they are accordingly given. If, 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[2] and Schwartze suggest, "a fluxion toward 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[3] 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.

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[1] Archiv für Ohrenheilkunde, B. I., p. 321, 1868. Politzer, loc. cit.

[2] Loc. cit., p. 5.

[3] Loc. cit., p. 12.

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 fundamental, 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.

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,[1] of Vienna, diminishes the intensity of the upper tone by gentle pressure upon the lower portion of the branches. 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.)

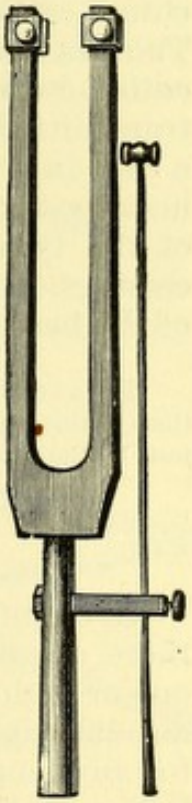

FIG. 2.—Blake's Tuning-fork.

Dr. Blake,[2] 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 woodcut (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.

[1] Blake: Reprint from Boston Medical and Surgical Journal, p. 3.
[2] Blake, loc. cit.

By affixing the clamps as Politzer directs, we obtain the variety of tone, and by the distance to which the hammer is sprung can regulate their intensity. The adjustment is simple, and obviates the necessity of employing any other musical instrument."

In cases of disease of the auditory nerve, it is often of interest to test the capacity of the patient for hearing high or low tones. For this purpose I use a piano, connecting the ear of the patient to the keys by means of a flexible stethoscope. Politzer[1] uses an harmonium, in the casing of which is an opening, for the insertion of the auscultation tube.

Dr. Bing makes what he terms an entotic application of the hearing-trumpet as a means of diagnosis. In practising Bing's method, words are spoken into the mouth of a hearing-trumpet, the other end of which is directly connected with the cavity of the tympanum by being inserted into the nozzle of a Eustachian catheter, whose extremity lies in the Eustachian tube. The waves of sound pass through the hearing-trumpet and catheter directly to the base of the stapes bone, and are thus transmitted to the terminal filaments of the acoustic nerve. In a case in which speech cannot be at all understood through a hearing-trumpet, but is heard by its application to the interior of the tympanum, we may conclude that the hindrance to the conduction of sound is in the malleus or incus, while the mobility of the base of the stapes is not impaired.[2]

For a full account of Lucæ's interference otoscope or apparatus see previous editions of this work. I have omitted it in this edition, since it seems to me that all the tests by the tuning-fork except the simple one have become unnecessary.

## MALINGERING.

In countries where liability to military service is universal, there are many malingerers, who claim to be dull of hearing in one or both ears. Next in frequency, it is claimed that there is absolute deafness of one ear only. It is so difficult to maintain for any length of time a false assertion of absolute deafness of both ears, that it is seldom attempted. The only malingerers that I have seen in our country since the close of the civil war, have been found among the applicants for the pensions that our Government gives with such liberality to those who were in any way disabled while in the national service. Dr. David Coggin's[3] method of testing a patient who states that he is deaf of one

[1] Text-book, p. 167.

[2] Politzer: Lehrbuch, S. 215. Translation, p. 186.

[3] Archives of Otology, Vol. viii., p. 177.

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

## 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.

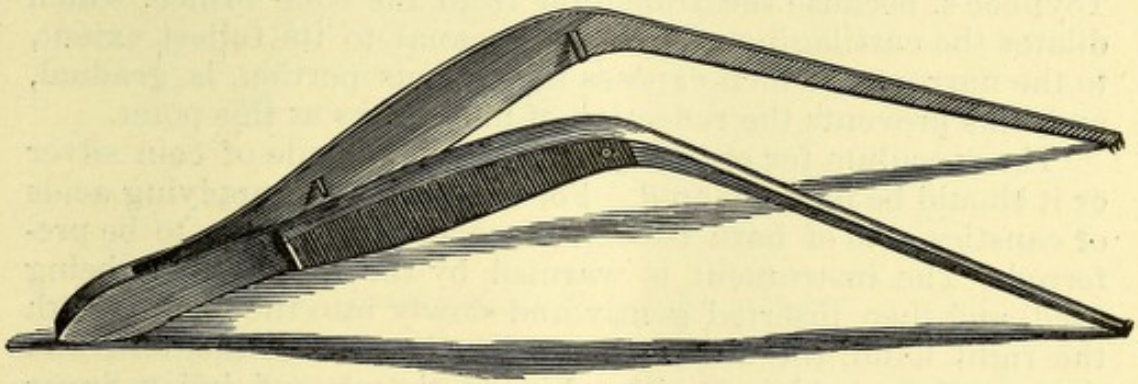

FIG. 3.—Angular Forceps.

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 forceps, 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,[1] 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 orifice. Subsequently this instrument, which was much too long, was improved by shortening it, by Dr. Ignaz Gruber, of 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

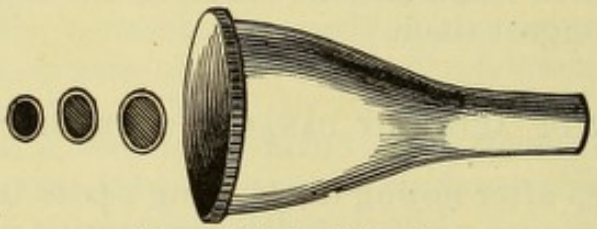

FIG. 4.—Gruber's Speculum.

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 for ordinary use should be made of coin silver or it should be nickel-plated. 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, the auricle being lifted up with the left, and the speculum held in position by the thumb and index finger of the same hand. It will thus be kept under complete control, and the examiner will be able 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 its upper wall.

It is very important that the speculum be held properly, for I have seen many a student, for the want of knowledge of this

[1] Treatise on Diseases of the Ear. English edition, p. 60.

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 canal. A very considerable amount of pain may be caused by the rude introduction of the speculum. I would advise each practitioner to allow one to be introduced into his own auditory canal, before he begins to use the instrument upon his patients.

Having thus dilated the canal, the light may be thrown into it by means of the otoscope or reflector of Tröltsch, which is a concave mirror of about three inches in diameter, having a focal

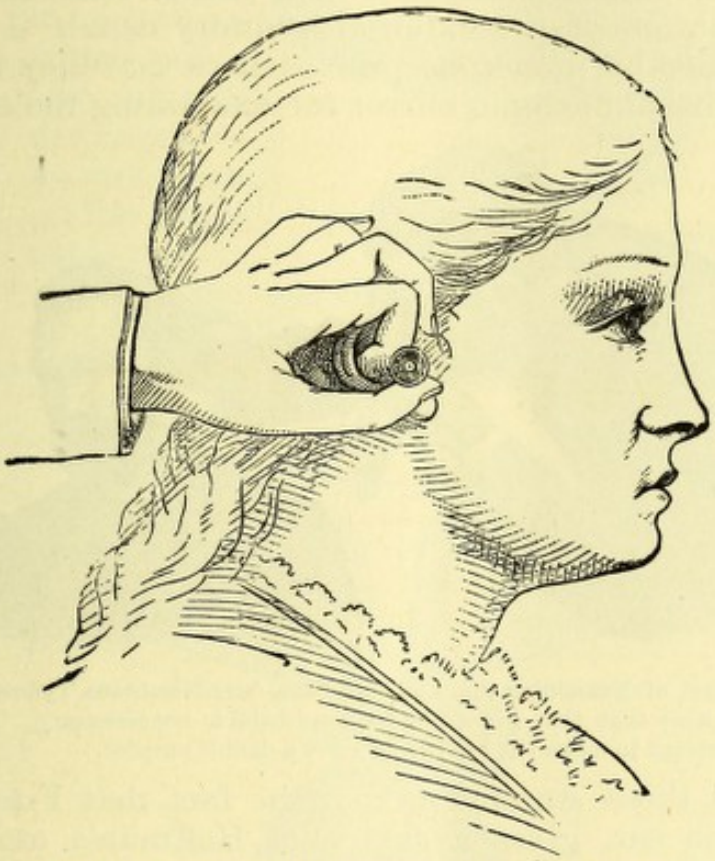

FIG. 5.—Method of Holding the Speculum in Position.

distance of about six inches. Ordinary daylight is the best source of illumination for this mirror, although sunlight, lamplight, gaslight, electric 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.

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 was first introduced to the profession at large by Professor Anton Von Tröltsch, in 1855, without previous 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 external auditory canal. I have also been informed by numerous practitioners that they have often used the ophthalmoscopic mirror for examining the ear ; but in

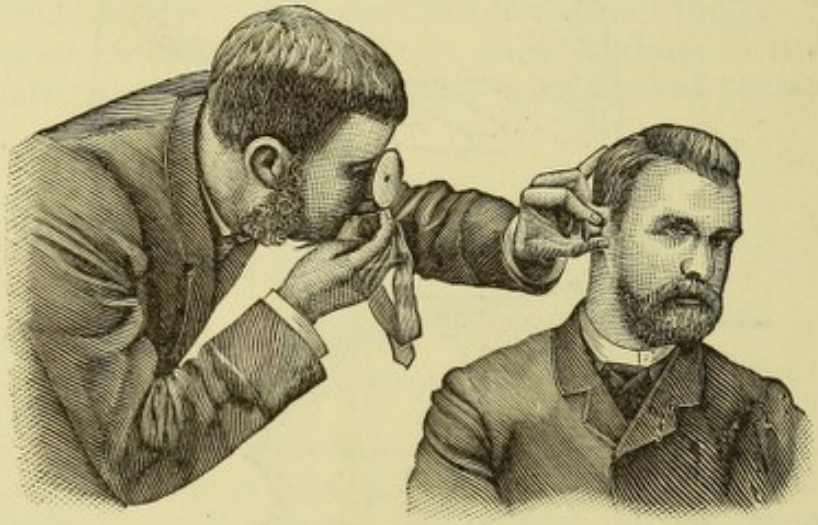

FIG. 6.—Method of Examining the Auditory Canal and Membrana Tympani. (A handle to the otoscope other than that formed by the head-band is not necessary. It will be found much more convenient to make the head-band serve a double purpose.)

spite of all these statements and the fact that Frank,[1] 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 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 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

[1] Practische Anleitung zur Erkentniss der Ohrenheilkunde, p. 49.

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.

FIG. 7.—Colin's Lamp.

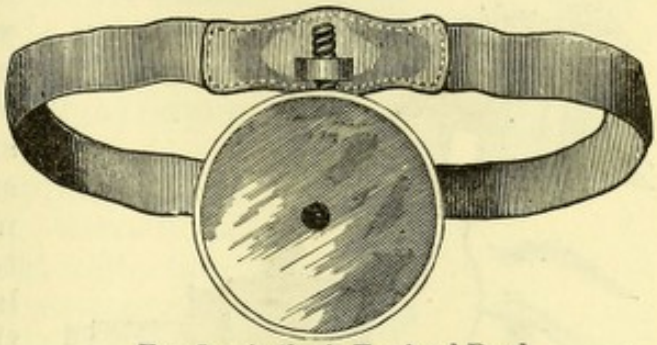

FIG. 8.—Author's Forehead Band.

Since the use of the electric light as a means of general illumination, excellent apparatus are constructed for examining the nose, pharynx, and auditory canal.

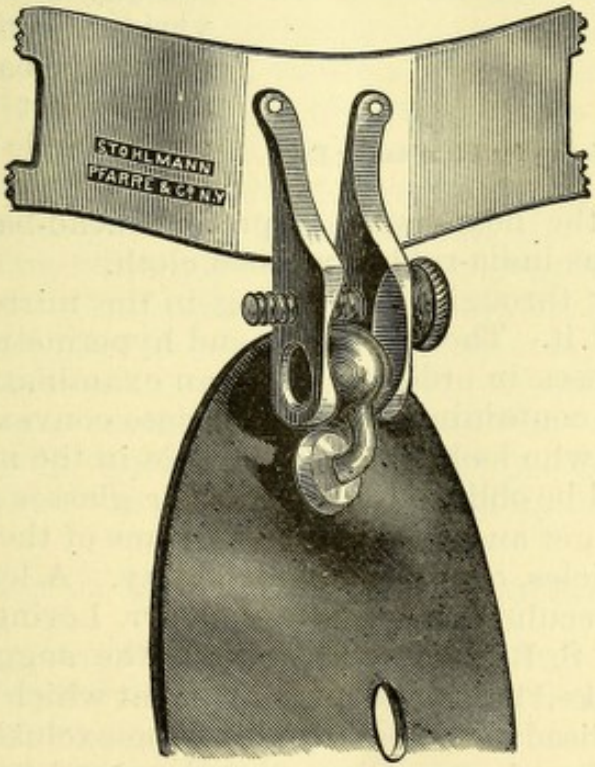


FIG. 8a.—Pomeroy's Forehead Mirror.

I deem it unnecessary to describe the numerous methods which preceded that of 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 forehead band is essential in making applications to the ear, and it is often convenient at other times. I cannot see any 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. I prefer a head-band of elastic material, such as india-rubber webbed cloth.

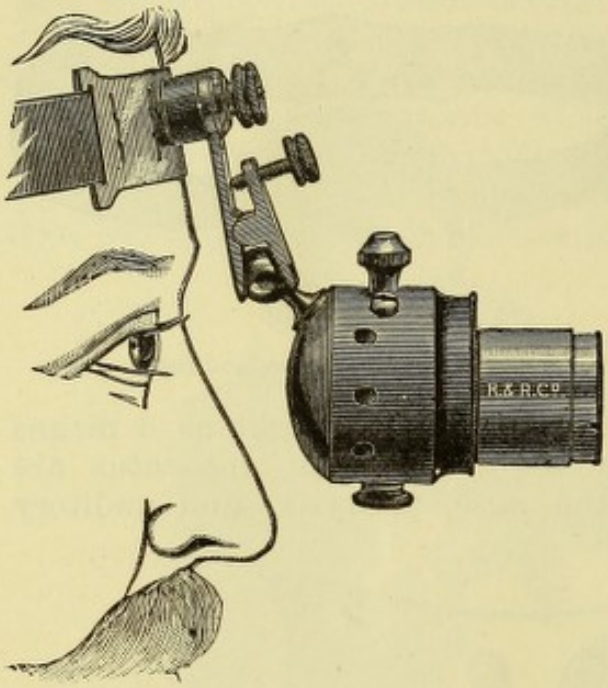


FIG. 8b.—Electric Lamp for Illuminating Ear.

I never look through the opening in the mirror, but rather over the rim of it. The presbyope and hypermetrope will need his reading glasses in order to make an examination of minute points. A clip containing the appropriate convex lens may be made for those who look through the hole in the mirror. Those who do not, will be obliged to employ their glasses used for reading, in order to get an accurate view of some of the details of the drum-head, ossicles, or the tympanic cavity. A lens may be inserted in the speculum, as suggested by Dr. Loring.[1]

Mr. Edward S. Ritchie, of Boston, at the suggestion of Dr. Clarence J. Blake,[2] 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:

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[1] Verbal Communication, N. Y. Ophthalmological Society.

[2] Late Contributions to Aural Surgery. Boston, 1870.

"It consists of a hard 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.

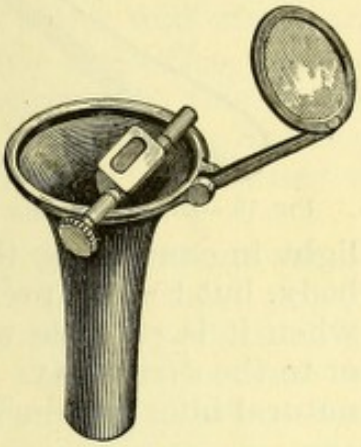

FIG. 9.—Blake's Operating Otoscope.

"The advantage of a 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 Tröltsch, but it is certainly of great advantage in the more complicated operations, where 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 or of Colin's lamp then becomes a very convenient and ample means of illumination. The finest changes on a membrana tympani and in the auditory canal 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 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.

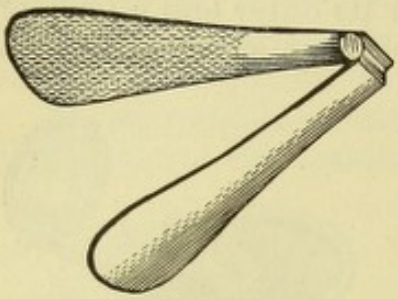

FIG. 10.—Hinge Speculum.

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,

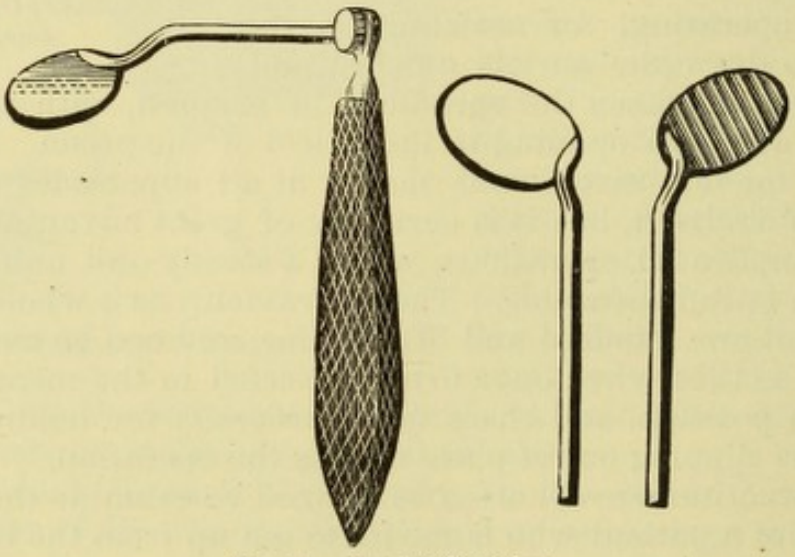

FIG. 11.—Turck's Speculum.

artificial light must be used. A reflector should then be employed. 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.[1]

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 afterward Surgeon to the Archduke Maximilian, while in Mexico, gave us the first full account of what was to be observed 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 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 condensing 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 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.

[1] Laryngoscopy and Rhinoscopy. By F. Semeleder. Translated by Dr. E. T. Caswell, 1866.

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 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 hand, after which it is gently and quickly introduced, with its reflecting face

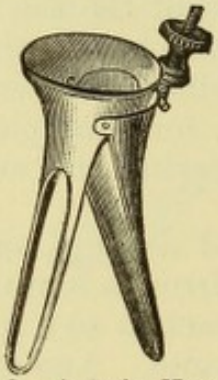

FIG. 12.—Anterior Nares Speculum.

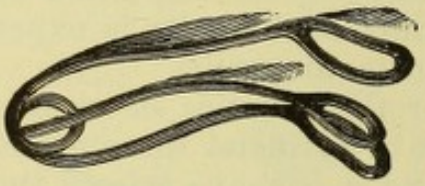

FIG. 13.—Goodwillie's Nasal Speculum.

upward, 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, 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[1]—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. A thorough examination of the anterior nares may be made with any of the specula of which cuts are here given.

Zaufal, of Prague, has of late years laid great stress upon anterior rhinoscopy. He has devised a set of nasal specula for this method of examination, and he has contributed largely to our knowledge of the morbid appearances of the nasal cavities. A little experience must be had with these specula, before the surgeon will be willing to trust himself to deductions from what he may see.

[1] Diseases of the Throat, p. 75.

Zaufal's specula are long tubes of various sizes adapted to the inferior meatus of the nose, with a funnel-like extremity through which the light is thrown. When Dr. Weir, of this city, was an aural surgeon to one of our infirmaries, he used the tube of the endoscope for the same purpose of obtaining an anterior view of the mouth of the Eustachian tubes, but Zaufal has made much greater publicity of the results of his examinations by this method—and probably never knew of Weir's work in the same direction.

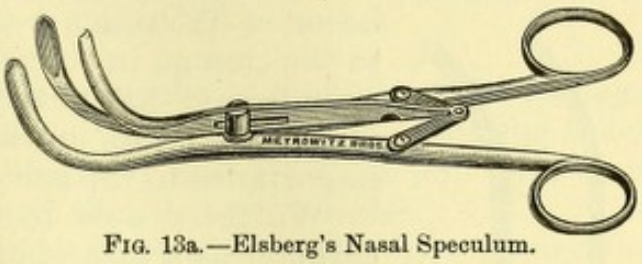

FIG. 13a.—Elsberg's Nasal Speculum.

## EXAMINATION OF THE 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 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 the publication of an English translation of Tröltsch's work on the ear. In respect 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.

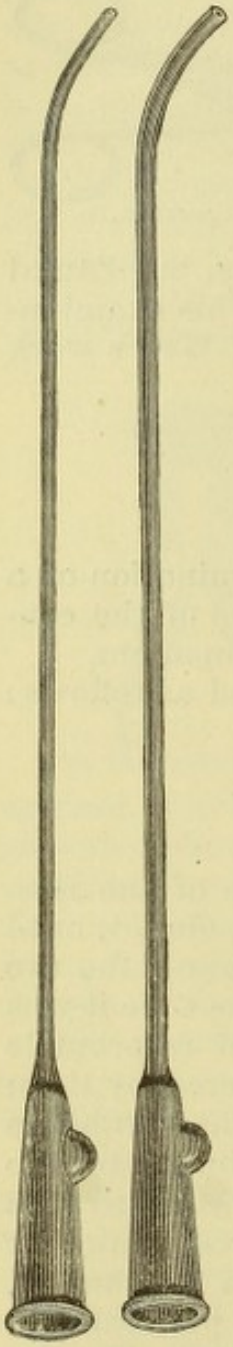

Fig. 14. — Eustachian Catheters (actual size).

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 hard rubber or alloyed silver. 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. For myself, I use the hard rubber instrument for all purposes.

In the method of introduction, we proceed as did Archibald Cleland, an English surgeon, who, after Guyot, did the most to demonstrate the utility of entering the mouth of the Eustachian tube with an instrument, and we pass the catheter through the nostril. It is very difficult to imagine how the Versailles layman succeeded in introducing an instrument into the tube, through the mouth. He certainly did not use a catheter such as we now employ, and which is represented on this page. This instrument is a delicate tube of about six inches in length, with a slight curve at its extremity. A long and flexible catheter might, it is true, be passed behind the soft palate into or opposite the mouth of the tube, and this is the operation which Guyot demonstrated to the Paris Academicians, and which, by removing mucus from about the trumpet-shaped pharyngeal extremity of the canal, relieved his impairment of hearing.[1]

The various steps in the operation of introducing the Eustachian catheter are as follows :

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

[1] For a fuller account of Guyot's operation, see Introductory Chapter.

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 almost exclusively use 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

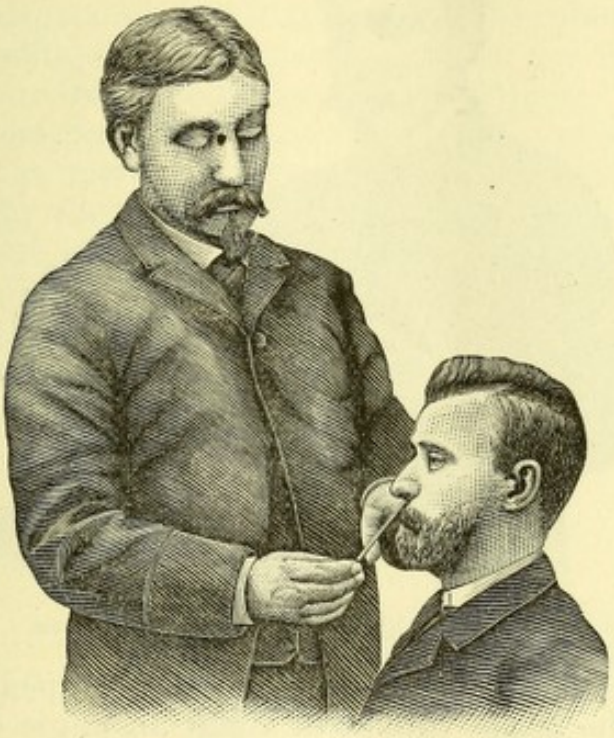

FIG. 15.—Introduction of Eustachian Catheter.

his right hand lightly holds the catheter close to the funnel-shaped end, nearly in a vertical position, so that the guide or projection at the side of the funnel-shaped extremity looks directly downward, until the catheter has entered the meatus, when it is quickly turned to an approach to the horizontal position, when the beak will rest on the floor of the nasal meatus, close to the septum, with its convexity upward.

4. The catheter is then to be slid or insinuated backward 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 outward. This motion lifts the beak of the instrument into the mouth of the Eustachian tube. This latter movement is aided somewhat 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

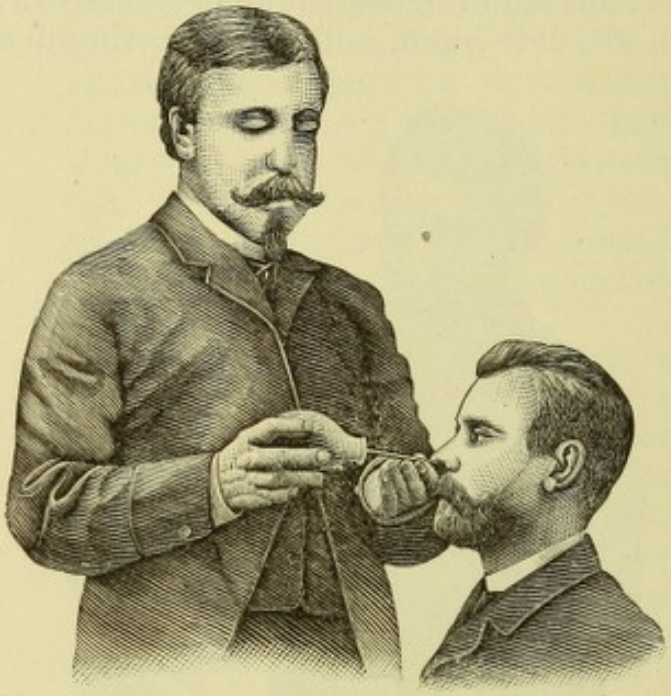

FIG. 16.—The Eustachian Catheter in Position.

not cause the patient any inconvenience in speaking or swallowing, and the guide will lie at about an angle of twenty-five degrees with the tragus.

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

First, the surgeon does not always hold the instrument in a vertical position (see Fig. 15) until he has got the beak well in the meatus. A failure to do this will often cause the instrument to pass between the inferior and middle turbinated bones, instead of along the floor of the meatus, which must be *hugged* in order that the instrument may get to the mouth of the tube.

Second, the patient is apt to shut his eyes spasmodically and contract his facial muscles, and thus prevent the relaxation of the parts that is necessary during the manipulation. This difficulty is only to be overcome by persuading the patient to open his eyes and look about the room, which can be done if the sur-

geon 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.

Having introduced the catheter we may force air through it into the cavity of the tympanum, by means of an air-bag whose nozzle should fit accurately in the funnel-shaped extremity of the nasal instrument. 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 the latter method, on the ground that it is not likely to offend the natural feelings of the patient, against the introduction of air from the lungs of the examiner.

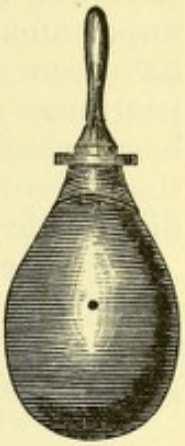

Fig. 17. — Air-bag.

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.

I have caused an exact representation to be made of the size and curve of the Eustachian catheters used by me, for I was for

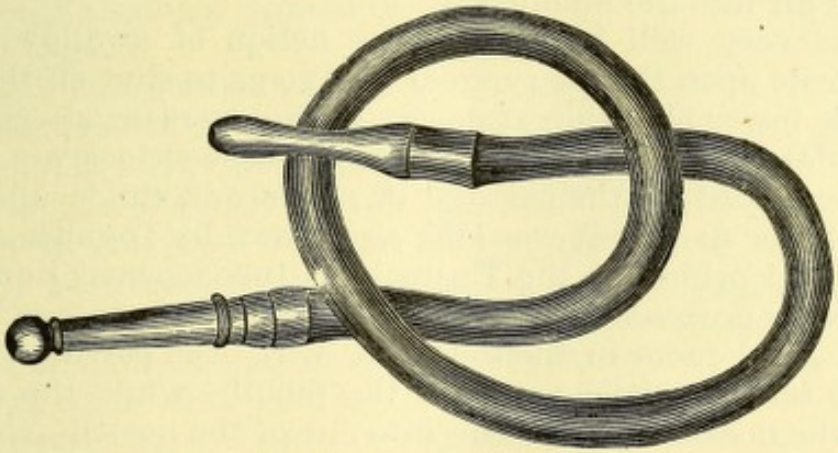

Fig. 18.—Diagnostic Tube.

a long time greatly annoyed by the difficulty which I often found in introducing instruments of a larger calibre and curve. I am constrained to believe that the catheter would be much more widely employed, were instruments of small calibre and curve generally figured in the text-books and sold in the shops.

Most authorities recommend the use of an instrument like the stethoscope, which is placed in the ear of the patient while

the air is being 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 believe it will be found 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 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 diagnostic tube.

I very rarely make use of the instrument. It was formerly called the otoscope, a manifestly improper name, as Kramer said. The mirror for examining the canal and membrana tympani is the only *otoscope*.

### 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 physician who suggested it, Politzer's method. It is a means of diagnosis and treatment of very great value, and we owe very much to Professor 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 upward to the posterior nares. It was long ago shown by Toynbee, 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 the nozzle of an air-bag 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 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 obstructed the calibre of the tube, or the mobility of the ossicles has been interfered with. In the former case it is driven away by the current of air, which must of necessity go against the 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, or perhaps where atrophy of tissue has rendered it less sensitive than normal. 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.

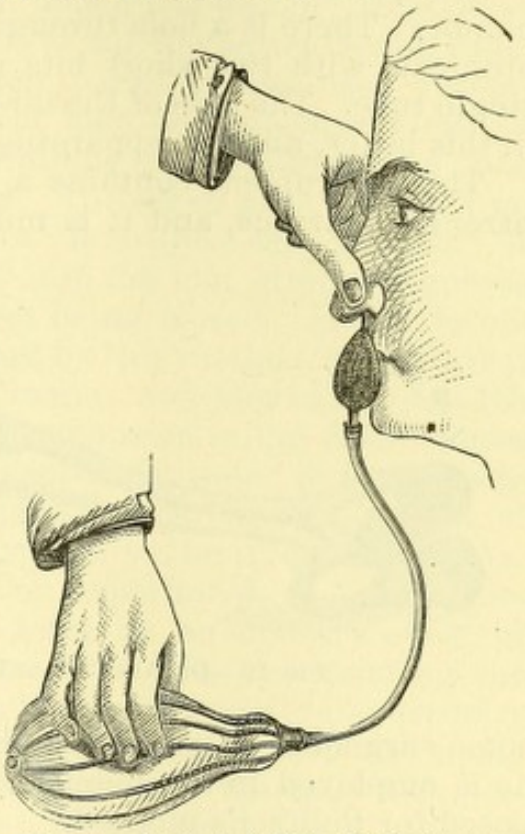

FIG. 19.—Method of Using Politzer's Apparatus (with box for containing iodine or other evaporating substance).

A great many modifications of Politzer's methods of procedure, chiefly, however, as regards swallowing as a signal for the operator to compress the air-bag, have been made by various persons. Some of these bear evidence of the tendency of the human mind to seek change, if only for the sake of change. Gruber causes his patients to say *hic, hoc,* instead of swallowing upon the signal. He enters into a laborious argument to prove that his method is better than that of swallowing. One of his objections to Politzer's method is, that patients object to drinking from the glasses which he has near at hand. Dr. J. Oscroft Tansley,[1] of New York, proposed that patients, instead of swallowing, shall blow as if about to blow out a lighted candle. Both of these modifications of one minor part of Polit-

[1] Medical Record, March 16, 1878.

zer's great invention, especially Tansley's, are of value in certain cases. They are not more important as modifications of the method, than Hinton's use, in the case of children, of an india-rubber tube, through which air is forced from the lungs instead of from an air-bag. The late Dr. Peter Allen [1] substituted a *nasal pad*, which is pressed *against* the opening into the nostrils, instead of *into* one of them. Two air-pads are mounted on a piece of covered copper wire. These can be brought close together or separated so as to stop up the openings into the nostrils.

The pads are held in place by the metal which serves as a handle. There is a hole through each pad, and these holes communicate with two short bits of rubber tubing joining into a single tube. The pipe of the air-bag used for inflating is inserted in this latter, and the apparatus appears as in the engraving.

This instrument contains a very useful modification of Politzer's apparatus, and it is much preferred to the original by

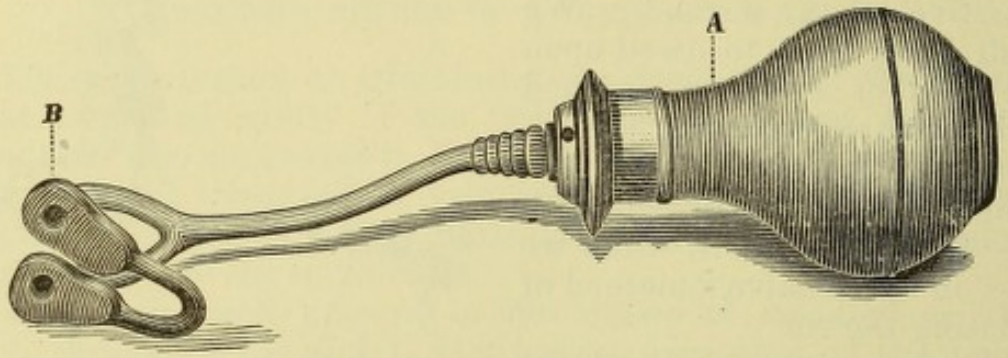


FIG. 20.—Dr. Allen's Nose Pads for Politzer's Apparatus.

some surgeons. There is no advantage in the double bag such as is employed in the nebulizers, and which has also been proposed for Politzer's method.

Tansley's method of blowing instead of swallowing was suggested to him, as he states, after practising Holt's method. Dr. E. E. Holt found that the air readily entered the tympana by closing the lips tightly and distending the mouth and cheeks easily with air, and then discharging the air-bag as in Politzer's method. He consequently caused the patients to undertake this manœuvre instead of swallowing. I find the methods of Gruber and Tansley very useful in many cases, but in by far the most instances, I prefer to cause my patients to swallow on a given signal.

I am told on reliable authority, that in one of the continental cities, rival teachers of otology lay great stress upon the impor-

[1] Treatise on the Ear, p. 97.

tant point as to whether the air-bag is pressed upon on its side or its distal end, when used for inflation. One teacher causes his pupils always to compress the bag on one side, while the other as strenuously insists that it can only be properly employed by compressing it from the distal end.

### 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.

### BOUGIES.

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." The examination of the condition of the drum-head and ossicles by Siegle's otoscope will also be discussed in the same place.

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 that an exact and consequently valuable diagnosis may be made. The time thus consumed is sometimes considerable, but it is not as great 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.

# THE EXTERNAL EAR.

# CHAPTER III.

## ANATOMY OF THE AURICLE AND THE EXTERNAL AUDITORY CANAL.

Auricle.—Etymology.—Anatomy of Muscles, Intrinsic and External.—Physiology.—Blood-vessels.—Nerves.—External Auditory Canal.—Anatomy of Curvature.—Ceruminous Glands.—Hairs in Canal.—Auditory Canal of Dog and Cat.—Relations of Canal to Parotid Gland, Inferior Maxilla, Mastoid Process, and *Dura Mater*.—Blood-vessels and Nerves.

THE auricle (*auricula*, external ear) is perhaps little more than an appendage to the human organ of hearing, although it is such an important part of the ear of certain animals. Its general shape is that of a funnel. Its frame-work, 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 which small cartilage cells are embedded. From the time of Rufus of Ephesus the different parts of the auricle, which give it its beautiful and useful shape, have been named as follows :

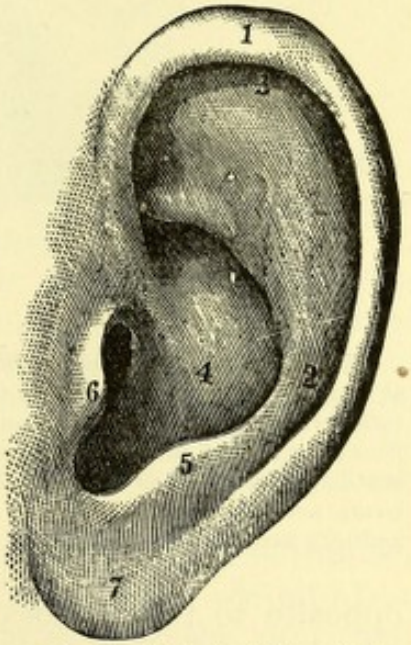


FIG. 21.—The Auricle. 1, Helix ; 2, anti-helix ; 3, fossa helicis ; 4, concha ; 5, anti-tragus ; 6, tragus ; 7, lobe.

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* (Latin for 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

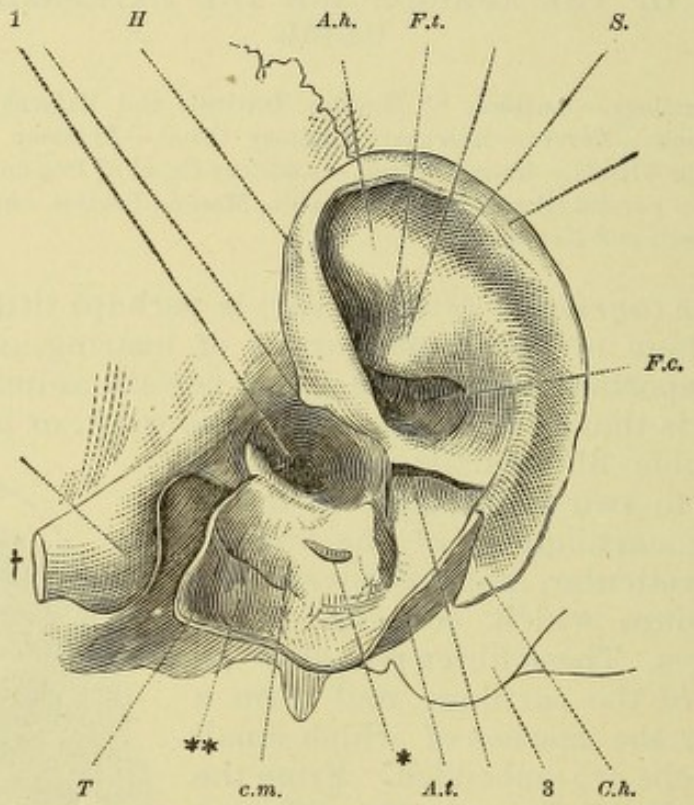


FIG. 22.—Profile View of the Skull, with the Skeleton or Cartilage of the Auricle, as well as that of the External Auditory Canal. The latter is exposed and drawn downward, *c.m.* (after Henle). 1, Meatus auditorius externus; 2, tuberculum articulare of the temporal bone; 3, mastoid process; †, transverse 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.

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 it a certain mobility. The auricle is completely covered by the common integument of the body. This integument is more firmly adherent to the anterior surface of the cartilage than to the posterior, and from it, at the extremity of the ear, a projection or tip, called the lobe, is formed. The lobe or lobule contains no cartilage, only fat and tough connective tissue. It is also poorly supplied with blood and nerves, and is consequently not very sensitive. It is very distensible, and when over-burdened by heavy ear-rings may become very much elongated, and thus its beauty be greatly marred.

In rare cases serious inflammatory reaction follows the usually harmless operation of piercing the ears for the wearing of ear-rings. Gruber [1] observed that the lobe contained cartilaginous structure in one case of this kind that he observed in his practice. He thinks that the inflammation was due to a wounding of the perichondrium.

## 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 auriculam.*
II. *Attrahens auriculam.*
III. *Retrahens auriculam.*

They are placed immediately beneath the skin. In man they are usually rudimentary ; but they are the analogues to 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 auriculam* is the smallest of the three. It arises from the lateral edge of the aponeurosis of the occipito-frontalis muscle. Its fibres converge and are inserted in front

[1] Lehrbuch, p. 61.

of the helix. This muscle is separated by the temporal fascia from the temporal artery and vein.

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

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

Hyrtl states that no brute has a lobe as a part of the auricle, and that none of the mammals living in water have an auricle.[1]

## INTRINSIC MUSCLES.

The auricle has also a set of muscles which are contained within 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 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 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. 23, 4.)

2. ANTI-TRAGICUS.—This muscle lies on the posterior surface of the posterior wall of the cartilage of the meatus. (See Fig. 23, 5.)

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. 23, 3.)

4. HELICIS MAJOR.—This muscle runs over the anterior margin of the helix, and is only loosely connected with it, and passes

[1] Lehrbuch der Anatomie des Menschen, Bd. II., p. 517.

over by a kind of tendinous termination into the levator of the auricle. (Fig. 23, 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 posterior surface of the auricle from the scaphoid fossa to the concha over the deep furrow corresponding to the anti-helix. (Fig. 24.)

6. OBLIQUE MUSCLE OF THE AURICLE.—*Obliquus Auriculæ.*—

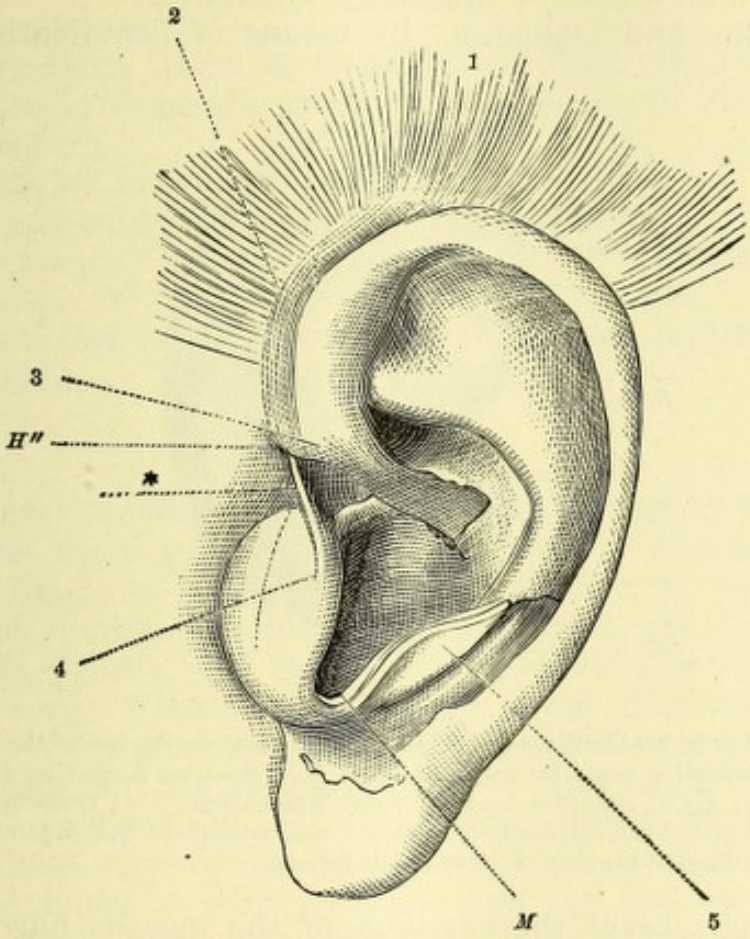


FIG. 23.—Muscles of the External Ear (after Henle). *M*, meatus auditorius externus; *H''*, spine of the helix; 1, attollens, or levator auriculam; 2, helicis major; 3, helicis minor; 4, tragicus; 5, anti-tragicus.

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. 24, O.m.)

7. DILATOR OF THE CONCHA.—*Musculus incisuræ majoris auriculæ Santorini.*—Sometimes the above-named muscle is found on the tragus. Hyrtl[1] has found it arising from the anterior

[1] Hyrtl, loc. cit., p. 518.

circumference of the external meatus, whence it runs downward and outward to the lower border of the tragus, which it draws forward, and thus enlarges the space of the concha. The 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,[1] by means of faradization, found

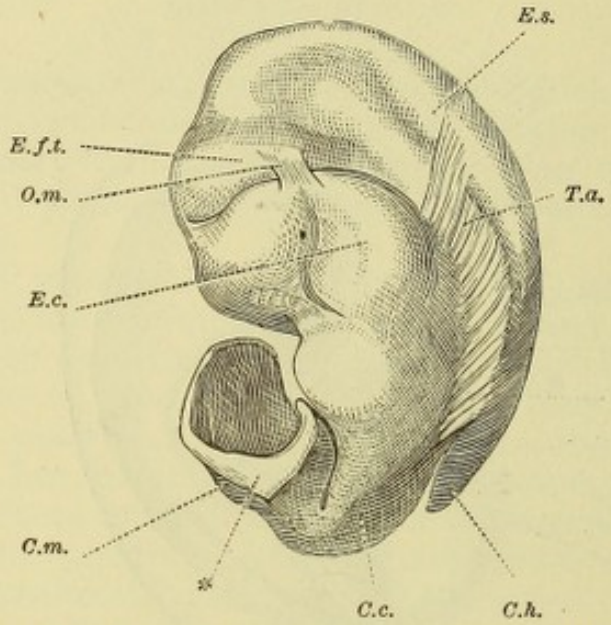


FIG. 24.—View of the Cartilage and Muscles on the Posterior Surface of the Auricle (after Henle). *E.s.*, elevation made by scaphoid fossa; *E.c.*, elevation formed by concha; *O.m.*, oblique muscle; *E.f.t.*, eminence made by fossæ triangularis; *T.a.*, transversus auriculæ; *C.m.*, cartilage of the external auditory canal; *, attachment to the edge of the osseous canal; *C.c.*, cartilage of the auricle; *C.h.*, cauda helicis.

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.

[1] Henle, loc. cit., p. 729.

(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.

### 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.

### PHYSIOLOGY.

The exact functions of the auricle still remain in doubt. We do not yet know to what extent, if any, the perception of the point of origin of sound, or the conduction of sound to the membrana tympani are assisted by the muscles of this part. According to Hensen,[1] the results of experiments as yet made are contradictory. Those that indicate much importance to the functions of the auricle are of doubtful significance, while those that indicate that the auricle is what we may call a rudimentary part are more positive. In 1832 Esser[2] showed that the reflection of sound-waves from the individual parts of the auricle do not assist much to their entrance into the auditory canal. It was also observed by Harless,[2] that the perception of sound was not weakened when a long glass tube was placed tightly in the passage, even when the body causing the sound lay far outside of the direction of the axis of the canal. Mach's[3] experiments also showed that the different parts of the drum-head were not differently affected according to the direction of the sound. Schneider's experiments are even more positive against

[1] Handbuch der Physiologie, von L. Hermann. Gehör von V. Hensen, p. 23. Leipzig, 1880.

[2] Hensen, loc. cit.

[3] Archiv für Ohrenheilkunde, S. 72. 1874.

the influence of the auricle. He filled the depressions of the auricle within and without with wax, only leaving the canal free. The canal then being directed toward the source of sound, tones were rather intensified than weakened. Hensen concludes from Schneider's observations, that the direction of the auricle toward the source of sound, has less influence upon the distinctness of perception than does the opening of the canal with a good round meatus. Sounds, according to the same author, are most distinctly perceived, when they fall upon the ear sideways. It remains an open question if vibrations of more than one thousand times a second can be concentrated on the auricle by reflection. On the other hand, Rinne, experimented upon an auricle filled with dough, and he found the tick of a watch was heard further when the auricle was uncovered. Politzer[1] thinks that the concha is the important part of the auricle in assisting the hearing. He found, on examination of persons hard of hearing, that the limit of audition was nearer the head as tested with the metronome, when the concha was covered by a stiff piece of paper, while no alteration in the hearing distance was observed if the other depressions of the auricle were covered. Politzer also regards the tragus as of great importance for the reflection of waves of sound that strike the auricle. Küpper[2] denies that the auricle has any influence upon the ear in the way of reflecting the waves of sound, or as an elastic body vibrating with the waves and conducting them directly to the deeper parts. He insists that Boerhaave's notion that the undulations, after long wandering, are united in the auditory canal by the depressions of the auricle is incorrect, and he believes that the auricle cannot perform any such office, but that a membrane like the membrana tympani is necessary for this. He reminds his readers that birds whose hearing power in every respect exceeds that of man, have no auricle. Küpper adopts the theory of Darwin and Haeckel, and classes the auricle among the organs that evolution has rendered useless in man except as appendages, in this case as an ornamental one. Mach[3] confirms Küpper's views, but he considers that the auricle is a resonator for high tones, such as the rustling of the grass, the leaves, sounds important to animals, but even this function he believes only exists to a slight degree in man. Burnett[4] claims to have anticipated Mach's views in regard to the reson-

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[1] Text-book, p. 61. Translation.

[2] Archiv für Ohrenheilkunde, Vol. IX., p. 76. Neue folge, Vol. III.

[3] Loc. cit.

[4] Text-book, p. 34.

ating capacity of the auricle, but the experiments of Burnett include the external auditory canal. In the opinion of the latter-named author, the absence of an auricle in birds does not argue against its utility as a resonator in man, for the wave lengths of the high notes used by birds are so short that they resound well in their shallow auditory canal. Dr. Sexton,[1] as the result of some experiments upon the living subject, concludes that the range of hearing for the tuning-fork is increased in some persons, when the occipito-frontalis muscle is contracted. He thinks that this muscle acts as an auxiliary to the attollens auriculam and attrahens auriculam. As the result of one dissection of the human subject, he found that traction of the deep temporal fascia moved the auricle freely. He also found that when alternate tension and relaxation were practised on the same fascia, the drum-head also became tense or relaxed, the motion being visible. The anatomists describe the occipito-frontalis as a muscle which occasionally has muscular slips extending to the posterior auricular muscle. It is possible that in exceptional cases the action of the former muscle would affect the auricle as well. The action of the deep temporal fascia upon the drum-head, as described by Dr. Sexton, is with difficulty conceived of, when we remember that the drum-head is nearly surrounded by bone, and only connected through the handle of the malleus with soft parts—the tensor tympani muscle. How the action of this muscle can be influenced by traction of the deep temporal fascia, I cannot conceive.

The relations of the muscles of the auricle to the occipito-frontalis, are well shown in the cut from Sappey on the next page. In the exceptional cases in which the power of moving the occipital and frontal muscles, as the occipito-frontalis is called by the French anatomists, it is readily seen that the auricle may also be moved.

A careful study of all that has been written upon the physiology of the auricle, as well as observations upon the living subject, render it tolerably clear to my mind, that the auricle is really, as Darwin and Hackel claim, only a rudimentary organ, and not of value in hearing, except under exceptional circumstances. Even if the tick of a watch be heard further, as Rinne and others show, when the concha be uncovered, this by no means proves that conversation is heard further by its aid, since the test by the tick of a watch is a fallacious one as compared with that by human speech or the notes of music. It is probable, however, that the rudimentary capacity of the auricle as a res-

[1] Medical Record, November 17, 1883.

onator is greatly increased by placing the hand behind it, and that those whose hearing is impaired, may sometimes increase their hearing power in this way. If this were not the case, the human race would have long ago abandoned the habit.

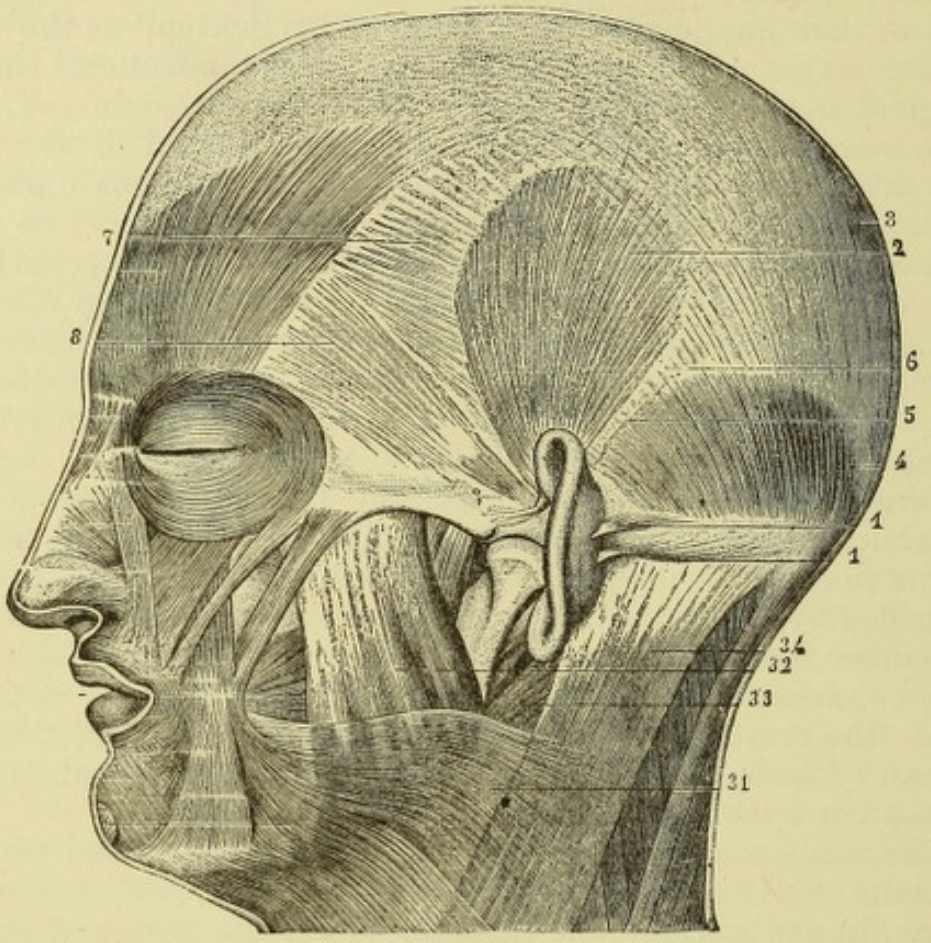


FIG. 25.—The Muscles of the Head (from Sappey). 1, Posterior auricular muscle, having two sets of attachments, a superior very short, an inferior much longer; 2, superior auricular muscle; 3, anterior auricular muscle; 4, occipital muscle; 5, section of the aponeurosis which extends from the occipital muscle to the superior auricular; 6, aponeurosis, extending from the occipital and running under the inferior surface of the auricular superior; 7, superior fibres of the superficial temporal muscle, situated at the termination of the two parts coming from the occipital muscle; 8, lower fibres of the superficial temporal, united to the anterior auricular by a fibrous band which forms a part of the epicranial aponeurosis.

## EXTERNAL AUDITORY CANAL.

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

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

the osseous meatus; above, it is bounded by the root of the helix.

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

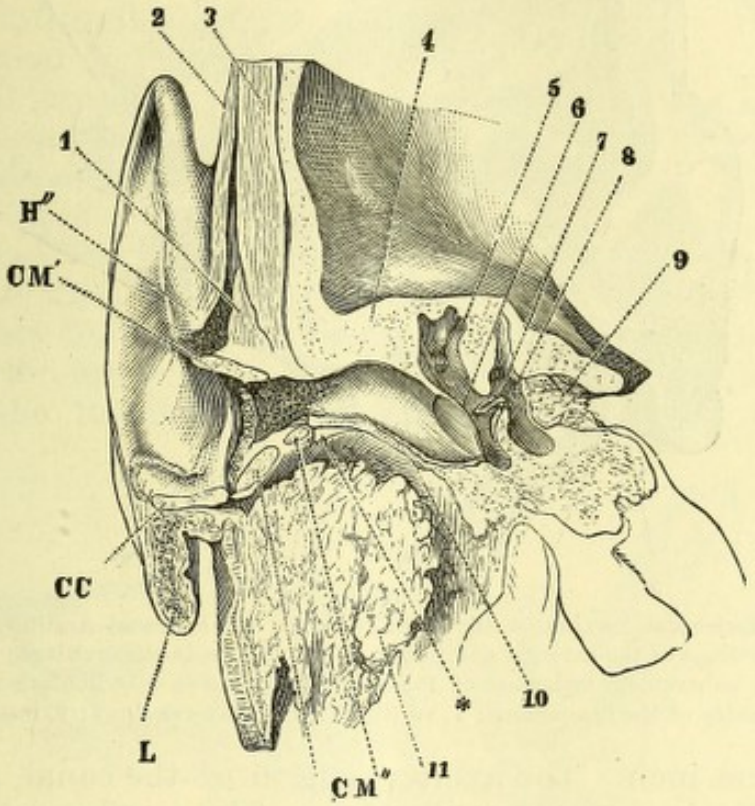


FIG. 26.—Section through the External Meatus and the Ear at the Point of Junction of the Cartilage of the Auricle, CC, with that of the Auditory Canal (after Henle). A small portion of the upper wall of the latter remains as a narrow band, CM′; CM″, lower wall of the cartilage of the external meatus; 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 cuts from his work on anatomy. 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 upward and backward. 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

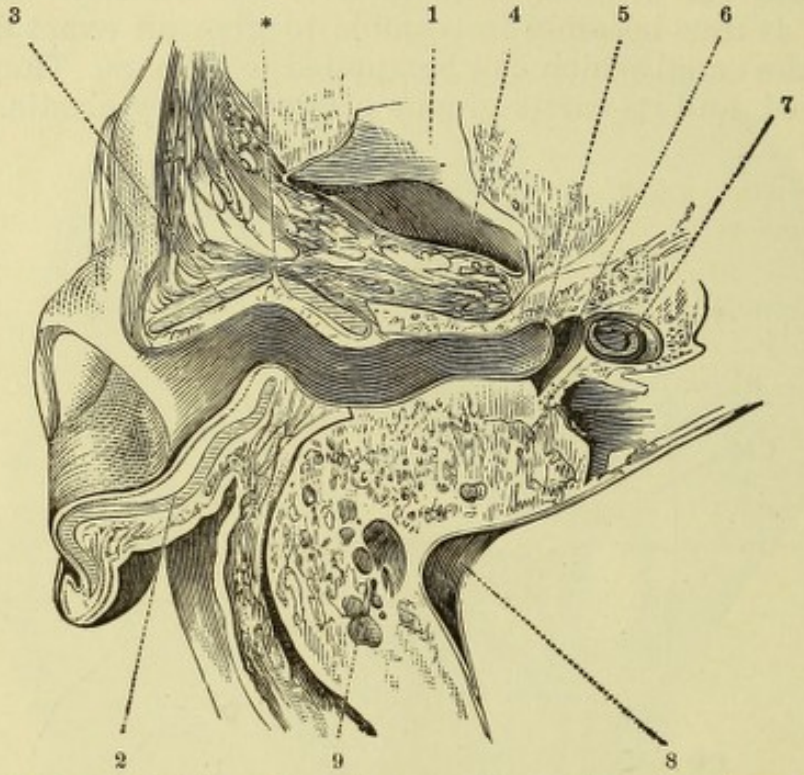


FIG. 27.—Horizontal Section of the Head, through the External Auditory Canal (after Henle). 1, Cartilage of the external auditory canal; *, fissure in the cartilage; 2, cartilage of the auricle; 3, tuberculum articulare of the lower jaw; 4, fossa mandibularis; 5, membrana tympani; 6, cavity of the tympanum; 7, vestibule; 8, transverse sinus; 9, mastoid cells.

lines to one inch. The average length of the canal, according to Tröltsch,[1] is about 24 millimetres. The cartilaginous portion forms about one-third of this, or 8 mm., and the osseous canal the remaining two-thirds, or 16 mm.

FIG. 28.—Annulus Tympanicus (actual size, from Professor Darling's museum).

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.

The casts made by Dr. F. M. Wilson, as here delineated, confirm Hyrtl's and Sappey's moulds of wax, and show that the canal is a spiral turning anteriorly inward and downward.

[1] Treatise on the Ear, second American edition, p. 18.

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.

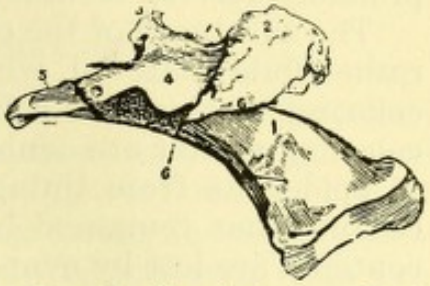

FIG. 29.—Cast of Auditory Canal and Adjacent Parts (actual size). 1, External auditory canal; 2, mastoid cells; 3, tympanic cavity; 4, Eustachian tube; 5, fenestra ovalis; 6, position of membrana tympani; 7, posterior opening of mastoid.

"The integument of the cartilaginous portion of the canal is 1½ mm. 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 0.1 mm. in thickness, the soft hairs become very few, and the ceruminous glands are found only on the posterior upper wall, where they are generally seen, even close to the membrana tympani. Small papillæ are found

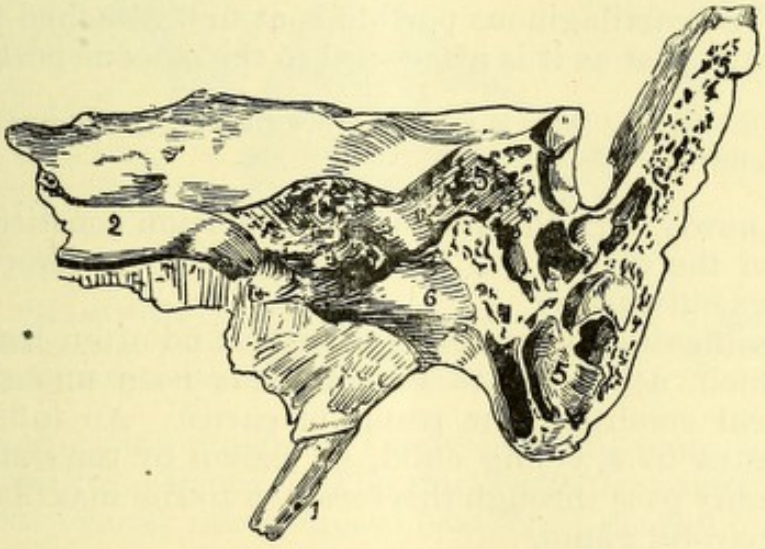

FIG. 30.—Section of Left Temporal Bone (actual size, from Professor Darling's museum). 1, Styloid process; 2, carotid canal; 3, promontory; 4, floor of tympanic cavity over carotid canal; 5, mastoid cells; 6, external auditory canal.

arranged in rows under the cuticle, and also a corium with abundant elastic fibres, of which the lower layers pass into the periosteum."[1]

The ceruminous glands are like the sudoriparous or sweat

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

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 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. By rubbing upon the surface of the membrana tympani, they may cause a tickling sensation in the ear and become a source of annoyance. Dr. R. F. Weir relates such a case.[1]

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 afterward to the osseous portion.

Gruber[2] 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 about one-half of the canal; but it gradually becomes shorter as the bone grows outwardly.[3]

This ossification proceeds irregularly, and often leaves a foramen, which, according to 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 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

[1] Transactions American Otological Society, third year.

[2] Monatsschrift für Ohrenheilkunde, Bd. II., p. 67.

[3] Tröltsch, loc. cit., p. 6.

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 (*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. This occurred during the fatal illness of the late President Garfield, while he was suffering from suppurative parotitis. Enlargements of the parotid or lymphatic glands may contract the calibre of the canal by pressure.

The anterior wall is also in relation with the posterior wall of the articular fossa of the inferior maxillary bone. Hence a blow

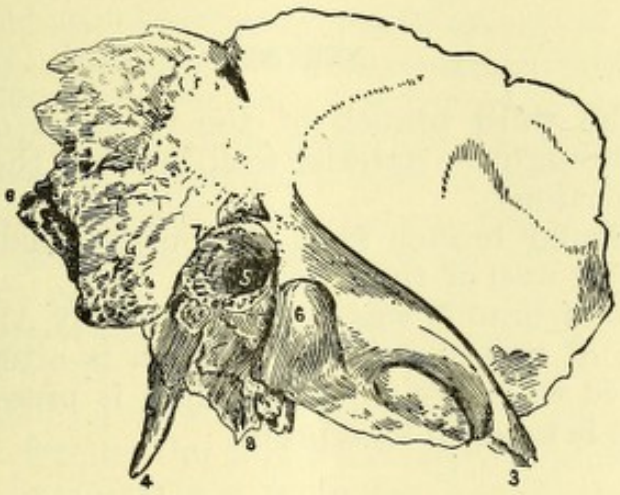


FIG. 31.—External Surface Left Temporal Bone (two-thirds size). 2, Mastoid process; 3, zygomatic process; 4, styloid process; 5, external auditory canal; 6, glenoid fossa; 7, tympanic process; 8, vaginal process; 9, mastoid foramen.

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 (*Tröltsch*).

The wall between the integument of the canal and the *dura mater*, 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 Tröltsch.

### BLOOD-VESSELS OF THE AUDITORY CANAL.

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

### NERVES.

1. From the third branch of the 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.

### PHYSIOLOGY.

The length and curvature of the auditory canal prevent the membrana tympani and auditory canal, under ordinary circumstances, from being injured by wind, changes of temperature, and the like. The cerumen probably also guards against the frequent entrance of insects. The auditory canal increases the power of tones by acting as a resonator.[1]

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[1] Hensen, loc. cit.

# CHAPTER IV.

## THE MALFORMATIONS AND DISEASES OF THE AURICLE.

A Finely Formed Auricle an Indication of Character.—Malformations.—Superfluous Auricles.—Ely's operation for Prominent Auricles.—Tumors.—Angiomata.—Othæmatomata.—Perichondritis.—Malignant Growths.—Syphilitic Affections.—Erysipelas.—Effects of Gout.

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 as a means of 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 Tröltsch, goes much farther than Lavater in his estimation of the signification of the auricle. 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 te dirai qui, tu es, d'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 somewhat fanciful. Whatever may be the significance of the auricle, as regards character or legitimacy, its perfect shape has very little to do with the power of hearing. Whether it lies properly fitted to the head, and has all its parts of helix, fossa helicis, beautifully shaped, or whether it laps over like that of an inferior animal, or be a shapeless appendage, makes very little difference in the power of hearing music or the human voice. As we have seen in the discussion in the preceding chap-

ter, the functions of the auricle are like its muscles—unimportant and rudimentary.

We may conveniently classify the prominent affections of the auricle as follows :

1. Malformations.
2. Tumors, benign and malignant.
3. Syphilitic diseases.
4. Othæmatomata.
5. Perichondritis.
6. Eczema.
7. Effects of Gout.
8. Erysipelas.

## I.—MALFORMATIONS.

Many of the so-called malformations are the natural results of ill-treatment of the auricle. Many women, especially those of the lower class, cover their ears so tightly with their hair, cap

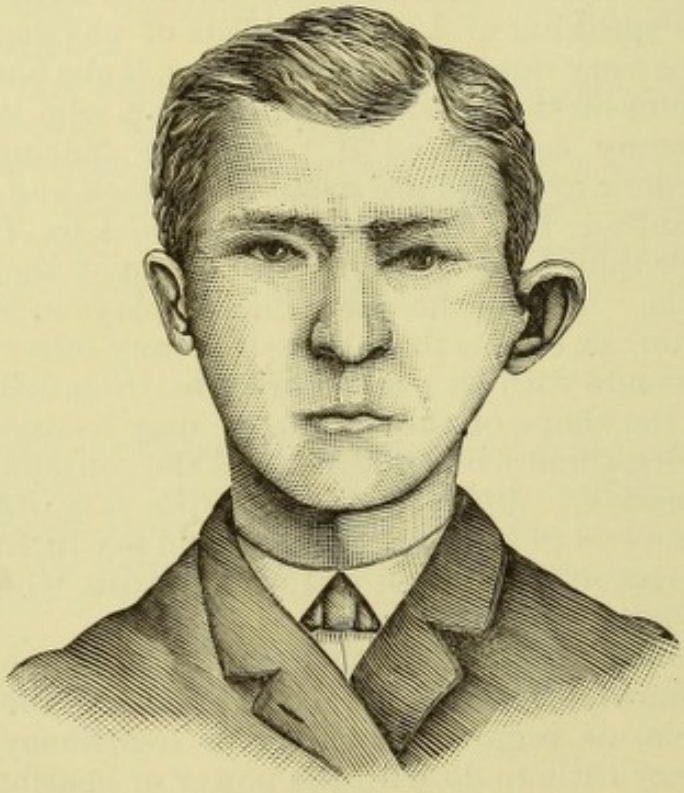


FIG. 32.—Case of Prominence of Auricles.

and hood, that they finally, by the excessive pressure, flatten out and fill up the natural elevations and depressions which go to make a finely shaped auricle. Children's auricles are sometimes

injured in their passage from the womb to the world. Boys often get into the bad habit of pressing their caps down upon their ears. They thus cause them to lap over and give them the unsightly appearance known as "dog ears." A boy, twelve years of age, presented himself in 1881 at the clinic in the Manhattan Eye and Ear Hospital held by myself and Dr. Ely, complaining that he was ridiculed by his companions on account of the prominence of his ears. He desired, if possible, that an operation be performed which should relieve him from this annoyance. The accompanying cuts give a good idea of the degree of the deformity of one side. It was equally deformed upon the other side until relieved by Dr. Ely's operation. The second cut

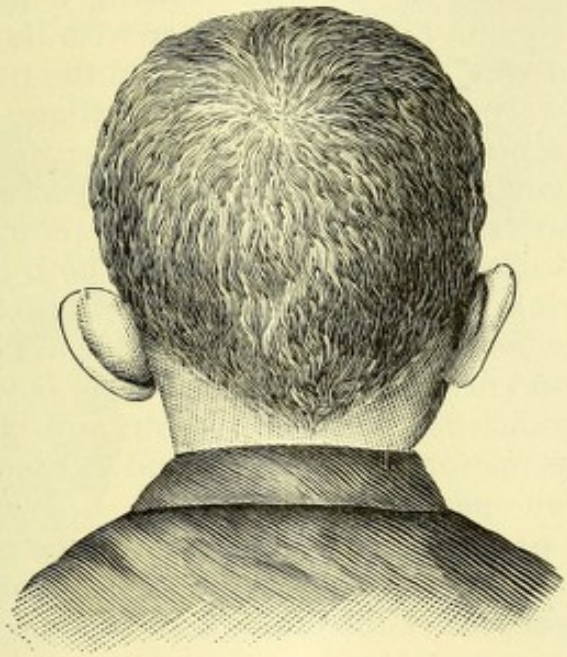


FIG. 33.—Case of Prominence of Auricles.

gives a good idea of the back view of the auricles before and after the operation.

Dr. Ely describes his operation as follows:[1] The right ear was first operated upon. An incision was made through the skin, along the entire length of the furrow formed by the junction of the auricle with the side of the head posteriorly. This was joined at each end by a curved incision carried over the posterior surface of the auricle, and the skin and subcutaneous tissue included by these incisions were dissected off. Two incisions, nearly parallel to the former ones, were then carried through the cartilage, and an elliptical piece of the latter, meas-

[1] Archives of Otology, Vol. X., No. 2, p. 97.

uring 1⅛ inch by ⅛ inch, was removed. The pieces of excised skin were considerably larger than this. The edges of the wound were then united by ten sutures, of which seven only included the skin, while three passed through both skin and cartilage. Owing to the natural folds of the cartilage, it was impossible to secure perfect coaptation on the anterior surface of the auricle, and a small space was here left to heal by granulation. The dressing consisted of absorbent cotton and a bandage. Healing ensued with very little pain or swelling—the posterior incision united by first intention and the anterior wound by granulation. The sutures were removed on the fourth day.

Dr. Ely varied the operation upon the left ear somewhat, by transfixing it with a scalpel and excising a piece of cartilage of the desired size and shape, together with its overlying skin. Additional skin was then removed from the posterior surface. Three sutures were used through the cartilage on its anterior surface and one on the posterior. The dressing was absorbent cotton and a bandage. Complete union by first intention was not obtained, but the result was as satisfactory as in the first ear. Ether was used as an anæsthetic for both operations. The posterior cicatrices were hidden by their position, and those on the anterior surface are hardly noticeable. The hearing was normal before and after the operation. The boy expressed himself as entirely satisfied with the result, and came of his own free will for the operation on the second ear, some weeks after the first had been operated upon.

I have since performed the operation in one case, in the manner which Dr. Ely performed his first operation, and I append the note of the father of the child, a physician, as to the result. Dr. S—— writes:

DEAR DOCTOR:

Before the operation the auricle projected at the extreme point 1¼ inch; the left ear 1 inch. Since healing the projection is ⅞. There is a red cicatricial spot on the auricle that shows, but would not ordinarily be observed. He is so much improved that people would not now notice anything unusual about the ears; but before, both being prominent, and one much more so than the other, it was observed by every one.

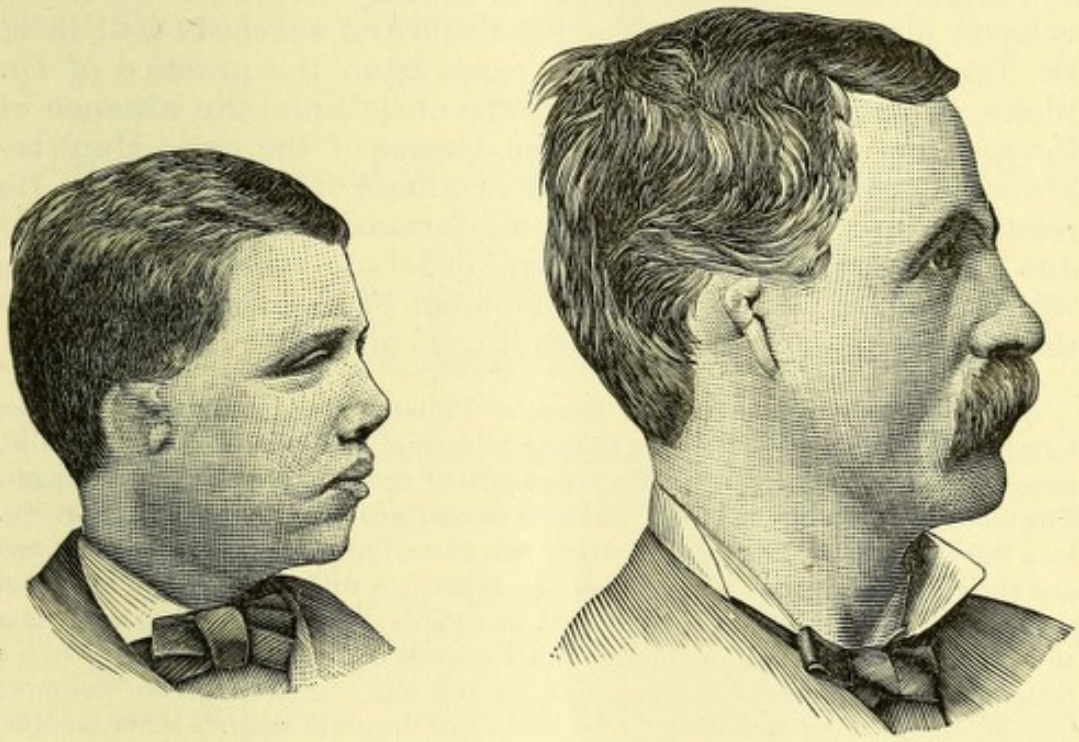
The detachment of the auricle is by no means a formidable operation, and I can cordially commend Ely's method as an excellent means of removing the deformity of prominent auricles.

### ARRESTED DEVELOPMENT—MICROTIA.

There is a class of malformations of the auricle which has the same pathological interest with other forms of arrested de-

velopment, 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 cartilaginous and osseous auditory canals are usually also wanting, but the middle and internal ear may be well developed.

There are cases, however, in which the whole ear is undeveloped. The deformity usually affects but one ear, but both ears are sometimes similarly affected. Attempts have been made by surgeons to make a passage to the drum-head and middle ear,



FIGS. 34, 35.—Deformity of Auricles.

but as yet they have failed. It is probable that the middle ear is not in a normal condition, for the impairment of hearing is usually, if not always, greater than could be explained by the mere absence of a canal leading to the membrana tympani.

The illustrations seen above, and the account of one case, give a fair idea of these deformities, for which art has as yet done very little. I have never seen any artificial ears that served any good purpose in masking the deformity. In females, the hair can be made to do very well in this respect. Fortunately, but one ear is usually deformed.

Superfluous auricles sometimes occur, just as do supernumerary toes and fingers. They are objects of anatomical curi-

osity rather than of therapeutical interest. Beck[1] 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.

The case of which an illustration is given on the preceding page, consulted me in 1881, with reference to a relief of the deformity. He was thirty years of age, and was born with a rudimentary and deformed auricle on each side. There was also bony closure of the canal on each side. He understood loud conversation some four or five feet away. He heard musical sounds well. In this case it is evident that the deformity is confined to the outer and middle ear. The patient, as is seen by the cut, is a well-developed man. He has learned a trade and succeeds well in it. Dr. David Hunt[2] reports three cases from the practice of Dr. Blake, in which the deformity of the auricle and the absence of the auditory canal constituted the disease of the ear. Hunt believes that these malformations originate in the auricle. He regards "the association of the malformation of the auricle as due to the interruption of a natural order of events, according to which a certain stage of development of the auricle precedes the formation of the meatus (auditory canal).

I am indebted to Dr. William Hunt, of Philadelphia, for an account of deformities of the auricle occurring in five children of one family. The first child, instead of an auricle, had a little pedunculated growth in front of the tragus. The second had the same defect, and two similar growths in front of the tragus. In a third, the upper part of the auricle was turned over forward. A fourth had one auricle half an inch longer than the other. A fifth child, whom Dr. Hunt saw when it was two or three weeks old, is described by him as having "no ear at all. There were mere nodulated small masses of cartilage and skin, with a little point which seemed to be an opening, but was a mere *cul-de-sac* not more than an eighth of an inch deep." Dr. Hunt saw the child again in a few months, but the auricles had not developed. It was difficult to tell whether the child heard or not. The monthly nurse was positive in her opinion that babies with good ears hear at once, and this coincides with the opinion of most nurses, as Dr. Hunt and I agree, but as I shall discuss this question in speaking of deaf muteism, I merely allude to it here. There was but one child in this family of six in whom there was a perfect auricle, although the children were perfect in other respects.

### FISTULA OF AURICLE.

I have seen two, if not more cases of fistulous openings in the auricle, which were said to be congenital and from which pus escaped at certain times. In one case these fistulæ were associated

[1] Krankheiten des Gehörorgans, p. 108.

[2] American Journal of Otology, Vol. III., No. 1.

with one just above the thyroid body. I advised incision of the fistulæ and the application of tincture of iodine or bichloride of mercury to the open canals thus made, but in neither instance was my advice followed. Indeed, I only saw the cases incidentally, the patients having consulted me for another form of aural disease, apparently not connected with the fistulous ulcers. The patients seemed to fear that a stoppage of the periodical discharge from these ulcers might do them harm. I should be inclined to regard these fistulæ as marks of arrested development of the auricle, since they were congenital and not connected with any other form of disease of this part.

They did not communicate with the auditory canal or middle ear. Schwartze[1] also reports such cases.

## TUMORS.

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

I. Fibro-cartilaginous.
II. Sebaceous.
III. Vascular.
IV. Malignant.

## FIBRO-CARTILAGINOUS TUMORS.

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

According to Billroth,[2] 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. It is not true, however, that they never occur in the white race. I removed one during the past year from the auricle of a German woman. 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

[1] Pathological Anatomy of the Ear. Translated by Orne Green, p. 23.

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

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, who use brass ear-rings, although the growths may occur even if gold ear-rings are worn. 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 toward the prevention of the custom rather than increasing the facilities for retaining it.

Dr. Agnew[1] reports a case of what finally came to be a myxo-fibroma of the auricle, which arose from a scratch from a toilet-pin. It occurred in a boy ten years of age. At the end of eighteen months a tumor occurred at the site of the injury, of the size of a buck-shot. It returned almost immediately, and at the end of two years it was again removed, and was found to be about three times the size of the original growth. Two years after, the tumor having returned, it was again removed. Dr. Agnew saw the boy when he had reached the age of eleven, and removed a tumor from the place from which these tumors had been removed. Six months after there was a small nodule in the lower end of the scar near the lobule. Removal of this was advised, but no subsequent history of the case is given.

In some cases it is impossible to heal the edges of the opening made for the ear-rings, so that there are a few females who are never able to wear them, on account of the impossibility of securing a sound cicatricial border. I once operated for the closure of a gap in the auricle, made by the dragging of the ear-ring. After paring the edges and uniting them by suture, a good result was secured. Wounds in this region heal readily, and with a remarkable absence of deformity. Sutures are well borne, and the pain in healing is generally very little.

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.

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[1] Transactions American Otological Society, 1876.

## ANGIOMATA.

Angioma of the auricle is not a common disease. Cases have been reported by Mussey,[1] Kipp,[2] Chimani,[3] Politzer,[4] and others. Chimani, however, entitles his case a cirsoid aneurism of the auricle and meatus. Repeated injections of chloride of iron seemed to cure the case, which was thus treated when the patient, a boy, was five years of age. In four years the disease had returned so as to be troublesome. The tumor was again injected with chloride of iron; three injections at intervals of some days were made, when the tumor of the auricle had nearly disappeared. That of the canal was removed by the knife. Kipp's case was the result of a frost-bite. After an injection of chloride of iron in the hands of another surgeon, the tumor increased in size. The tumor was situated on the outer side of the left lobule. It was of the size of a hazel-nut. The tumor was situated beneath the skin, which was movable over it, and traversed by numerous large veins. Dr. Kipp removed the tumor with the knife. The wound healed by first intention. It was found to be covered by a fibrous capsule. The tumor itself was composed of spongy tissue, similar to the *corpus cavernosum* of the penis. By the microscope the growth was seen to consist of a network of connective tissue trabeculæ. The walls of the spaces were lined with a layer of endothelial cells. Politzer[5] treated his case by cauterizing the part of the tumor lying behind the ear with Pacquelin's cautery (thermo-puncture). He first tried subcutaneously the largely dilated posterior auricular artery. The patient was dismissed cured in ten weeks. The auricle had decreased in size by two-thirds and no longer pulsated.

When an angioma can be readily separated from the surrounding tissue, enucleation is to be preferred to any other means of removal.

Dr. F. Eve[6] reported a case of aneurism by anastomosis occurring in the auricle, which probably started from a congenital nævoid growth. The whole pinna above and behind the meatus was enlarged, soft, of a dull red color and pulsating moderately. A humming bruit could be heard on auscultation. The right com-

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[1] American Journal of the Medical Sciences, 1853.

[2] Transactions of the American Otological Society, 1875, p. 79.

[3] Transactions American Otological Society, Blake's report, 1874.

[4] Text-book, p 634. Translation.

[5] Loc. cit.

[6] London Medical Times and Gazette, May 8, 1880.

mon carotid and the temporal and posterior auricular arteries were enlarged. Hemorrhage had occurred. The whole auricle was removed by Dr. Thomas Smith. There were changes in the tissue such as increase in the number of arterioles and capillaries, hypertrophy of the Malpighian layer of the cuticle, and enlargement of the sebaceous glands, which were attributed to the increased blood-supply. This case is probably essentially of the same nature with those described under the head of "Angioma."

Mussey's case of "aneurismal tumors upon the ear," is a remarkable one. There were three tumors. They apparently had their origin on a so-called *nævus maternus*. An alarming hemorrhage occurred from one of these about a month before Professor Mussey was consulted. They were compressible almost to obliteration, and communicated with each other. The common carotid on the side of the tumor was first tied; in four weeks, as the tumors were not markedly diminished, the carotid of the other side was tied. A cure was then obtained.[1]

## SYPHILIS OF THE AURICLE.

Bumstead and Taylor[2] state that only one case of chancre of the auricle has been reported. This was by Alb. Hulot, in the *Ann. de Derm. et Syph.*, t. x., p. 47. Paris, 1879. The secondary manifestations of syphilis are, however, occasionally seen upon the auricle. The various syphilitic eruptions may occur here as upon the other parts of the common integument. Ulcerative processes from syphilis may take place in the auricle. Gummy tumors may also occur in this part. It is hardly necessary to say anything more with reference to these evidences of constitutional syphilis, than that they should be subjected to the appropriate constitutional treatment by means of mercury and iodide of potassium, while soothing local applications are made.

## HORNY GROWTHS.

Buck,[3] Burnett,[4] and Pomeroy[5] report horny growths of the auricle. Their removal is, of course, easily accomplished. If not thoroughly done, the tumors will probably recur.

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[1] American Journal of the Medical Sciences, 1853, vol. xxvi., p. 333.

[2] The Pathology and Treatment of Venereal Diseases. Fifth edition, p. 789.

[3] Transactions American Otological Society, 1870.

[4] Treatise on the Ear, p. 231.

[5] Treatise on the Ear, p. 50.

## 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[1] and E. R. Hun,[2] 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. 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 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

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[1] Die krankha˜ten Geschwulsten, Bd. I., p. 135.

[2] American Journal of Insanity, July, 1870.

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 spurt 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

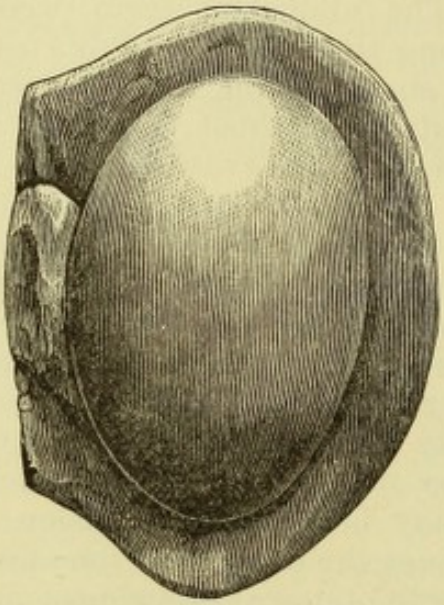

FIG. 36.—Othæmatoma. From a photograph taken from a plaster cast, when the tumefaction was greatest (after Hun).

FIG. 37.—The same Ear after Rupture and Contraction had taken place (after Hun).

must, therefore, I think, strictly distinguish the idiopathic from the traumatic form.

The etiology of hæmatoma is deemed by Hun to be two-fold, 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."

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

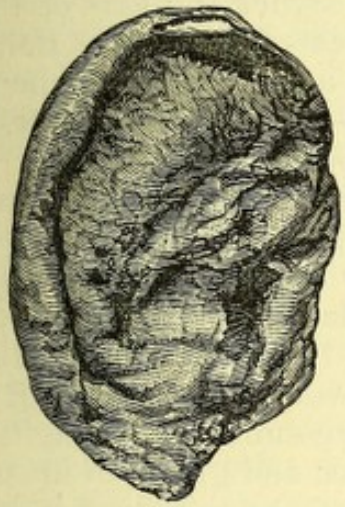

Fig. 38.—Showing Amount of Contraction after Rupture of Cyst (after Hun).

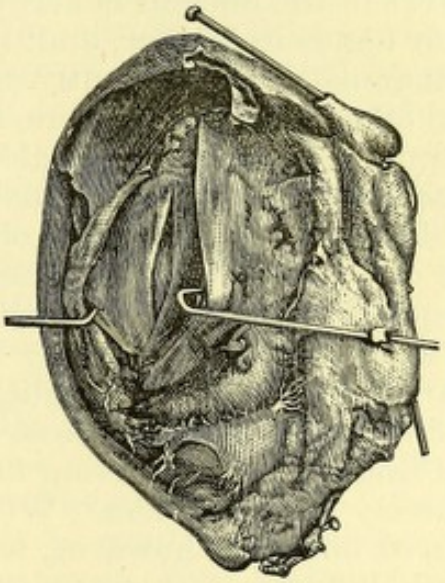

Fig. 39.—Shows Separation of Perichondrium from the Cartilage (after Hun).

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 afterward serve as means of adhesion. When suppuration does not take place, great deformity is apt to occur from the thickening and retraction of the soft parts, especially of the perichondrium.

CASE II.—D. M——, æt. —. Melancholia. Second attack. Hæmatoma began May 18, 1869. On July 3d had hæmatoma on both ears. August 1st 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 twelve feet. Died September 9, 1869. A section of the 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.

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 pre-eminent for pugilists, scarcely mention them. Wilde[1] 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[2] 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 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

[1] Aural Surgery, English edition, p. 164.

[2] Diseases of the Ear, American edition, p. 53.

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 was so strongly of the opinion that the idiopathic othæmatoma are symptoms of insanity, that he considered 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 I obtained in a conversation with him upon this subject.

While Professor Brown-Séquard was a resident of New York, I had an interesting and instructive interview with him on the subject 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 twelve to twenty-four 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 clinical observations of the latter.

Meyer[1] and Blake[2] report cases of othæmatomata in which pressure and massage were employed in treatment with good results. Both of Blake's cases were males, with no trace of other physical disease, of sound minds, and with "no antecedent or individual history of insanity or intemperance." The first case, however, occurred in a pedestrian, being the "champion short-distance walker." As Dr. Blake suggests, this occupation, from

[1] Archiv für Ohrenheilkunde, vol. xvii., p. 2.
[2] American Journal of Otology, vol. iii., p. 193.

its severe strain upon the muscles and the circulation, may have had some bearing upon the etiology. This patient flushed easily under any physical exertion or slight mental excitement. The tumor was opened, two drachms or more of bloody serum and a little dark blood withdrawn, the cavity was then well probed, and sponge pads were adjusted to the anterior and posterior surfaces of the auricle and kept in place by an elastic flannel bandage. This treatment was continued for a week, and then massage was employed four times at the interval of several days for about fifteen minutes at each visit by an expert, Dr. Graham, of Boston. "The tissues were gently and firmly rolled between the thumb and finger with gradually increasing force until the last five minutes, when the pressure was gradually diminished." Under this treatment the ear resumed its normal appearance in about two months.

In the second case, that of a teamster, the hemorrhage occurred the day after the patient had exerted himself very much in loading heavy bales of goods. He was a temperate man, but undersized, and was occasionally subject to very severe exertion in his business. He was seen by Dr. Blake on the very day the hemorrhage occurred. The same treatment was applied as in the previous case, and on the fifth day the auricle had nearly resumed its normal appearance, and the patient was discharged. Meyer's cases did not do quite as well as these. Blake thinks it possible that the stuffing of the cavity with picked lint and too frequent massage—four times daily, as practised by Meyer—may have prevented the best results.

The result in three of Meyer's cases was very satisfactory; in two of them resorption took place within a few weeks, and there was finally no deformity of the auricle. It is interesting to note that one parent in each of Meyer's cases had been insane. In view of this, Meyer calls attention to Hun's observation, that the appearance of othæmatoma in sane persons usually precedes a later mental disturbance, and agrees with my own opinion, that while all those suffering from this vascular tumor of the auricle may not be insane, yet they probably have some kind of disease of the brain. These observations seem to be borne out by Brown-Séquard's experiments, and by an analysis of the cases of Blake and Meyer. Othæmatomata do not seem to occur in persons entirely free from cerebral disease.

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, or they may belong to the large class of neurotic or neurasthenic people.

*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.

*Fourth.* — The treatment by pressure after evacuation of the contents, followed by moderate massage, seems to give very good results and may be confidently practised.

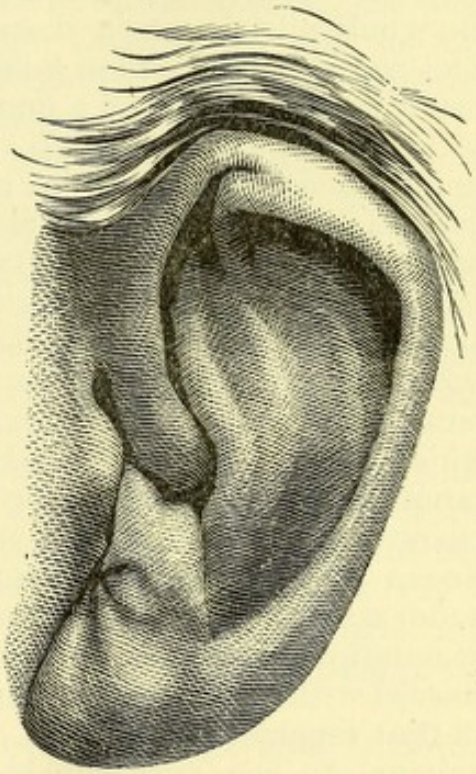

FIG. 40.—Auricle Deformed by Inflammation (chondritis).

### PERICHONDRITIS AND CHONDRITIS.

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.

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 for the relief of what was supposed to be a furuncle, 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.

Several cases of inflammation of the tissues of the auricle

have been published since my case was reported in 1873,[1] and some of the reporters have fallen into the natural error of stating that similar cases have not been before noticed. All these cases, although differing in minor respects, agree in being essentially inflammations of the perichondrium, and in leaving some deformity behind them as a rule. I did not name my case perichondritis, when it was first reported, but a comparison of the account of the case with those of later writers will show, I believe, that the various reporters are speaking of the same form of disease. Chimani was one of the first, if not the first, to report a case of perichondritis[2] of the auricle. His was that of a soldier in the Austrian army, who was suddenly seized with a sensation of heat and pain in the left auricle, with swelling of its concave surface. Four days after the attack, when he entered the hospital, the whole auricle was a shapeless mass of inflammation. Poultices were applied, and in three days fluctuation appeared. An incision was made; quite a quantity of synovial-like fluid mingled with pus was evacuated. It was afterward treated as an abscess and dressed with picked lint and a bandage. In two weeks after the patient came under Chimani's care, the auricle had recovered its normal form and elasticity. Chimani considers this case as a primary one of the perichondrium—"an inflammation with the formation of exudation." The absence of a bluish-red coloring and the character of the contents distinguish it from a vascular tumor. Dr. Pomeroy's[3] case of abscess of the auricle was one in which the disease extended from the tympanic cavity to the canal and thus to the auricle. The patient was a man forty-two years of age. The auricle did not become involved for some weeks after the primary inflammation. The patient was not under constant observation, and recovery took place after free evacuation of the pus, with great deformity. This case is to be classed with those of secondary inflammation of the auricle, such as that reported by myself. It may be said here, that it is not unusual to see very considerable swelling of the cartilaginous part of the canal following an inflammation of the tympanic cavity. This usually subsides under the use of the warm douche, and generally without extending to the auricle. Knapp[4] reports three cases. The first began as an inflammation of the canal, and after some weeks recovered also with deformity. The second case was seen but once, and no details are given except that there was fluctuation in the concha. The third case

[1] Transactions of American Otological Society.

[2] Archiv für Ohrenheilkunde, Vol. II., p. 171.

[3] Transactions of the American Otological Society, Vol. II., p. 83.

[4] Archives of Otology, Vol. IX., p. 196.

was one shown Dr. Knapp by his colleague, Dr. Brandeis. Dr. Brandeis' patient had a "mild chronic aural catarrh." There was a reddish diffuse swelling of the cartilage of the meatus and the adjacent parts of the concha. After an incision watery pus escaped, and the swelling disappeared in a few weeks.

Pooley's case[1] occurred in a woman of twenty-one. When she came under Dr. Pooley's care, there was the history of a boil in the ear; the swelling extended from the canal to the concha, and finally to the entire anterior surface of the concha. It was treated by incisions, injections of a weak solution of carbolic acid and iodine. Pressure was also employed by means of a bandage. The pressure seemed to alleviate the pain. Considerable deformity of the concha remained. The acute inflammatory symptoms lasted for about two months, and, as in all these cases, the long-continued suffering, the discharge undermined the general health. Pooley does not regard frequent incisions as assisting very much, but as perhaps aggravating the case.

The lobule may be affected in perichondritis and may not. The cases reported do not differ in character, but simply in intensity and course. Dr. Knapp's case, like mine, arose from a furuncular inflammation, and after this suppuration of the drum-head occurred. This is an unusual order of things. Whether or not the lobule is affected certainly depends upon other causes than the existence of a perichondritis. In my case there was perichondritis and also a slight affection of the lobule.

These cases, except that of Chimani, are essentially the same with that reported by me in full in 1873.[2] As I then said, the extension of the inflammation of the auditory canal to the cartilage and perichondrium of the auricle is unusual. I believe with Pooley, that incisions may be too frequently made, and that they are rather to be avoided than employed, although not entirely given up.

Kipp[3] also reports, under the head of "Spurious Othæmatoma of Both Ears the Result of a Burn," a case of perichondritis of the auricle. In his case there was scarcely any deformity, simply a wrinkled condition of the fossa of the helix. After incision Kipp employed tincture of iodine to the outer and inner surface of the swellings.

It will be seen that Chimani's case is the only one of those here reported, that bears any close resemblance, in its origin or course, to the othæmatomata. The others are clearly like the

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[1] Medical Record, 1881.

[2] Transactions American Otological Society. Boston, 1873.

[3] Ibid., 1873.

cases of Dr. Pomeroy and myself, and belong to those of secondary inflammations. While this form of disease, as has been said, is rare, the primary form is much rarer.

Chondritis and perichondritis of the auricle may result by simple extension of an inflammation of the cartilage of the canal. It is probable that prolonged poulticing may favor such an extension. The deformity from such an inflammation will be considerable, under the most favorable circumstances, if the inflammation once set in. When fluctuation occurs, it is better to make a thorough opening, and to connect sinuses by cutting so as to convert them into open wounds. Gruening recommends cutting through the entire auricle, from before backward; while it is of the utmost importance to secure thorough drainage, I do not think incisions entirely through the tissues necessary for this. Iodoform gauze forms a good dressing after incisions. Vaseline is a good application for the swelled tissue when suppuration does not occur. Over this, cotton wool and a bandage generally form a comfortable dressing, and perhaps aid in lessening the inevitable deformity. I have seen several of these tedious and trying cases since the last edition of this book was issued, and see no reason to doubt my original opinion that they usually originate in the cartilage of the canal, and that any case of furuncle under unfavorable conditions, or perhaps injudicious treatment, may result in chondritis or perichondritis of the auricle. Perichondritis and chondritis may be readily distinguished from othæmatoma, if the disease be seen early in its course, but when the canal, if once diseased, has recovered, and the auricle alone remains affected, there may be a possibility of error.

### MALIGNANT DISEASE.

*Epithelioma.*—The auricle is sometimes, although not frequently, the seat of malignant disease. 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,[1] 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

[1] Transactions American Otological Society, third year.

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 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, 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.

The accompanying engraving is a representation of a tumor

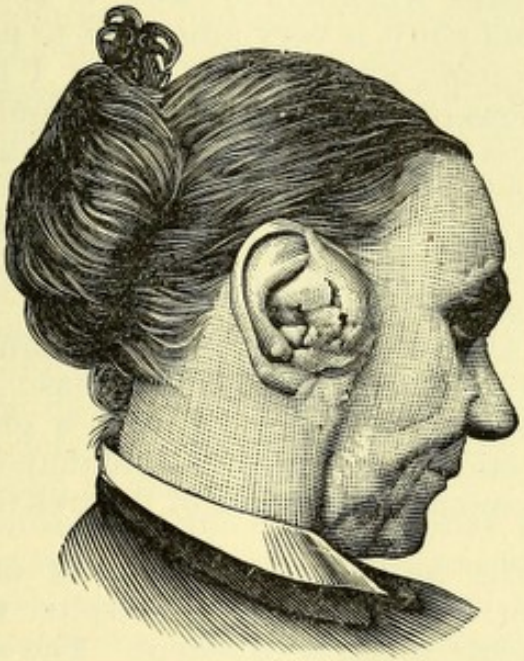

FIG. 41.—Tumor of the Anterior Part of Auricle and Auditory Canal.

of the auricle, apparently beginning in the parotid gland, which was seen at my clinic in 1883. The patient was a woman of about forty-five years of age, otherwise healthy.

## 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,[1] formerly an assistant to Hebra, 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 more serous fluid than is usual, together with the more frequent appearance of fissures in the tissue.

*Treatment.*—The results of treatment of acute eczema are usually soon seen. 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 :

℞. 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

[1] Archiv. für Ohrenheilkunde, Bd. I., p. 124.

solutions of sulphate of zinc may be used. I usually employ vaseline or cold cream in the early stages of eczema of the auricle. Cod-liver oil is also a good application. I endeavor to keep the parts constantly covered with such a non-stimulating ointment as one of those just named.

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

Eczema of the auricle and auditory canal is not often brought to the notice of the surgeon until it has become chronic. Its treatment then may require the greatest patience and care. The treatment which I have found usually successful is the following: The auricle is carefully, but liberally, anointed with a one per cent. solution of carbolized oil. The auricle is then covered with an impermeable sheeting of rubber tissue-paper or oiled silk, in order to keep the parts soft and pliable, and bandaged accordingly. An improvement will soon be noticeable, inasmuch as the crusts will become detached. The inflamed corium which is now exposed will soon yield to a soothing salve.

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

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—impairment of hearing. The auditory canal should be therefore carefully cleansed every day with the syringe and angular forceps or cotton-holder, under a good illumination with the otoscope, and then an appropriate *liquid* application be made. A liquid preparation is to be preferred to an unctuous

one, 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 obstinate cases of inflammation of the canal, that have existed for years, cured by its use alone.

The application of nitrate of silver in solutions of from ten to forty grains to the ounce, is, I believe, on the whole, the best that can be made in the treatment of eczema of the canal. The disease may be often complicated with aspergillus, or a vegetable fungous growth in the canal. Diachylon ointment on a little cotton, forms a good application to keep apart the walls of the canal at the meatus.

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

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

There are various arsenical waters that are of service in the treatment of chronic eczema in the ear, as well as that affecting other parts of the body. One that I have used with apparent benefit is from the Virginia Springs.

### ERYSIPELAS.

Facial erysipelas often begins at the auricle, and sometimes it is limited to this part. It sometimes also occurs in the course of chronic eczema. Indeed, erysipelas occasionally has its origin in a small eczematous patch or spot near the auricle. It is probable, however, that this never occurs if the subject be in good general condition. The local treatment that I have employed with satisfaction, is an application of a solution of acetate

of lead, in tincture of opium and water, the famous lead-and-opium wash. It is important, especially in delicate subjects, that eczematous spots behind the ear be promptly treated, lest they become the starting-point of erysipelas. Oxide of zinc ointment is a good application for small eczematous ulcers.

### THE EFFECTS OF GOUT.

Calcareous formations are often found in the auricle, in persons of a gouty habit, as in other parts of the body. These symptoms of gout are often accompanied by a great deal of local pain, which is sometimes relieved by an unctuous application to the hardened and tender parts. Dr. Garrod,[1] 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 saw 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.

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

### INJURIES OF THE AURICLE.

Wounds of the auricle may sometimes be followed by an erysipelatous inflammation, but this is not apt to be the case.

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

### ANGIOMA.

At the February meeting (1884) of the New York Ophthalmological Society, Dr. E. Gruening reported an interesting case of angioma, of which he has been kind enough to furnish me an account for these pages.

In October, 1883, a man, aged twenty-three, consulted Dr. Gruening on account of a circumscribed swelling in his right ear. He stated that he had first noticed

[1] Tröltsch: Diseases of the Ear, p. 56.

a little growth two years before. He had never suffered from any injury of the ear. No congenital anomaly had been observed. He consulted Dr. Gruening about the tumor because its pulsating sounds had become very annoying, especially in the stillness of the night. There was found a semi-globular, bluish, soft, and strongly pulsating tumor occupying the right concha and encroaching somewhat upon the lower wall of the external auditory canal. The tumor had a diameter of fifteen millimetres at its base, and an elevation of nine millimetres above the surrounding skin. Pressure with the fingers easily emptied the tumor, but the pulsation was not diminished by pressure upon the arteries of the head and neck. The whole mass was excised on October 25th. The incision was carried through sound skin and the underlying cartilage was removed with it. The copious hemorrhage, venous from the centre and arterial from the edges, was arrested by pressure. The wound healed slowly by succulent granulations. Four weeks later a soft pulsating cicatrix had formed.

Dr. Gruening's case is an essential contribution to our knowledge of this rare affection. If the pulsating cicatrix enlarges or is troublesome to the patient, it will be proper to excise it.

# CHAPTER V.

## DIFFUSE AND CIRCUMSCRIBED INFLAMMATION OF THE EXTERNAL AUDITORY CANAL.

Comparative Frequency of these Affections.—Diffuse Inflammation.—Leeches.—Incisions.—Warm Douche.—Fountain Syringe.—Fayette Taylor's Douche.—Method of Syringing.—Syringes.—Anodynes.—Desquamative Inflammation.—Furuncles.—Local and Constitutional Treatment.—Calcium Sulphide.—Lowenburg's Views.

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. Narrowing and closure of the canal.
X. 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 generally 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 that part. 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 6,800 cases of the different

varieties of aural disease observed by myself in private practice, but 387 were cases of inflammation of the auditory canal. This proportion varies somewhat from the statistics of other authors and those of public institutions.

In the Manhattan Eye and Ear Hospital, during the past nineteen years, there were examined 20,103 cases of aural disease. Of these 1,060 were cases of inflammation of the external auditory canal. This does not include cases of impacted cerumen or foreign bodies, or inflammations which had their origin in the parts beyond and extended to the canal. Including inspissated cerumen and foreign bodies, there were 3,538 cases of affections of the external canal, or about one-sixth of the whole number.

Dr. Bückner, of Göttingen, has compiled a table of reports from various authorities.[1] In a total number of 58,645 cases of diseases of the ear thus reported, there were 14,905, or 25.5 per cent., of affections of the external ear.

The highest percentage of diseases of the external ear in Bückner's tables is 39.5 (Ocker), the lowest 13.3 (Roosa). In Wilde's tables,[2] also quoted by Bückner, the percentage of external affections is very high, 55.8. Since the time of Wilde it is undoubtedly true that our means of diagnosis are better, and we are enabled to transfer many cases from the column of the external auditory canal, to that of the middle ear.

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

An account of diffuse or general inflammation of the external auditory canal will first be given.

## DIFFUSE INFLAMMATION.

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

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 that in which the itching sensations occurred, as the one

[1] Archiv für Ohrenheilkunde, 1883.

[2] Text-book, English edition, p. 114.

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 perhaps of the membrana tympani, swelling, and, at a subsequent period, suppuration of the epidermis and integument. In the lower part of the canal, where we have the density and tenseness of periosteum, the pain may be as severe as that from inflammation of the lining of the tympanic cavity, or as that occurring in paronychia.

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 seen several 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.

Another case occurred in an Irish laborer, whom I saw while I held a clinic in the University Medical College. I removed a large polypus from the canal, 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 drum-head, 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.

A 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 practitioner need give himself no uneasiness about the occurrence of these granulations. As a rule, they subside spontaneously. If not, when well pedunculated they are easily removed with a curette with sharp edges.

The microscopic appearances of the growths are identical with those of polypi springing from the mucous membrane of the cavity of the tympanum, 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. 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 Haarlem oil, Cologne water, camphorated oil, and so on, are frequent causes of an inflammation of this part.

Surf-bathing sometimes is a cause of inflammation of the auditory canal and outer layer of the membrana tympani, either with or without an inflammation of the middle ear. This is not apt to occur among careful, intelligent persons. In surf-bathing the bather should take a little pains that the shock of the waves does not come upon the side of the head, but in front. When the ears are filled with water, they should be carefully dried. Prolonged and repeated diving should be avoided, especially by those who have sensitive or diseased ears. Caps of oiled silk and plugs of oiled cotton are also useful in bathing to those whose ears are sensitive to the entrance of salt water. In serious cases of aural disease, sea-bathing must be prohibited. This subject will be again alluded to in the discussion of diseases of the middle ear.

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.

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

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

Cousins, of London,[1] recommends a little conical cap of vulcanite, made of flesh-colored material, as a protector to the auditory canal from cold and noise, and from water in bathing. This

[1] British Medical Journal, December 31, 1881.

protector seems to me to be an excellent contrivance for use in the cases where protection of this kind is needed.

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 diffuse inflammation of the external auditory canal (*otitis externa diffusa*) in an adult may often

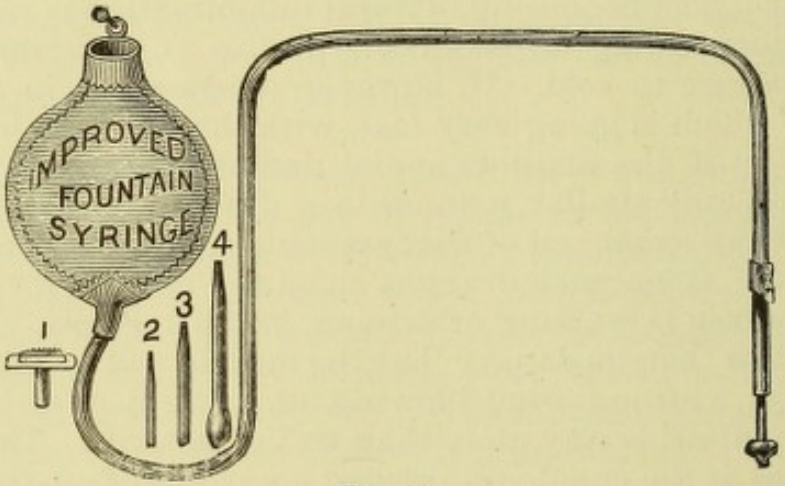


FIG. 42.

be 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 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 to afford relief, 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 the fountain syringe, the Fayette Taylor douche, Clark's douche, or any similar

means. 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. I am thus particular in my advice, because, even to this day, I find that many physicians advise that warm water be applied to the ear by means of the piston syringe instead of by a douche. 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 in the minds of a profession filled with the idea of the virtues of composite "ear-drops."

The fountain syringe and Taylor's douche are more convenient than the solid cup making up Clarke's douche, and they have pretty generally superseded the latter.

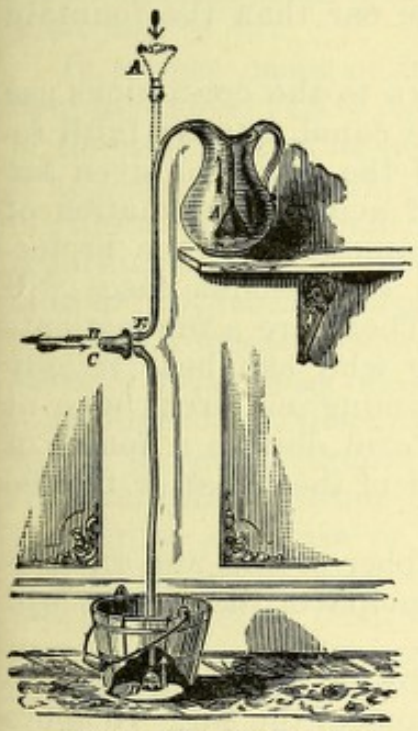

FIG. 43.—Fayette Douche.

The Fayette aural douche[1] consists of two siphons, so arranged that the flow starts at the same moment in each; and while one siphon conveys the water into the ear the other lifts it gently out, without friction or pressure upon the inflamed tissues.

In the figure, *BC* represents the *ear-piece*, which is made of suitable size and shape. Two holes are bored through it, one lying above the other when it is in its proper position. On each of the two projections at the larger end, a piece of flexible rubber tubing (such as is used for nursing-bottles), about four feet long, is fitted. At the small end of the ear-piece the division between the holes is cut back about one-eighth of an inch, so that placing the finger over this end leaves one continuous passage from the top, *A*, to the bottom, *D*. With the finger over the small end of the ear-piece, as just described, when water is poured into the funnel *A*, it will flow directly through both tubes, and come out at the lower end, *D*, in the drip-vessel. When all the air has thus been excluded and a current established, the funnel *A* is dropped into the basin or pitcher which serves as a reservoir, and a single siphon is formed. The rubber tubes are now compressed by the thumb and finger at *E*, so as to arrest the

[1] Archives of Otology, Vol. VIII., p. 355.

flow, the finger is removed from the end *BC*, and the ear-piece is inserted into the auditory canal; then letting go the tubes at *E*, a *double* siphon is instantly established, *AB* conveying the water into the ear, and *CD* carrying it out by atmospheric pressure. Thus the resistance and pressure, often painful, of the in-coming and out-going currents is avoided, and a small amount of constantly changing water, of any desired temperature, is kept in contact with the auditory canal and drum-head. Any amount of water desired can be used in one continuous bath, without the trouble of refilling the reservoir several times, as is so often required in using the fountain syringe.

Dr. Taylor invented this douche while under my care, and he found it, as have many of my patients since, a pleasanter method of using a warm douche to the ear than the fountain syringe.

Objections are made by some writers to the continuous use of warm water in inflammations of the canal, but my faith remains unshaken in the great value of the warm or even hot douche in the vast majority of cases of acute inflammation of the canal and tympanum, and I recommend it to the profession in great confidence that only in exceptional cases will they be disappointed with its effects. There are a few patients who never find it pleasant, and some who can bear it only for a time, but most patients, even young children, who at first object to its use, soon find in the warm douche a source of relief from pain in acute inflammation of the canal or middle ear.

In the absence of the cup, a bit of rubber tubing and an ordinary bowl, by the application of the principle of the *siphon*, will make an efficient and simple douche.

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 meatus, over the mastoid, and in front of the auricle; but the ear should not be covered by a large poultice, as is often done, for reasons that have been already fully given. 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 cot-

ton, and the patient should lie on a pillow that is warmed from beneath, by means of a rubber bag filled with hot water, or some similar contrivance. A plug of cotton saturated in glycerine or smeared with diachylon ointment, is also of value in subacute cases. 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.

In severe cases of inflammation of the external ear occurring in adults, I have lately, at the suggestion of Dr. W. S. Ely, of Rochester, used at bed-time, to be repeated every two hours, if necessary, a formula, embracing sulphate of morphia, hydrate of chloral, and bromide of sodium in each dose, with the effect of securing sound sleep in cases where other means for the relief of pain did not enable the patient to get but snatches of repose. The wit of the medical attendant will sometimes be taxed to its utmost in order to secure rest for his patient suffering from acute inflammation of the auditory canal. Indeed, I find it generally easier to secure prompt relief from a pain in the ear, arising from an inflammation of the tympanic cavity and mastoid cells than from a diffuse or furuncular inflammation of the canal. Yet, in all the anxiety to relieve pain, the physician may derive much consolation from the knowledge that the patient will ultimately recover with perfect hearing, if the auditory canal and drum-head be the only parts seriously involved.

The popular remedies for ear-ache, dependent upon whatever cause, are usually sweet-oil and laudanum, molasses, Haarlem 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; the leeches sometimes also fail us in the disease now under discussion.

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. Haarlem 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 vapor of chloroform, 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 slowly 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. I formerly supposed that they were not of much value except in chronic cases, but I am convinced that harsh as is the remedy apparently, it is sometimes very efficient. The following case is one almost in point, and I do not now hesitate to advise blisters in severe inflammations of the canal as well as those of the middle ear.

I lately saw a case in consultation with Dr. S. Beach Jones, of acute catarrh of the middle ear, occurring in the course of measles, in a young boy, for which the mother had applied a blister over each mastoid, and apparently with good effect. In these days of pleasant remedies this seems harsh treatment, but the mother and the boy seemed satisfied with what Dr. Jones and I would have hesitated to recommend. I only object to blisters because I think better results may be attained with milder means. Their efficacy can hardly be doubted in many cases. 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. Warm douche; 3. Blisters; 4. Scarification; 5. Conical poultice in the canal; 6. Steam or warm vapor; 7. Narcotics.

Dr. A. D. Williams recommends the use of a solution of a sulphate of atropia, two to four 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 found this an uncertain remedy, but in some cases it quiets pain. I think, however, that it is more apt to be of use in the rare cases of neuralgia of the ear—cases where there is pain without the usual signs of inflammation—than in external otitis. Knapp[1] reports a case of

[1] Archives of Otology, Vol. XI., p. 23.

transient poisoning from the instillation of a few drops of atropia in the auditory canal. The patient was a woman of twenty-five, in good health. Four hours and a half after dropping in a half per cent. solution of sulphate of atropia the hands of the patient began to swell and become stiff, the face became scarlet, her throat dry and so forth. The symptoms abated in about five hours. The pain in the ear was relieved and a subsequent instillation of a weaker solution had no evil effect. The auditory

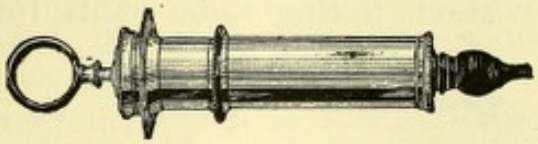

FIG. 44.—Syringe for the Ear.

canal and membrana tympani were free from excoriation and ulcer. We sometimes see this extreme susceptibility to atropia, but it is so rare, that I do not think it is to be regarded if it becomes necessary to use it for the relief of pain. I wish I could say, that it had often proved an efficient agent in my hands for the relief of the pain of otitis.

Most adult patients go about while suffering from external diffuse otitis. During the more acute stages it would be better

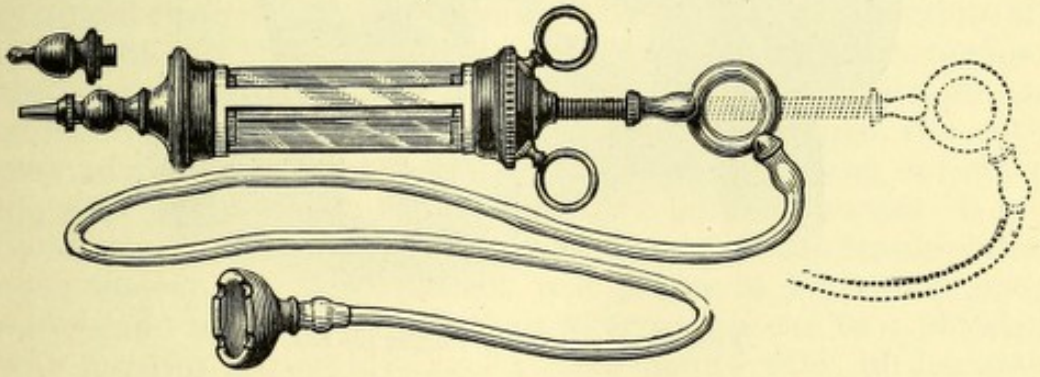

FIG. 45.—Reservoir Syringe.

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 piston syringe is the best, and I do not advise the common soft rubber enema syringe called "Davidson's" in this country. The glass syringes are of no use whatever.

Where patients are likely to need an aural syringe for a long time, it is better to advise them to get one made of brass or German silver. The hard-rubber syringes are carelessly made as a rule. Indeed, the practitioner will find it difficult to secure a good syringe without taking some pains, for even the metal

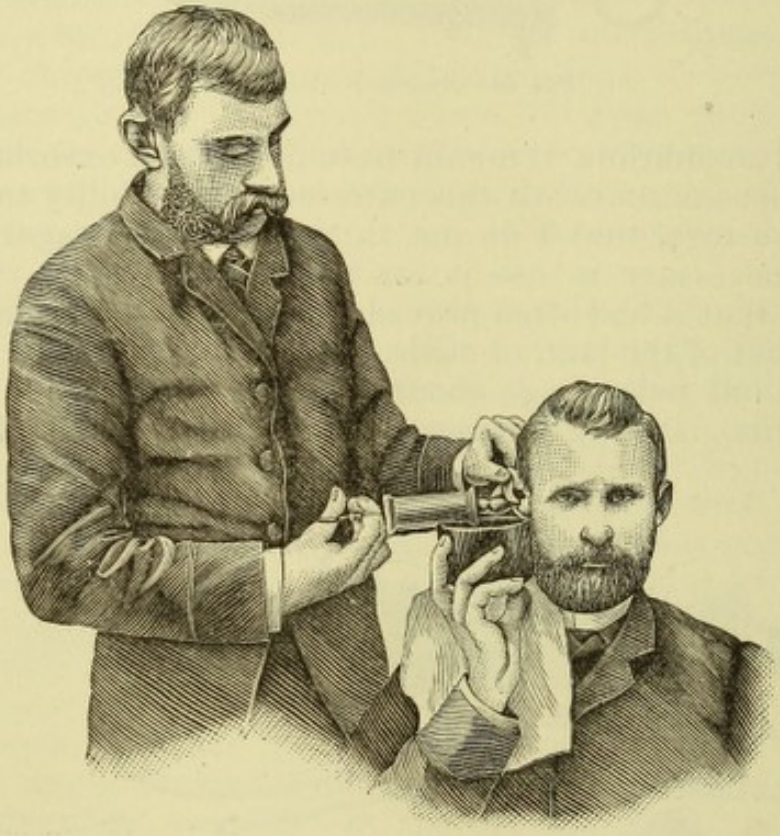

FIG. 46.—Method of Syringing the Ear.

ones sold by the instrument manufacturers of New York are often very carelessly made. Luer, of Paris, sells a reservoir syringe, represented in Fig. 45, which is exceedingly useful, especially in hospital practice, where much use of a syringe is required.

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 injury from 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.

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, and, if it be perforated, the tympanic cavity. 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 syringed from one to three times daily while the secretion is at its height. It should afterward be carefully dried by means of absorbent cotton, upon a cotton-holder. The cotton-holder may be made of wood or metal. If the end be roughened, the cotton may be more easily kept upon it. Neither syringing nor cleansing with a cotton-holder need be at all a painful process ; it must be done *gently*, and this direction applies to all the manipulations upon the ear. A wise patient will prefer to leave his case to nature and to his own care, than to trust his ear to a physician who handles it roughly. As I have before said, in discussing another subject, one of the best means of becoming a gentle and successful aural surgeon is to submit one's self to the use of the Eustachian catheter, the speculum, syringe, and cotton-holder before beginning to practise upon patients.

The agents which may be used in checking ulceration in the canal are numerous. I perfer 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. The patient or his attendants should use the syringe from once to four times a day, according to circumstances.

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. Astringent or absorbent powders are more applicable to diseases of the middle ear than to those of the canal.

Indeed, careful and thorough cleansing, without the subsequent use of astringents, will often effect a cure. It is now my habit to delay the use of astringents until I am sure that no progress in a case is being made without them. In some cases I am never compelled to resort to any other treatment. This is sometimes overlooked by those who attach much importance to the use of constitutional remedies or internal medication in the treatment of localized suppurations of the ear. A suppuration of the external auditory canal, like the same disease in the middle ear, has a natural course, which often needs mere guidance to lead it to a successful termination. To study this course is more important for the young practitioner than to learn what drugs are said to be of service in certain diseases.

If the pain be severe and the tension evidently marked, the proper treatment is incision. A narrow knife is a very good one for the operation. The incision should be deep and free. In very delicate and sensitive patients it may be well to put the patient under the primary anæsthetic effect of sulphuric ether before making the cut. This is done by causing the patient to inhale the fumes of the ether in the usual way, holding up the arm while inhaling. When the arm drops, usually in twenty seconds, the incision may be made without causing pain, while not enough ether will have been taken to cause nausea or vomiting or other serious inconvenience. In place of the ether patients may take a dose of brandy or whiskey before submitting to this painful operation. I dare not recommend any other anæsthetic than sulphuric ether, even after hearing all that is said for chloroform, bromide of ethyl, and the rest.

In the writings of Dr. Buck[1] and others, some stress is laid upon what is termed "desquamative inflammation" of the ex-

[1] Diseases of the Ear, p. 86; also Medical Record, December 15, 1877.

ternal auditory canal. A separate form of diffuse inflammation is made by this method of naming diseases, but I continue to regard the desquamative variety as merely one of the very common stages of diffuse inflammation. A certain amount of desquamation must occur in any severe inflammation of the integument of the canal. The kind of desquamation described by Buck, I have often observed in cases of aspergillus of the canal, and also after eczema and impacted cerumen. I think bichloride of mercury, gr. $\frac{1}{10}$ to gr. $\frac{1}{4}$ ad aq. $\bar{3}$ j., and nitrate of silver and pure alcohol, particularly well adapted for the treatment of these cases.

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

### CIRCUMSCRIBED INFLAMMATION, OR FURUNCLES OF THE EXTERNAL AUDITORY 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 impairment of the hearing 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 otoscope. One or more circumscribed swellings are found in the calibre 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. If the pus be deeply situated it will be better to make the incision with a scalpel, cutting downward. If it be near the surface a bistoury may be used, and the cut made from below upward. The ear should be syringed with warm water after the 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 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. Sometimes steam, conducted into the canal from any suitable vessel, is of great comfort to the inflamed part.

Leeches are not usually of much service in furuncular inflammations of the canal. Warm water is not always well borne, but in the majority of cases it is of the greatest value in palliating this troublesome affection. In this respect I cannot agree with Politzer,[1] who thinks the warm douche gives rise to fresh eruptions. After all my experience in this painful, although not dangerous affection, I still hold to the knife, warm water, small poultices in the meatus and in front and behind the auricle, and the internal administration of narcotics, as being, on the whole, the best means of treatment.

Dr. Buck[2] thinks that we cannot expect the same relief from an incision into the auditory canal as that made in paronychia, because "a comparatively unyielding cylinder of cartilage surrounds the inflamed tissues and renders relaxation of the parts almost an impossibility." I think there will be no difficulty in relaxing the tense point, if the incision be made *through* it. In order to secure this, the surgeon should feel about very carefully with a probe for the most sensitive part before operating.

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[1] Text-book, Cassel's translation, p. 600.

[2] Text-book, p. 71.

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

Buck and Politzer have seen furuncles of the ear occurring in persons otherwise in good health, but, as I have already said, I consider auditory furunculosis to be an indication of a low state of the system, and I do not think I have ever seen a primary affection of this kind in a thoroughly well person. When such cases come to me, I invariably find a necessity for constitutional treatment. It is not unusual to observe a circumscribed inflammation of the canal after a tedious or severe suppuration of the middle ear, or rather while it is in progress, but this I consider an entirely distinct affection from that which is now being discussed.

Ringer,[1] in an article upon the sulphides, in his work on therapeutics, says that the sulphides appear to him to have the property of preventing and arresting suppuration. He thinks that in an "inflammation threatening to end in suppuration they reduce the inflammation and avert the formation of pus." Based upon Ringer's statements many cases of suppuration of the various parts of the ear have beent reated by Sexton, Bacon,[2] Rupp,[3] and others, and reports of the results made in special and general journals. These writers are loud in their praise of the value of the drug when used to prevent or limit suppuration in the ear. The Therapeutical Society of New York reported on the whole favorably upon the results of the drug in suppurations. I have given the sulphide of calcium a fair trial, and I have never seen any benefit whatever from its use. I have also carefully studied the reports of the cases furnished by the various authorities just quoted, and I fail to find any evidence in them that the favorable results are any different from those occurring in similar cases when no drug was used internally. It is the habit of those who use the sulphide of calcium, as will be seen by a study of their cases, to employ all the local means that are used by surgeons in treating suppurations. It is claimed that the use of the knife is avoided by the abortive power of the drug.

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[1] A Hand-book of Therapeutics, p. 137. Tenth edition. New York, 1883.

[2] Archives of Otology, Vol XV., p. 122.

[3] American Journal of Otology, Vol. IV., p. 194. Transactions of the American Otological Society, Vol. III., Part II., p. 181.

But all of us see many cases subside without incisions and when no internal medication is employed. Sexton[1] says, "In some instances I rely entirely on this remedy (calcium sulphide) in the treatment of inflammation in the ear; but free incisions are in some instances of course not to be omitted."

The question of the value of internal medication is one notoriously hard to solve; but certain it is, however, that calcium sulphide has not yet obtained a firm hold upon the profession as a means of aborting or checking suppuration. I have not been able to satisfy myself that we as yet have any specific for aural inflammations of a suppurative character.

We shall probably not be done with the case when one furuncle has been evacuated, and has healed; for here, just as in other parts of the body, one boil is apt to follow another in rapid succession.

I have recently used a menthol solution, as advised by German writers, but I have not found this to be an abortive, although it is on the whole a good application. If there be, as there perhaps is, a specific bacillus to be found in furuncles, an agent to kill this would be in order. Yet, I think, there is a soil prepared for it before the germ becomes noxious, here as elsewhere. But we should be on the alert for any means of cutting short this obstinately recurring affection. It is well to remember that the old English adage, *an ounce of prevention is worth a pound of cure,* holds good in medicine as well as in other arts.

*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 good 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.

Dr. Lowenburg,[2] of Paris, examined furuncles of the auditory canal, prior to their opening, before the pus formed in them had come into contact with the atmosphere. The pus freshly

[1] American Journal of Otology, Vol. I.
[2] Archives of Otology, Vol. X., p. 220.

obtained was cultivated in beef soup or diluted extract of beef. The coccus of furuncle was abundantly produced by these experiments. Lowenburg regards these micro-organisms as the cause of furuncular inflammation. Micrococci suspended in air and water get into the canal, and passing into the glandular structure set up inflammation.

His exact language is, "I think that every furuncle is an *invasion* of a particular species of microbes, which exist in the air and in water, and which are multiplied under the influence of the decomposition of certain substances. In consequence of some circumstances still unknown, these microzotes (microzoaires) enter a pilo-sebaceous follicle; they then fructify and excite the characteristic furuncular inflammation." Lowenburg then goes on to show that once having entered the follicle, the micrococci propagate themselves by what he styles "auto-infection." The parasitic origin of furuncles is further substantiated, in Lowenburg's opinion, by the fact that they chiefly occur in parts exposed to the air, the face, the hands, the neck. "The first aural furuncle," he continues, "is found at the entrance of the canal, the succeeding ones affect the deeper parts, and the predilection of furuncle for those who handle rags."

The contagiousness of furuncle is also insisted upon by this writer, and he records a case where a strong and healthy man suffered from one in the ear after his wife had been affected by one. The furuncle in the man was in the left ear, in a corresponding situation to one in the right ear of the wife. Lowenburg treats furuncle by an incision, under local anæsthesia by the cold spray. The part is then kept moist with solutions of thymic or boric acid. Weber-Liel injects their tissue with a solution of phenic acid. Lowenburg considers that poultices favor the formation of micrococci, and that they should not therefore be used in the treatment of furuncles in the ear. These views of the parasitic origin of furuncles are entitled to great respect in the present condition of the mind of the profession, in regard to the parasitic origin of disease, yet I cannot regard it as yet settled that micrococci are not consequences rather than causes of the diseases thought to be produced by them. Certain it is, that there must be in the general system some preparation for the invasion of these dangerous micro-organisms, or in the frequency of furuncle, contagion would be much more common. If furuncles be contagious, common experience shows that they are only so to a limited degree. I have never observed that they passed through families. Lowenburg's one case seems to me slender evidence upon which to base such a theory. Then as regards the value of thymic and boric acid

as antiseptics, I am, from experience in their use, and from the results of recent experiments, extremely skeptical. I believe that water is quite as efficacious as many of the so-called antiseptics. When a question such as the great one of the septic origin of disease is being discussed, I believe that the great truth that must be somewhere in this subject will be the sooner brought out the more frank and critical are the analyses of the theories and experiments that are being constantly set forth.[1]

[1] Congrès Périodique international d'otologie. 2e Session. Milan, 1880; Trieste, Imprimerie G. Caprin, 1882.

# CHAPTER VI.

## PARASITIC INFLAMMATION OF THE EXTERNAL AUDITORY CANAL —SYPHILITIC ULCERS AND CONDYLOMATA—CONTRACTIONS—DIPHTHERIA—SARCOMA—CARIES.

History of the Discovery of the Growth of Aspergillus in the External Auditory Canal.—Varieties of Vegetable Fungi found in the Ear.—Cases.—Syphilitic Ulcers and Condylomata.—Narrowing and Closure of the Canal.—Diphtheritic Inflammation.—Sarcoma.—Caries of the Canal.

It is more than twenty 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 interesting and important, and a full account of it will, I am sure, be welcomed by the reader.

In 1867, Schwartze[1] reported a case of inflammation of the auditory canal, in which the aspergillus fungus was found. Professor 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, p. 401, 1844, 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 the parasite was contained in round and oval cysts, of the size of a cherry-pit. The walls of the cysts were fibrous, filamentous,

[1] Archiv für Ohrenheilkunde, Bd. II., p. 7.

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[1] 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.[2]

Soon after the publication of Schwartze's and Wreden's cases others were reported by Orne Green,[3] of Boston, C. J. Blake, Knapp, and by myself[4] 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.

The literature of vegetable fungus in the human ear has become very large since the publication of the cases of Schwartze, Wreden, and of the observers immediately after them, but in very few directions has it increased the knowledge given us by Wreden's first brochure.

Wreden[5] and Swan M. Burnett,[6] however, have lately reported cases which furnish pretty strong evidence that the fungus known as *otomyces purpureus* may be found in the auditory canal without being a part of the *aspergillus nigricans*, or, as Wreden had thought, *the highest form* (most developed) of the specific aural fungus. In other words, a distinct variety of vegetable fungus has been found in the ear. In Burnett's case a mixture of tincture of opium, sweet oil, and glycerine had been poured into the auditory canal to relieve the symptoms of what was called psoriasis. The ear became painful after this, and on examination Dr. Burnett found a plug of dark-red, quite consistent material. An examination with the microscope showed this to be a fungoid growth. In Wreden's case evidences that the growth was one of the highest forms of devel-

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[1] Archiv für Ohrenheilkunde, Bd. III., p. 1.

[2] Die Myringomykosis aspergillina. St. Petersburg.

[3] Transactions of the American Otological Society, 1869.

[4] American Journal of the Medical Sciences, January, 1870.

[5] Wreden: Archives of Ophthalmology and Otology, Vol. IV., No. 1.

[6] Archives of Otology, Vol. X., p. 319.

opment of aspergillus nigricans were found, but not so in Burnett's. He found in his specimens at no stage of their growth nothing but *otomyces purpureus*. Professor Farlow, of Harvard University, thought the specimen was probably not a variety of aspergillus, as Wreden supposed, in regard to his case.

*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, that is the formation and development of a vegetable fungous growth, may result from an eczema, or, as in Burnett's case, just quoted, from a psoriasis, or probably from any form of inflammation of the canal, especially if oils have been dropped into it. I have not yet seen a case of otitis parasitica in which I thought there was any evidence to show that the ear was sound just before the growth occurred. The soil must first be prepared by a loosening of the epidermis before the fungus will grow.

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

The fungus is actually a mould, such as clings to damp walls and adheres to bread that is not kept thoroughly dry. 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 or eczema, 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.

The wax is thought by C. H. Burnett to be a protection against aspergillus, but I regard it rather as an incident in the formation

of the fungus, for I think it is pretty well established that cerumen never becomes hardened or impacted in a healthy auditory canal.

It is not very uncommon to find a growth of aspergillus at the bottom and on the sides of an auditory canal that was packed with cerumen. The disease is apparently much more rare in England than in this country, for an aural surgeon in large practice in London had not even seen a specimen of aspergillus that had been found in an ear until I sent him a slide containing one, taken from one of my cases.

*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 usually, 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, or even reddish flakes, that may be readily mistaken for simple epidermis or hard wax. Sometimes these flakes or casts block up the whole passage. They cannot be removed by a syringe; but the angular forceps, 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 and macroscopic evidences of a vegetable fungus, will, however, not be apt to fail to recognize it in a subsequent case without a microscope.

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

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

The aspergillus fungus, which, in one of its varieties, is the parasite most commonly found in the ear, seems to have a pecu-

liar 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 afterward appeared in the auditory canal. Wreden was not able to find any penicillium fungus in his cases, but Blake[1] reports a case in which, on the second attack of otitis parasitica, specimens of bastard penicillium were found.

Dr. Hassenstein,[2] 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.

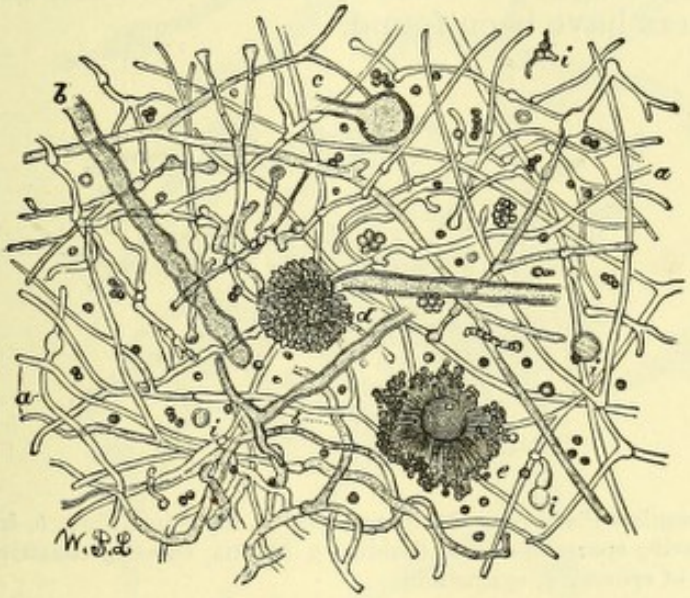

FIG. 47.—Aspergillus Nigricans (220 diameters). *a*, Mycelium fibre; *b*, fruit-bearing fibre; *c*, naked sporangium; *d*, sporangium covered with basidia only; *e*, more mature sporangium; *i*, spores in a state of germination.

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

[1] Transactions of the American Otological Society, fourth year, 1871.

[2] Archiv für Ohrenheilkunde, Bd. IV., p. 164.

Dr. F. Steudener,[1] 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 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.

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

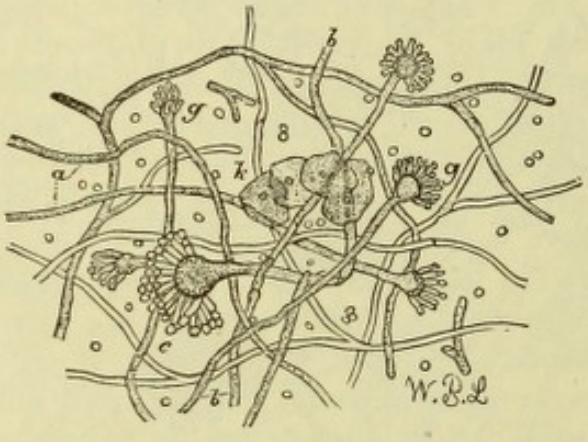


FIG. 48.—Aspergillus Flavescens (220 diameters). *a*, Mycelium fibre; *b*, fruit-bearing fibre; *c*, sporangium-bearing spores upon the basidia; *g*, basidia, showing constriction preparatory to the separation of spores; *k*, epithelium.

The first two of the accompanying drawings of the aspergillus were made by my friend, the late Dr. William B. Lewis,[2] for an article by myself upon the subject, from specimens of cases occurring in my practice. The third engraving (Fig. 48) represents another specimen from the same source, which was drawn by Dr. Charles S. Bull. Dr. Lewis describes the fungus as of three essential parts:

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

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[1] Archiv für Ohrenheilkunde, Bd. V., p. 163.

[2] American Journal of the Medical Sciences, Vol. LIX., 1870, p. 105.

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).

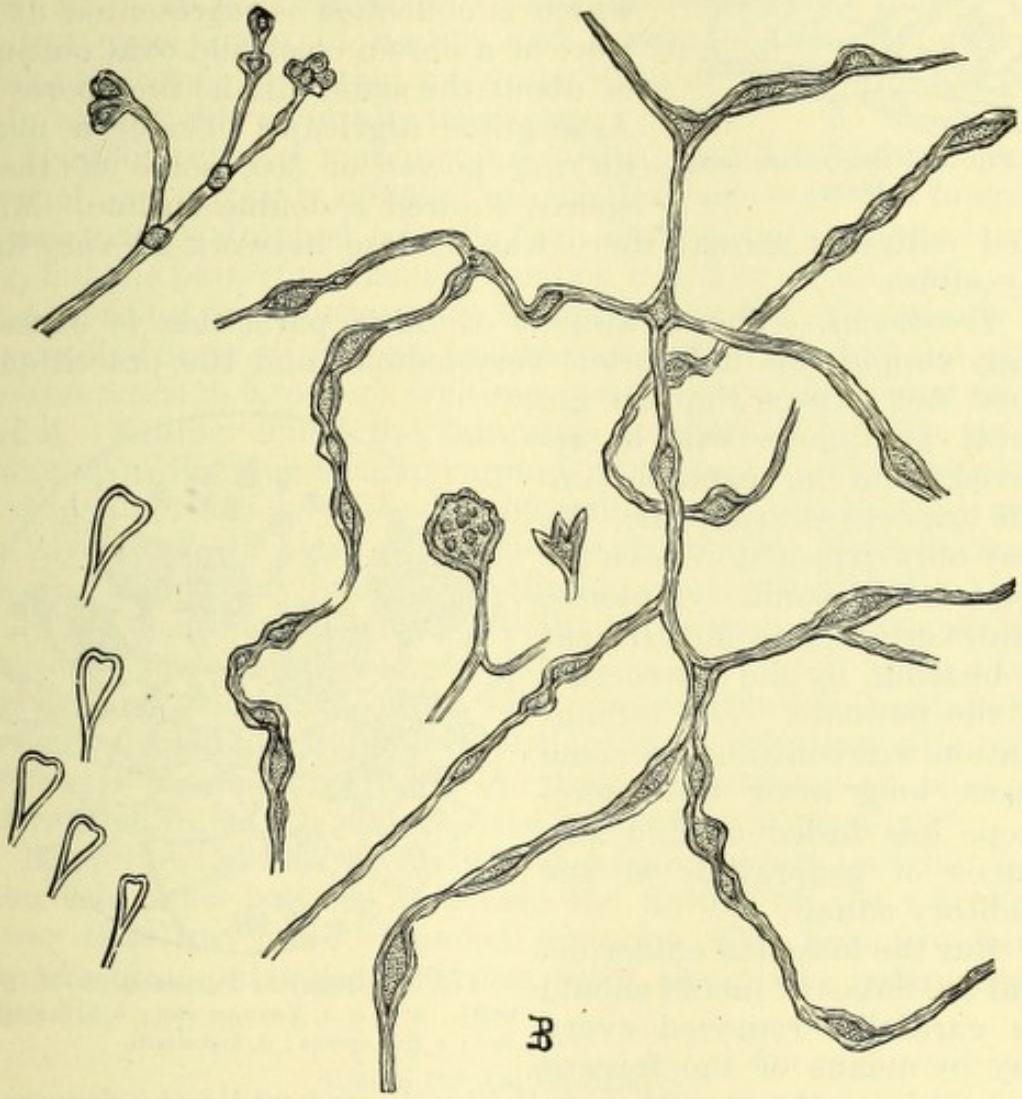

FIG. 49.—Specimen of the Spores and fully developed Growth of the Aspergillus Flavescens. (Case III.)

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

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.

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.

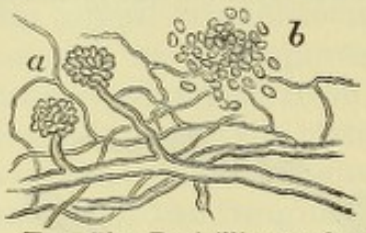

FIG. 50.—Penicillium (after Blake).

*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. 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.

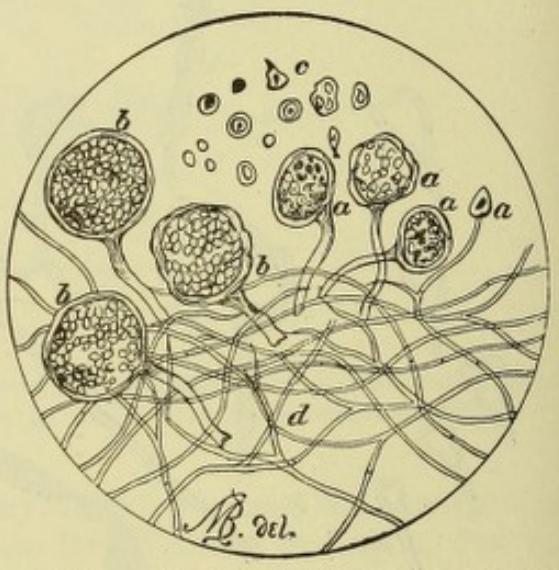

FIG. 51.—Otomyces Purpureus (S. M. Burnett). *a*, *a*, *a*, *a*, Younger asci; *b*, *b*, *b*, mature asci; *c*, free spores; *d*, mycelium.

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 the fountain syringe or the Fayette douche. I am in the habit of pencilling the canal with nitrate of silver in strong solutions, after the cleansing process is over, for the purpose of destroying the fungus, and subduing 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 generally necessary.

The bichloride of mercury in solution, gr. j. ad. ℥ j., and pure alcohol are certainly efficient in the destruction of the fungus. Either may be dropped into the ear; alcohol causes some burning, but the pain is not usually severe, nor does it last long.

According to Siebenmann,[1] Kramer described a specimen of aspergillus niger with great accuracy in 1859. He does not give the reference to Kramer's writings, and I have not been able to find it. Kramer found the fungus in the form of a white membrane upon the membrana tympani. Its inner surface was covered by black specks supported by pedicles. The membrane was the mycelium, the black points the condiophores. Kramer cured his case after many relapses by the use of acetate of lead.

In the treatment of parasitic otitis it is wise to observe all the antiseptic precautions suggested by Lowenburg: 1. Do not use oils or fats. 2. Use alcoholic solutions, or solutions containing as little alcohol as possible. 3. Dilute these solutions with boiling water before using them. 4. Heat all instruments—that is, wash them in boiling water—used in treating aspergillus.[2]

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,[3] 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,

[1] Archives of Otology, Vol. XV., p. 189.

[2] Loc. cit., p. 196.

[3] American Journal of the Medical Sciences, loc. cit.

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.

On examination, a watch which is usually heard at least thirty inches from the auricle is only heard one and a half inch, 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 Clark'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 27th, 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 materi-

ally benefited, as shown by the rigidity of the membrana tympani and the impairment of hearing. The membrane is now (November 19th) 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 opinion. 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.—September 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 tenacious 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, besides 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, October 18th, 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 middle 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.—December 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 24th, and treated by the use of leeches, the syringe and warm water, with the subsequent application of nitrate of silver, gr. xl. 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 twenty-two 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 sixteen feet distant 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 improving.

Cases of the formation of vegetable fungi in inflamed auditory canals are now matters of such every-day occurrence, among those that see much of aural disease, that they are not cases of great interest. Nevertheless they are of considerable importance. Their origin should be understood and their occurrence not overlooked.

### SYPHILITIC ULCERS.—CONDYLOMATA.

In the course of secondary syphilis ulcers and condylomata may occur in the auditory canal, just as syphilitic eruptions may occur on the auricle and on other parts of the general integument. They are, however, somewhat rare. The manifestations of syphilis in other parts of the body, with the characteristic appearance, and the absence of itching sensations, will usually

make the diagnosis quite clear. While it is true, as Schwartze intimates,[1] that it is sometimes difficult to decide whether a given case of granulations in the auditory canal depends upon a syphilitic dyscrasia or not, since the anatomical constitution of the tumors are the same whether syphilitic or not, yet this is not usually the case. There is no more difficulty in making a diagnosis here, than in determining whether a case of iritis is or is not caused by the poison of syphilis. Of course it is important to decide as to the existence of syphilis in a person suffering from ulcers or granulations of the auditory canal, for if syphilis be not present, local treatment will often be all that is required. If, however, the ulcers be the manifestations of the venereal poison, or be modified by it, the use of mercury and iodide of potassium will be essential.

### NARROWING AND CLOSURE OF THE CANAL.

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

### DIPHTHERITIC INFLAMMATION.

That diphtheria of the middle ear may and does occur, has been shown by numerous observers. I have seen it in one case where no antecedent inflammation of the middle ear existed. A suppurative inflammation of this part may readily take on a diphtheritic form in case the patient be attacked with the constitutional disease. I have never seen diphtheria of the canal, but, as we should imagine, it is sometimes developed on the excoriated parts of an auditory canal already suffering from simple inflammation during an epidemic of diphtheria.

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[1] Archiv für Ohrenheilkunde, B. IV., p. 263.

### SARCOMA OF THE CANAL.

I have seen one case of tumor in the canal, which was said by a competent microscopist, Dr. Welch, to be a round-celled sarcoma. The case is elsewhere reported in full by Dr. Buck,[1] who sent it to me for consultation. The patient was a girl of fourteen. The first intimation that she had of trouble was a fulness and pain in the part. The canal was found to be filled up near the meatus by a firm fleshy mass. It sprung by a broad base from the upper and posterior wall of the bony part of the canal. The child was healthy in all other respects. Besides the marks of sarcoma Dr. Welch found osseous tissue in the centre "with wide medullary spaces in which the tissue is rich in cells and fibrillated." Dr. Welch pronounced the tumor to be osteosarcoma, taking its origin most probably from the periosteum. Dr. Delafield confirmed Dr. Welch's opinion, and he added if the bone be not involved and the tumor can be completely removed, the prognosis is not very bad. Dr. Buck, Dr. Weir, and myself agreed that the tumor should be completely removed, which was done by Dr. Buck, under ether, by means of knives and a sharp-edged steel scoop. A zone of skin, apparently healthy, surrounding the entire base was also removed. The growth sprung from the periosteum. The exposed bone was scraped and a solution of chloride of zinc, forty grains to the ounce of water was painted over the exposed surface. The patient, who was of strong and healthy parents, did perfectly well, and remains well four years after the operation. Dr. Buck, in closing his account of this remarkable case, states that the maternal grandmother died of some uterine disease which may have been cancerous in its nature, and that a grand-aunt and two second cousins suffered from cancer.

### CARIES OF THE AUDITORY CANAL.

Death of the bony wall of the auditory canal with no disease of the tympanic cavity, is not a common affection, but it may occur. I have under my care, while writing this, a gentleman of more than eighty years of age, who, while not suffering from any other form of aural disease, has an affection of this kind. Just at the junction of the osseous with the cartilaginous canal, anteriorly, the bone is diseased, and my associate, Dr. Emerson, has removed a small piece of dead bone from it. The disease be-

[1] Diseases of the Ear, p. 121.

gan as a severe local inflammation of the canal furuncle, for which the patient was treated by his physician in Newport, Dr. Rankin. The symptoms, which were severe, abated, and when Dr. Rankin referred him to me, at the end of the summer, there was some tenderness at the junction of the auricle with the bone, and an offensive discharge of pus, but no serious general symptoms or disease of other parts of the ear. In a few days loose bone was detected and removed. The bone does not heal. It is some four months since the occurrence of the original inflammation, but the surrounding parts are now free from tenderness and pain. The indications of treatment are, of course, to keep the opening free from granulations and pus, and to favor the throwing off of the bone. At the advanced age of my patient, I feel obliged to content myself with mild measures. I occasionally scrape the granulations and also the surface of the bone with a curette. The patient lived some four years after the above was written, and his ear gave him very little trouble, although I do not know that it completely healed.

I have seen one case of nearly complete absence of the auditory canal, to which I am puzzled to assign a place, or rather I am uncertain whether it belongs among the cases of bony growth from inflammation in infancy, or in intra-uterine life, or with those of arrested development. It may perhaps be properly inserted at the close of this chapter.

Dr. W. J. Welch sent to me, for advice, a very interesting case of closure of the auditory canal. The patient was twenty years of age, said to be "deaf since he was five years of age." His ears were never treated, and he had not grown worse. He has always been well in other respects. He is intelligent. His ancestors were healthy people. He never had a discharge from his ears, and very rarely has he had an earache. His hearing distance is: right ear, $\frac{\text{contact}}{40}$; left, the same. The voice is heard behind him three feet. The bone conduction seems to him louder than aërial. The duration is about the same as aërial. The auditory canals are each less than half an inch deep, and funnel-shaped. Air enters the tympanic cavity by Politzer's method of inflation. No change in the hearing distance is observed after inflation.

I considered the condition as congenital, and no treatment was urged upon the patient, although an explorative opening of the canal by a dentist's drill was suggested. Whether this bony closure of the canal was the result of intra-uterine inflammation or merely of arrested development of the canal, remains an unsolved problem to me. If the former be true, then the case is one of hyperostosis of the canal. It is possible that an inflammation occurred in early infancy, which led to closure of the canal. In the chapter upon the "Consequences of Chronic Suppuration," this subject will again be discussed.

# CHAPTER VII.

## INSPISSATED CERUMEN.

Merely a Symptom of Aural Inflammation.—Frequency of the Affection.—Symptoms.—Reported Cases of Damage to the Ear from the Presence of Wax, probably not based on Correct Observation.—Causes.—Treatment.—Cases.

ALTHOUGH I am convinced that the hardening of cerumen is merely one of the symptoms of aural inflammation, I do not feel as yet justified in discussing its nature and treatment in an incidental manner. As a symptom, inspissated cerumen is so prominent or annoying, that it has been classified as a separate disease for a long time, if not always, although it is merely, in my opinion, a consequence of an inflammation.

The writers on otology of the future, will, I am sure, treat of hardened cerumen in connection with their accounts of the diseases of the external and middle ear, and will not award it a place by itself, although the writers of the present day do not as yet feel justified in this manner of discussing it.

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 6,800 aural cases observed by myself in private practice, only 497 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 of the aural symptoms.

In the Manhattan Eye and Ear Hospital, of the 20,103 aural cases recorded in twenty-one years, 2,228 are classified as cases of inspissated cerumen. Yet, in a large proportion of these, it is

admitted by the attending surgeons, that the hardened wax was but a symptom of what may have been more serious disease. I have found that it is the habit in certain circles, to speak of the hardening of cerumen, as if it were a trivial affection which almost any one is competent to manage, and one that needed no considerable attention.

In the first place, no one is competent to remove hardened cerumen without careful instruction, and in the second, it is a significant symptom, the careful study of which will in many cases be of great value in preserving the hearing of the person affected with it. Hardening of the cerumen often occurs in the course of suppurative processes in the middle ear, as well as in cases of chronic non-suppurative disease. It also occurs in disease of the internal ear—the nerve or labyrinth. In such cases removal of the wax may slightly or even considerably improve the hearing. If it be improved, a superficial examiner may be led to believe that impaction of the wax was the only disease, but an exact test of the hearing power will often convince him that the patient still has defective hearing, even though it be greatly benefited by the removal of a large plug of cerumen. The cases of inspissated cerumen, in which the hearing becomes perfect after its removal were in the beginning, I believe, cases of inflammation of the canal or of the tympanic cavity, which have run their course, leaving behind them the wax made hard by the evaporation produced by the abnormal heat, when the canal or tympanum or both were inflamed.

Cases are sometimes presented to me, where the patient can state positively that there was, some time anterior to the impairment of hearing from the blocking up of the ear, a period, although a brief one, of decided pain. In many cases also, it is easy to see the evidences of inflammation in the epidermis of the canal, after the wax has been removed. In some, I grant that it is not, but I feel confident that close examination will show in every case, a probability at least, that an inflammation in some part of the ear, a morbid condition, preceded the period when the wax was not removed by the motions of the jaw, but when it remained as a nucleus about which the whole secretion of the canal collected, until it finally became an obstruction to hearing. In my opinion, the proper way to classify inspissated cerumen would be to say, for example, inflammation of the canal *with inspissated cerumen.* Suppurative inflammation of the middle ear *with inspissated cerumen*, and so forth. I speak thus in detail, upon this point that inspissated cerumen is but a symptom, because I believe that many curable cases are dismissed with but partial relief, because it is thought when its removal is

secured and the hearing is much improved, that impaction of the wax is the only disease. In many of these cases, unless the ear be subjected to appropriate treatment, not only may the wax soon become again inspissated, but the fundamental disease which caused the impaction of the wax remains uncured, and it may become permanent. From careful observation, I believe I may state, that the activity of the ceruminous glands is usually increased, and the canal becomes exceedingly hot and moist during a subacute or acute catarrh of the tympanic cavity. It is in this increased action of the glands that the beginning of impacted cerumen is to be sought.

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

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. In children, however, in whom the disease also occurs, the wax is usually of a yellow color, and is more apt to be in layers. The presence of even quite an amount of soft yellow cerumen, which still leaves an opening, however narrow, down to the drum-head, can hardly cause any unpleasant symptoms.

The diagnosis of inspissated cerumen is sometimes obscured, by the useless habit indulged in by so many of the laity and of the profession also, of pouring olive 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 examina-

tion. 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.

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

The loss of hearing from hardening of the cerumen, as has been intimated, is apt to occur very suddenly. 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 rumbling vehicle 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.

These rare cases of suppuration caused by wax, should not be confounded with those frequent ones of chronic suppuration where the wax hardens over the opening of the membrana tympani.

It is probable that some of the cases reported by the earlier authors as instances of great damage to the ear from inspissated cerumen, were cases of this kind. Toynbee's[1] cases of absorption of the bone, imbedding of wax in the mastoid cells, are possibly only cases where hardened wax supervened upon chronic suppuration of the middle ear.

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.

Great depression of spirits, almost becoming melancholia, was observed in a case reported by Dr. Edward T. Ely and myself.[2]

### MENTAL DEPRESSION FROM IMPACTED WAX.

Mr. T——, æt. 18, has been seen at intervals for several years on account of a chronic suppuration in the right middle ear. The left ear was normal. On May 15, 1879, the right ear was in very good condition; the hearing was $\frac{15}{15}$, and there was no discharge. Patient came again on September 24th, complaining that since June he had suffered from "a feeling of heaviness in his head." Was "unable to concentrate his mind on anything for more than a few minutes." Felt as if he must give up his studies (in which he was very much interested), and wished to know whether he must leave college. Thought his deafness had increased, but had no pain, tinnitus or discharge. The patient was sullen and very despondent Otherwise his health seemed to be excellent. He was very reticent by nature.

H. D., R. $\frac{C}{40}$. External auditory canal filled with hard wax. After removing the wax, the hearing became $\frac{12}{40}$, and the tympanic cavity looked as it had at former visits; there was no discharge.

The patient obtained speedy relief, and in a few days reported the discomfort about his head gone. He was then as cheerful as usual.

This case was interesting, as illustrating the disturbing influence of impacted wax, even with an entire absence of tinnitus.

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

[2] Archives of Otology, Vol. IX., p. 16.

## CAUSES.

The causes of hardening of the wax in the auditory canal are not as well settled as we could wish. As I have already observed, I no longer believe that it is an independent affection, or a disease only of the ceruminous glands. There are cases, however, in which at the time of the removal of the inspissated cerumen, its presence is the only bar to a perfect recovery of the hearing power. In such cases the disease which caused the wax to harden has passed away, and it only remains as a foreign body. Yet in by far the majority of cases the hearing is not fully restored by the removal of the wax. I will tabulate the diseases in which hardening of the wax may occur.

### I.—*Chronic Suppuration of the Middle Ear.*

Hardening of cerumen in such cases is not always injurious. A layer of hard wax sometimes serves as a good artificial drumhead, and improves the hearing. When the mass has become thick enough to cause pressure, pain, tinnitus and vertigo may result, and it should be removed. It is important, therefore, in extremely chronic cases of suppuration of the middle ear, to remember that a layer of black wax may be sometimes more profitably left than removed, since it sometimes acts as an artificial membrana tympani. It is to be understood, however, that this is not the rule when there is a hope of healing the membrana tympani by local treatment.

### II.—*Chronic Non-Suppurative Inflammation of the Middle Ear.*

The symptoms of patients suffering from this form of disease are often aggravated by impaction of the cerumen. So unobservant are many as to a loss of hearing, that until a plug of wax has closed the canal and rendered hearing of ordinary conversation carried on near them, very difficult, do they admit that their hearing is at all defective. In such cases the rule is without exception to remove all the hardened material.

### III.—*Diffuse Inflammation of the Auditory Canal.*

I have seen hardening of the wax, especially in children, in the course of this disease. As has been before intimated, the black color that usually indicates hard wax in adults is not found, when it is impacted in the ears of children. The mixture of layers of epidermis with the wax is more marked in these cases than in others.

### IV.—*Foreign Bodies.*

The cerumen may become impacted in the ear in cases where foreign bodies have been placed in, or have entered the auditory canal, and have not been removed. I have on several occasions removed hardened wax that contained insects that had entered the ear. In one case, that of a little boy, the parents remembered, on questioning, that he had once, about a year before, complained of pain in his ear for a few hours, and that he had said something was in his ear. The pain was stilled and the occurrence was forgotten until new symptoms appeared, such as impairment of hearing and tinnitus. An examination revealed impacted cerumen, in the centre of which was found an insect.

### V.—*Exostosis and Hyperostosis of the Canal.*

Impacted cerumen occurring in a case where the canal is narrowed by a bony growth, is difficult to manage, for it is particularly difficult to remove the wax when it lies behind the contraction of the osseous canal. I have one such case in my mind as I write, that of a physician from the South, who in his annual visits to the North, is obliged to devote as much time to getting the hardened wax from his auditory canal, as is usually devoted to the care of the teeth. The presence of the wax greatly diminishes his already impaired hearing. Even a thin layer lying on a part of the drum-head is sufficient for this. In his case, the connection of the hardening and massing of the cerumen, with an inflammatory condition of the canal is very plain.

### VI.—*Parasitic Inflammation.*

Impaction of cerumen is not at all unlikely to occur in conjunction with parasitic inflammation of the canal. As was incidentally mentioned in the preceding chapter, wax may harden upon a growth of aspergillus in the canal and upon the drum-head.

While these pages are passing through the press I have under my care a boy of eight years of age, who came to me some four weeks ago on account of defective hearing. Both his auditory canals were found to be filled with impacted cerumen, which, as is apt to be the case in children, was removed slowly and with difficulty. Dr. Emerson, my associate, has spent many hours upon the case, using the syringe, curette, probe, and forceps at each sitting. When several layers of wax had been removed, we found aspergillus of luxuriant growth underneath, clinging closely to the canal and membrana tympani.

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, although it is given by some authors.

I have no doubt 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 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 coincident 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 as packing of the secretion by improper attempts to cleanse the canal, or from a peculiar tendency to excessive action of these numerous glands. Certain it is, that some cases require only local treatment, and that whatever inflammation preceded the evaporation of the fluid of the cerumen, was fully removed when the 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*,[1] 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. Wakely 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 only value is as an emollient to soothe an irritated or dry canal. It should be diluted with water when used in this way.

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;"[2] while in the same city, Wakely's book was gravely noticed as a contribution to clinical medicine.

From present appearances another quarter of a century will pass away, before many physicians will cease to advise the use of glycerine and sweet oil, for a disease of the ear, of the exact nature of which they know nothing. Were it not that valuable time is often lost in the treatment of inflammation of the ear, in many cases where this advice is given, there would not be much to regret, since in many instances the glycerine or oil softens the hardened wax, so that its position is changed at least. Sometimes it even effects a removal of it without the use of a syringe, but for one case where inspissated cerumen actually exists, when this advice is given without an examination, there are a score where there is no hard wax to soften, and where the advice is positively harmful. Glycerine, as usually prescribed for the ear, has very few antiphlogistic virtues. It usually perpetuates rather than cures an inflammatory process.

*Treatment.*—The treatment of inspissated cerumen is exceedingly simple. The hardened material should be removed by the

[1] Wilde's Aural Surgery, p. 38.

[2] Wilde, loc. cit., p. 43.

use of the syringe and warm water. The syringing should be performed in the manner that has been depicted on page 133. 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 or more is necessary to its removal. I have notes of several 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 recommended 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."[1] I am constrained to say, that I consider such advice from so eminent a source as the late 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 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 some cases it will be necessary to lift the first layer of hard wax with a delicate probe before the syringe will make any impression upon it. In others, this will be necessary even down to the last layer. In such cases the curettes of Buck and Politzer, used under good illumination are of great assistance. Too great stress, however, cannot be laid upon the necessity for care in the use of instruments upon the auditory canal, especially near the drum-head. In the hands of the average practitioner, the syringe is the best instrument for the removal of impacted cerumen, because it is usually efficient and always safe. Dr. Pomeroy[2] recommends a syringe "with a flange and a long narrow tip" for the removal of hardened wax. The stream of water from the instrument is no doubt efficient, but I think this syringe in unprac-

[1] American Journal of the Medical Sciences, October, 1864.

[2] Text-book, p. 85.

tised hands is more dangerous than a probe, and I still use a short nozzle as seen on page 132. When it becomes necessary to make an opening in wax upon which the stream of water may act, nitric acid may be used, or a saturated solution of caustic potash (Blake), a small hole being burned in the centre of the mass.

The auditory canal may contain a surprisingly large quantity of hardened cerumen, and it is necessary to examine the ear quite often during the syringing process, in order to see how much remains, lest we continue the injections after the wax is removed, and thus injure the drum-head. *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 several 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 or causes 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.

Case I.—*Buzzing Noise for Two Days, then Pain—Inspissated Cerumen.*—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, $\frac{P}{4\,8}$, 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 $\frac{3\,5}{4\,8}$ in a few moments.

Case II.—*Head Symptoms for some Months, ascribed to Sunstroke—Treated for Cerebral Disease, without Examination of the Ears—Inspissated Cerumen—Removal—Cure.*—A. B——, coachman, at New York 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 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 caused by inspissated cerumen.

Case III.—*Abscesses near the External Meatus—Impaction of Cerumen—Restoration of Hearing after Removal of the Cerumen.*—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 J——, 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, $\frac{0}{4\,8}$; Left ear, $\frac{0}{4\,8}$.

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 twenty minutes by syringing, when the hearing distance became $\frac{5}{48}$.

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

March 6th: 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.

CASE IV.—*Recurrent Attacks of Inspissated Cerumen for Twenty Years—Ulceration of Membrana Tympani during Two Attacks—Recovery, but Inspissation of Cerumen continues to recur.*—I have under observation and care a gentleman of about thirty-eight years of age, who has suffered from attacks of inspissation of cerumen for more than twenty years. He has been under my care for fourteen years. At first the wax hardened at intervals of months, but now, especially in the summer, the intervals are so short, that the patient is obliged to present himself once a month for examination, and generally for the removal of the plug that has formed in one or both ears.

Five years ago, the hardening of the wax was followed by ulceration of the outer layer of the membrana tympani. This healed under the use of nitrate of silver. A few months after, a granulation was found at the bottom of the canal, and an attack of pain occurred. The canal became red and swollen at the junction of the auricle and the mastoid. The canal and drum-head were again treated by the warm douche, and in a few months the wax again accumulated and hardened. A year after the patient again had an abscess in the right ear. Although the wax hardens in each ear, inflammation has as yet only occurred in the right one. This probably perforated the drum-head, but it healed again.

The inflammation extended from the canal inward, and hence it was not so easy to decide as to whether it had passed through the layers of the drum-head or not. The last inflammation that as yet affected the ear, in conjunction with the impaction of the cerumen, occurred a year and a half ago. This did not perforate the drum-head, and healed under the use of iodoform. The patient now comes for examination every few weeks, in summer especially, and by removing the wax before the plug has formed, we hope to prevent the recurrence of inflammation. After a careful study of this case, I have not been able to satisfy myself as to what causes the wax to harden.

That the inflammation follows, rather than causes the inspissation, seems to be true here. The patient is a gentleman of excellent, even vigorous general health, whose habits are correct, and whose position in life enables him to take the best of care of himself in every respect. I have tried in vain, to prevent the accumulation of the wax by pencilling the canal with nitrate of silver.

It ought finally to be stated, that although the hearing has often been much impaired for some time, it as yet remains practically normal, except when the patient is suffering from a recurrence of impaction of cerumen.

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,[1] but I think it worthy a wider circulation than it has hitherto obtained.

CASE V.—*Inflammation of the Auditory Canal, caused by Quinine—Impaction of Cerumen—Use of Nitric Acid to effect Removal.*—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 until 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," 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."

[1] Transactions of the American Otological Society, 1873.

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. = $\frac{4}{4}$.

This was his condition when he first came under my 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 con-

siderable 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 allowed 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 gave 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 believe is sometimes an inflammation of the conducting portions, as well as of the acoustic nerve or labyrinth. We have long suspected 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,[1] 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, for there is no doubt in my mind, that while the impaction of cerumen is sometimes caused by inflammation, that it in turn may produce ulceration—by mechanical pressure.

Case VI.—*Pain—Tinnitus—Deafness—Inspissated Cerumen—Suppuration of the Canal—Incisions—Recovery.*—D. H——, aged 28, laborer, presented himself at Dr. Roosa's clinic, at this hospital, November 1, 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. 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.

November 2d.—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

[1] Medical Record, vol. v., p. 536.

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.

November 3d.—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.

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

Dr. F. M. Pierce,[1] of Manchester, England, reported a case where the symptoms, arising apparently from inspissated cerumen, were more severe than any I have ever seen in my practice, yet from the severity of cases which I *have* seen, I can well imagine Dr. Pierce's case.

Four days before Dr. Pierce saw the patient—a chemist, age not stated—he had a severe earache after taking a cold bath, which soon became a diffused incessant pain over the whole head and neck, with nausea, vomiting, and fever. His case was regarded as one of cerebral inflammation until the fifth day of his illness, when Dr. Pierce saw him and examined the ears. The watch was not heard on that side, while a tuning-fork placed on the head was heard only on that side. The walls of the canal were swollen and congested, and there was impacted wax. This was removed piecemeal by the forceps, syringe, and a warm lotion was dropped into the ear. The next day the patient was free from pain, fever, and nausea, and he could hear the watch two inches. After syringing the ear (clearing out the remains of the wax?), the watch was heard thirty-six inches, and the patient fully recovered.

Dr. Pierce suggests, and I suppose the reader will agree with him, that the cold water in the canal set up a diffuse inflammation, which was favored by the presence of a hard foreign body, which was probably not fully impacted when the water got into the ear, but which became so, and increased the inflammatory symptoms.

In many cases it will be necessary to treat the auditory canal, after the removal of the wax, for a diffuse inflammation. I then use a solution of nitrate of silver of say twenty grains to the ounce, pencilling it upon the canal, especially at the junction of the cartilaginous with the osseous portion, every other day, until the normal condition is restored.

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[1] Medical Times and Gazette, March 30, 1878.

### STATISTICS.

Two hundred and thirty-one of the 497 cases mentioned on page 158 as treated by me in private practice, were plainly also affected with other diseases of the ear, as follows:

| | |
|---|---|
| Chronic catarrh of the middle ear | 120 |
| Subacute catarrh of the middle ear | 20 |
| Chronic proliferous inflammation of the middle ear | 24 |
| Chronic suppuration of the middle ear | 19 |
| Inflammation of the external auditory canal | 16 |
| Eczema | 9 |
| Foreign body | 1 |
| Parasitic inflammation of the external ear | 1 |
| Acute catarrhal inflammation of the middle ear | 5 |
| Disease of acoustic nerve | 9 |
| Other complications | 7 |
| | 231 |

It will be seen that about one-third of the cases seen in my private practice were plainly accompanied, if not caused, by aural inflammation. I am bound to say, that this proportion would have been largely increased, had I earlier in my practice given as much attention to the study of inspissated cerumen as I now do. It was easy, especially when the patients who were relieved by the removal of a large plug of cerumen said they heard perfectly, "had no more trouble," were "in a new world," and so forth, to conclude that their delight at their recovery from the fulness, pain, and impairment of hearing was founded upon a complete cure of the aural lesion. A little more thorough examination often shows, however, that the wax is but the most striking symptom of an insidious process that will finally, unless checked, destroy all useful hearing power.

The case of recurrent attacks of inspissated cerumen related on page 170 is by no means a very uncommon one, although not in as aggravated a condition as the one there described. A patient once having inspissated cerumen, is very apt to have a recurrence of the affection.

### COMPOSITION AND FUNCTIONS OF CERUMEN.

According to J. E. Petrequin,[1] cerumen is of a smeary consistency, on account of the soapy material made by the potash

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

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

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

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,[2] 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.

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

[2] 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 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. He imagined that the continued screaming at last lessened the sensibility of the *portio mollis*.[1]

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.

Hallucinations have been in rare instances relieved by the removal of inspissated cerumen. Professor Mayer, formerly director of the Insane Asylum at Hamburg, is the authority for this statement.[2]

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 hallucinations of which she seemed to be a victim. Epilepsy is said to have been cured by the removal of hard wax from the ear. (See page 205.) Certainly it has been from the removal of a foreign body. It will be seen, by reference to the following chapter, that it may cause ear cough and ear sneezing.

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[1] 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.

[2] Tröltsch on the Ear, second edition, translation, p. 531.

# CHAPTER VIII.

## FOREIGN BODIES.

Exaggeration of the Importance of this Subject.—Statistics.—Insects.—Living Larvæ.—Fish.—Inanimate Foreign Bodies.—Treatment.—Delusions as to Foreign Bodies in the Ear.—Foreign Bodies in the Eustachian Tube.—Ear Cough.

In entering upon the discussion of the subject of foreign bodies in the ear, I desire to express the conviction that its importance has been often exaggerated. The reader of medical journals, who has not given any special attention to diseases of the ear, must be surprised to find this subject figuring so largely in literature, when he knows that the general practitioner of large experience sees but very few of such cases, even if he lives remote from specialists and surgical experts. The reports of hospitals and infirmaries for diseases of the eye and ear also show that the entrance of a foreign body into the auditory canal is brought to the attention of the attending surgeons with comparative infrequency.

The following table shows this :

| | Total number of aural cases. | Number of cases of foreign body. |
|---|---|---|
| Manhattan (New York) Eye and Ear Hospital, 20 years, | 20,103 | 130 |
| New York Eye and Ear Infirmary, 1889..... | 3,738 | 49 |
| New York Ophthalmic and Aural Institute, 1889..... | 983 | 10 |
| Brooklyn Eye and Ear Hospital, 21 years..... | 23,729 | 309 |
| Massachusetts Eye and Ear Infirmary, 1889..... | 3,952 | 19 |
| Salem Hospital, 15 years..... | 1,276 | 21 |
| St. Michael's Hospital (Newark, N. J.), 1888..... | 615 | 3 |
| Newark Eye and Ear Infirmary, 1889..... | 1,296 | 13 |
| Illinois Eye and Ear Infirmary, 1885–1886..... | 1,971 | 7 |
| Buffalo Eye and Ear Infirmary, 1889..... | 171 | 1 |
| | 57,834 | 562 |

In the Manhattan Eye and Ear Hospital, for twenty years, 130 cases of foreign bodies in the ear have been presented for

treatment, and 2 of supposed foreign body. In my private practice in 4800 cases there were 26 of foreign bodies, and 4 in which the patient or friends supposed there was one, and yet none was found.[1] These statistics show that foreign bodies in the ear, are not as frequently seen by the surgeon, as the inexperienced practitioner might be led to suppose.

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

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

The usual point of entrance of foreign bodies into the ear, is through the external auditory canal. They sometimes 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," 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, or which may be thrown into the ear.

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[1] Buckner's statistics, made up from various authorities, show that of a total of 43,730 cases, 670 were cases of foreign bodies. Archiv für Ohrenheilkunde, 1883.

## INSECTS.

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.

I have seen a few cases of cockroaches in the ear, as well as croton bugs. I have never had any difficulty in removing them. In some instances they die in the ear, and then they become the nucleus for the collection of cerumen about them.

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

Some writers advise the use of an oil dropped into the ear before the water is used, but Wilde and Tröltsch agree that this is an unnecessary waste of time. In all the cases I have treated, 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,[1] insects have a very acute sense of smell. "No flock of vul-

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

tures 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. It is probable, that these so-called worms, were the larvæ of insects which germinated from eggs deposited in the pus of a chronic suppurative process. Certain it is, that the practitioner of the present time, sees very little of worms in the ears, since the habit of cleansing an ear from pus, has become a well-recognized duty. The pain from the presence of these grubs, which actually fasten themselves, when hatched, into the tissue of the canal, and bite upon it, as it were, is apt to occur suddenly. An Austrian physician, Dr. Scheibenzuber,[1] 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[2] 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

[1] Monatsschrift für Ohrenheilkunde, Jahrgang III., No. 3.

[2] Archives of Ophthalmology and Otology, loc. cit.

framework of horny consistency and of two hooks also of a stout horny structure, articulating with this framework. The larva burrows its way into the tissue on which it feeds by repeated extension and contraction of the hooks, alternately piercing and tearing. These movements explain the agonizing pain which patients experience when the larvæ appear from the eggs. These hooks are very large in proportion to the size of the body of the larvæ.

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 half an inch in length, and of the diameter of a large knitting-needle.

Dr. Gruening reported at a meeting of the New York Ophthalmological Society, in 1882, a case of living larvæ in the auditory canal when the tissues were sound, but his case is as yet unique in literature, I believe.

Very small fish, have been known to enter the auditory canal while the victim was bathing. One of my patients, a lady, gave me a minute account of such an occurrence to herself. The little intruder caused great pain for some hours, and finally came out spontaneously. In the *Reading* (Pa.) *Eagle* of July 9, 1880, there is a circumstantial account of a case of the entrance of a fish two inches long, into the ear of a boy of fourteen, while he was bathing. According to this account, he suffered for two weeks from intermittent and severe pain. As his parents thought it was "only an earache," no physician was called. Laudanum, rabbits' fat, and molasses were among the remedies used for the two weeks that the boy was suffering intolerable pain, which greatly reduced his strength. The mother of the boy, finally, in one of his fits of pain, wound a handkerchief around the head of a pin and probed the ear. "She saw something protrude," and got hold of it and pulled it out, when it proved to be a living fish of the length above stated. The lady who, while she was under my care for aural affection of another kind, told me of her sufferings from the entrance of a small fish into the auditory canal, also said that the pain was so decidedly

intermittent in character, she being for some hours at a time without pain, that she could not believe anything animate in her ear was causing the trouble.

*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 abrade 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.

## INANIMATE FOREIGN BODIES.

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. 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,[1] that poison poured into the ears was as dangerous as if

[1] Hamlet, Act III., Scene 2.

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

It would be well, if this fear of foreign bodies in the ear, were transferred to cases where they have entered the eyeball, where the most serious results do occur from the neglect to promptly remove a foreign substance. Unskilful or indiscreet attempts to remove a foreign body from the ear, are often more dangerous than the foreign body itself. In the case of a foreign body in the eye, it is the loss of sight that is threatened, and it is usually the worst 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.

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

Voltolini,[1] in writing on this subject, 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 downward 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.

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[1] Monatsschrift für Ohrenheilkunde, Jahrgang II., No. xi.

*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—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 canal, and having been able to see it, have pushed it well in, in their misguided zeal to remove that which in itself is not dangerous to the ear or its functions.

Many cases are on record where foreign bodies, which had not occluded the auditory passage, have remained in it for years without doing harm. Thus Wreden[1] 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 have subsided before any further attempts at removal are made.

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

In cases where injections made while the patient is in an upright position, do not remove the foreign body, 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 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.

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[1] Monatsschrift für Ohrenheilkunde, Jahrgang III., No. 12.

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 notes of forty-four cases of foreign bodies in the ear that have occurred in my practice, and I have never but in one case failed to remove the offender, 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.

For years, I had 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, 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 was under treatment for years 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 generally contain instruments adapted for the individual cases as they occur. Let him remember, however, that once beyond the membrana tympani, he is dealing with parts whose injury becomes dangerous not only to hearing but to life.

Dr. Elsberg[1] thinks very highly of a delicate double screw hook, with two little prongs pointing in different directions. It can be introduced into the canal and laid against a sensitive part, according to Elsberg, without causing pain or injury. By twirling it around from left to right, the prongs will endeavor to bury themselves into the substance they rest against; on reversing the motion it unscrews, taking no hold, or letting go if previously fastened. Dr. Elsberg, also uses this instrument for foreign bodies in the nose. He only advises its use in the ear in *exceptional* cases, that is, those in which syringing fails. For the removal of impacted cotton, such as one case reported by Elsberg,[2] I have no difficulty when I use the ordinary angular forceps, with delicate teeth. I have never been in the habit of classifying all the cases where wads of cotton are pushed down to the bottom of the canal, in cases of aural disease, among foreign bodies. They are very common accidents in the treatment

[1] Medical Record. February 1, 1870.

[2] Detroit Lancet, September, 1882.

of aural disease by the patient himself, and hardly seem to me worthy of more than an allusion.

Patients who use Toynbee's artificial drum-head, occasionally lose the disk of rubber in the ear, and come to a surgeon for its removal. This is usually easily accomplished by the syringe. If not, a bent probe may be used to lift up the disk to a situation where it can be readily grasped with the forceps. Such patients from their experience in this direction, are very tractable and tolerant of manipulations in the canal. Consequently the removal of foreign bodies from their ears is a very simple matter, as a rule, certainly as compared with a similar operation upon children. Some years after Dr. Elsberg had published his account of his instrument, he found that other surgeons, some forty years before him, had invented similar instruments. It will be found on study of the old text-books, especially those of Lincke and Frank, that most, if not all, of the modern inventors of instruments for extracting foreign bodies from the ear, have been anticipated, and that there remains not much to discover in this field.

For example, Dr. Kinne[1] recommends a hook made of a pin. Dr. Gross' instrument is essentially this instrument, as is the cystotome used in cataract operations and often used by aural surgeons. It is passed behind or to the side of the foreign body, when it is easily fastened upon, and a dislodgement occurs. One of my staff at the Manhattan Eye and Ear Hospital, Dr. F. M. Wilson, lately removed a bead from the auditory canal of a child by "*stringing*" it upon a Bowman's lachrymal probe. Dr. Wilson intended to use the probe to dislodge the bead, but finding he could easily pass it into the eye of the bead, he did so. Dr. Knapp[2] lays some stress upon the use, in difficult cases, of a flexible silver hook, the concave side of which is roughened and hollowed out. Such a hook, it is claimed, is less likely to slip off the foreign body. Dr. Knapp adds his testimony to the nearly unanimous general statement of experienced surgeons upon this subject, that he does not remember a single case in which he failed to remove a foreign body by syringing or by the hook. The recommendation by Politzer[3] to use alcohol in the ear to avoid swelling of the canal from the prolonged use of water, is a good one, and, as Knapp says, it may be enlarged so as to include its use for swelling of the canal from the swelling of the foreign body itself, since alcohol is such an excellent remedy for the shrinkage of proliferating tissue.

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[1] Detroit Lancet, June, 1882. [2] Medical Record, January, 1883, p. 25.
[3] Text-book, translation, p. 628.

The ancient suggestion of Hippocrates, Paul of Ægina, and Du Verney, which was revived and re-suggested by Tröltsch in 1862, 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 is not a dangerous operation, and it is much to be preferred to any risk of serious injury to the cavity of the tympanum or the labyrinth.

Following the suggestion of Tröltsch, I performed the operation of detachment of the auricle for the removal of a foreign body in April, 1874. In 1881 Dr. J. Orne Green[1] performed the same operation, and, in 1882, Dr. A. H. Buck.[2]

According to Politzer,[3] it has also been performed by Langenbeck (*Berliner Med. Wochenschrift*, 1876), who removed a button from the tympanic cavity after partial separation of the posterior attachment of the auricle. Moldenhauer,[4] in 1881, also removed a stone from the auditory canal of a boy of three and a half years of age, after completely detaching the auricle posteriorly. Schwartze adds a note to Moldenhauer's article, the latter writer having quoted him from Tröltsch's text-book, to state that he has separated the auricle in three cases for the removal of foreign bodies from the ear. Schwartze gives no more exact date to his operations than to say, "In the beginning of the last ten years," (*Aus dem Anfange des vorigen Decenniums*). This probably means in the years 1872, 1873, or 1874. From all this it appears, that either Schwartze or myself, was the first to perform this operation, after it was suggested by Paul von Ægina (see introductory chapter), and re-suggested by Tröltsch in the first edition of his text-book.

Schwartze[5] urgently advises against the cutting out of pieces of the cartilaginous canal or a partial chiselling out of the posterior wall of the osseous canal, in order to get a larger field of operation in removing a foreign body from the ear.

The case in which I performed this operation, was that of a gentleman, who when about sixteen years of age, was accidentally shot by himself, the shot entering the ramus of the upper jaw. The zygoma and the outer wall of the orbit were fractured. The auricle was detached and the lower jaw was broken. Twenty-two shot were removed from various parts of the face. The auditory canal became nearly closed, but there was a constant discharge of pus from it. It was evident that the bony canal or tympanic

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[1] Transactions American Otological Society, Vol. II., p. 471.
[2] New York Medical Record, December, 1882, p. 676.
[3] Text-book, translation, p. 631.
[4] Archiv fur Ohrenheilkunde, Bd. XVIII., p. 59.
[5] Loc. cit.

cavity, or both were fractured, for pieces of dead bone came away. Granulations sprouted up in the canal, and severe headaches constantly recurred, so that the patient was prevented from engaging in business or study. Lead probes were used to keep the canal dilated. In 1874 one was lost in the canal or tympanic cavity, and all attempts to remove it had failed. Then Mr. W—— came under my care. I used the usual means to find and remove the style—Nélaton's probe, sponge tents, and so forth—but I was unsuccessful. I was never certain that I had found it. The canal was narrow and inflamed, the drum-head was gone, and manipulation was difficult. I then determined to detach the auricle. The patient was placed under ether, and with the assistance of Dr. F. H. Rankin, now of Newport, R. I., and Dr. Sturgis, of this city, I separated the auricle from the bone posteriorly, and searched for the style. Similarly with the experience of Buck and Moldenhauer, I did not find that the operation enlarged the field of operation or exposed the tympanic cavity, as freely as I had been led to hope. Yet the detachment was of very great and essential assistance. *The style was not found, but a shot was removed from the tympanic cavity.* The wound was united by suture and healed by first intention, the facial neuralgia passed away after the removal of the shot, and in 1879 the *leaden style* came away spontaneously, the patient all the time taking good care of the purulent affection of the middle ear and canal by syringing, and so forth. The shot must have made the pressure that caused the neuralgia, since it ceased when this was removed.

The operation of detachment of the auricle, has certainly now a sufficient foothold in the experience of surgeons, to relieve it from the stigma cast upon it by a distinguished professor, who once said that "the idea of separating the auditory canal from the squamous process of the temporal bone, with a view of obtaining access to the extraneous substance, as suggested by Von Tröltsch, is so absurd that it ought to be ranked among the exploded notions of the barbarous ages." Another writer, in the *American Journal of Otology*, January, 1881, alluded to the operation only to speak of its "utter futility," but in spite of this, it is now a sound surgical procedure, based on an experience that fully justifies its performance, whenever it may be indicated by an inability to get at a foreign body through the canal.

Dr. Orne Green performed the operation on May 11, 1881, upon a man who, with suicidal intent, placed the muzzle of a small revolver directly in the right auditory meatus, and fired two shots in that passage. Three days after, the patient was brought to the City Hospital of Boston, complaining only of headache, sore-

ness of the ear and face on the side of the injured ear. The meatus was found filled with half-burnt powder, and with a probe loose foreign bodies were detected. Three days after admission a semi-circular incision was made above and behind the auricle, through the periosteum, and the periosteum with the auricle and cartilaginous meatus carried forward until the edge of the osseous meatus was reached. Dr. Green then readily seized a loose foreign body, an irregular bit of lead. After syringing and digging out masses of powder, the anterior osseous wall of the meatus was found to be loose and was removed. A porcelain-tipped probe detected a second mass of lead firmly wedged in. This was loosened and removed. A third mass of lead, also detected by the probe, was gradually loosened and removed. The auricle was replaced, the incision united by sutures, and a carbolic dressing applied. The patient did well for four days, he then refused to eat, became delirious, and died six days after the operation. The post-mortem examination showed serum beneath the *pia mater* and congestion. The dura mater, pia mater, and brain-substance just over the roof of the tympanum were firmly adherent and could not be separated from the bone. Just above, passing into the brain for half an inch, was a small sinus, evidently the track of a piece of one bullet. There were small bits of bone embedded in the dura mater at this point. On examination of the right temporal bone the whole anterior wall of the osseous meatus was found to be wanting, the tissues in front of the ear around the glenoid fossa were gangrenous. The roof of the tympanum was perforated by an opening 8 mm. long and 4 mm. broad. The bone within the tympanic cavity was entirely bare. The ossicles were gone, and the lower edge of the fenestra ovalis was broken away. No lead was found in the bone. The lead removed weighed in all 48¼ grains. Two bullets of the size used would weigh 60 grains, leaving 11¾ grains, which in all probability entered the brain. When Dr. Green first examined this case, he found that the meatus was unusually small, and this fact, with the certainty that if the bullets were found they would be flattened, caused him to undertake the operation of detaching the auricle.

Dr. Green goes on to state, that if one portion of the bullet had not glanced upward, and passed through the roof of the tympanum into the brain, a condition impossible to diagnosticate beforehand, there were no reasons why recovery should not have occurred. Langenbeck, by the aid of this operation, removed a small button which had entered the left tympanic cavity, and caused a very extensive reflex-neurotic pain in the arms, upper jaw, with hyperalgesia of the skin of the affected parts, and finally contraction of the left hand. The wound healed by first intention, except a slight fistula under the parotid. The patient recovered in three days from the reflex symptoms.[1]

Dr. Buck's case should also be given, for I am sure a careful consideration of this subject, will establish this operation in full favor, especially in cases where the foreign body has entered the tympanic cavity, and where in addition to this the meatus externus and canal are abnormally small. It goes without say-

[1] Tröltsch, Lehrbuch, Sechste Auflage, p. 510. Leipzig, 1877. Berlin. Klin. Wochenschrift, 1876, No. 15.

ing, as Tröltsch said when he advised a revival of the operation, that it is to be reserved for urgent cases. Yet no surgeon need be deterred from it, by the idea that it is a formidable surgical procedure. It is far from this, and I have no reason for withdrawing my recommendation of it, which I gave in the first edition of this book, published in 1873.

The case in which Dr. Buck detached the auricle, is in brief as follows :

The patient was a boy of nine years, in whose right auditory canal a playmate had thrown or pushed a bean. An effort was made to remove it by a physician, but it failed. The boy was then brought to Dr. Francis Delafield, of New York, who, with Dr. Buck—the little patient being under the influence of sulphuric ether—tried to dislodge the bean, which was seen between the anterior and posterior walls of the canal near the membrana tympani. These attempts were made with steel hooks. The bean was what is known as a locust bean, very hard, "the surface is essentially as hard as ivory" (Buck). A locust bean measures 10 mm. in length, 7 mm. in breadth, and 5 mm. in thickness. After waiting for some days and making experiments with a dental drill, and by soaking the beans in hot water and nitric acid, and finding the results unsatisfactory, Dr. Buck determined to detach the auricle, which he did. The bleeding was profuse. The bean was seen lying transversely across the long axis of the canal, but it was so firmly impacted that there was great difficulty in removing it with the steel hook, although this was finally accomplished. The case finally did well, although the auricle healed slowly, and granulations formed in the auditory canal. A perforation of the membrana tympani was found after the operation. This Dr. Buck is inclined to think was caused by the attempts at removal. A note from the physician who first saw the case just narrated, to Dr. Buck,[1] states that he never saw the foreign body at all, but that attempts were made to remove it by "a nurse or one of the lady guests at the house," who used a hair-pin, and then by "a gentleman guest," who used a crochet-needle.

Thus the old story is repeated. Nowhere do "fools step in where angels fear to tread," more promptly, than when a foreign body has entered the auditory canal of some luckless child. This locust bean was probably firmly lodged by the hair-pin and crochet-needle of the "lady and gentleman guests" who took part in the hunt after a bean, which would have been easily removed by the syringe, if it had been left where it first lodged. This case caused Dr. Buck, who formerly looked somewhat askance at the syringe as the first means to be tried for removing a foreign body from the ear, to state that "it is a fair inference to draw from this case, that it is decidedly better for the general practitioner, when called upon to remove a foreign body from the ear, to restrict his efforts to the employment of the syringe with tepid water."

[1] Medical Record, January, 1883.

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

Of the cases of foreign body in the ear, that I have seen in private practice, very few are worthy of more especial notice than I have already given them.

In two of the cases, both male adults, the foreign bodies were thrown in the ear. In one case the patient was passing along the street when a bean was thrown into his ear. The bean was dislodged by means of a small hook, and then removed with an angular forceps. In the other case some young men were engaged in "flipping" beans, and one entered the auditory canal. It was displaced by a probe, and then removed by a syringe. In another case, an okra seed had been pushed through the membrana tympani in the efforts to remove it. Suppuration of the middle ear existed when I saw the child, and the okra seed could not be seen. In the course of a year it came out during the syringing, which was advised as a means of treating the ulceration. There was one case, in which a cockroach entered the ear of a man of thirty-six. He came to the office, stating that he had pain in the ear during the night, but without knowing the cause. The insect was easily removed by the syringe. In another case, that of a lady, quite a large quantity of sand

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

was removed from the canal and from the surface of the drum-head. Of the Manhattan Hospital cases, a very large proportion were removed without an anæsthetic, and whether with another instrument than the syringe or not, at least without difficulty. Ten were removed under the use of sulphuric ether, and chloroform was used in one case. Failure to remove the foreign body did not occur in any case. Two of the cases are said to have been injured by instruments before they came to the hospital. If the notes had been fully kept, a greater number of cases of injury from attempts at removal would, I think, have been shown.

In one of the cases the foreign body had been pushed into the tympanic cavity. It was removed, five days after the first visit to the hospital, by Dr. Pardee, he having dislodged it at the first visit.

There were two cases in which no foreign body was in the ear, although one was supposed to be. In one case, a piece of the point of a lead-pencil broke off in the ear while the patient was carrying it in her hand. She ran against some obstruction and broke the pencil in her ear. It was easily removed with the syringe.

My distinguished countryman, the late Dr. J. Marion Sims, published an article, illustrated by three cases, in the *American Journal for Medical Sciences*,[1] that very warmly and ably advocated the use of the syringe for the removal of foreign bodies from the ear, but which did not receive the attention it deserved.

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

Dr. Sims maintained his interest in this subject long after he had won great fame as a gynæcologist. He read a paper upon

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

"The Extraction of Foreign Bodies from the Ear" before the British Medical Association in 1878,[1] in which he repeated his views as to the value of the syringe. He criticised the ear syringes made in London as being clumsy, as having a large nozzle, so that they throw a large stream of water. Dr. Sims recommends for occasional use, in removing foreign bodies for example, the ear syringe so commonly sold in the United States. It is of hard rubber, and holds about an ounce. It is very light and is easily managed with one hand. Useful as this syringe is for occasional use, it is usually so carelessly made, and is so small, that the practitioner who has much use for an aural syringe will prefer one of metal, a size or two larger, but having the same nozzle, and made on the same general plan as the "American hard rubber ear syringe." Even *patients* who are obliged to use a syringe for a long time, will find a metal syringe the cheapest.

Dr. E. D. Speir,[2] of Boston, recommends pressure with the fingers "upon the skin, close to and in front of the tragus, carried upward and around the meatus, upon the auricle, and back again to their starting-point, when the manœuvre is repeated several times," for the removal of a foreign body found in the cartilaginous portion of the canal, and lying upon the wall.

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

*A Pea in the Ear for Thirty Years—Unpleasant and Painful Symptoms—Final Removal by the Patient Himself.*

My friend, Professor William Darling, having told me of a well authenticated case of a foreign body remaining in the ear for thirty years, at my request, he procured the history for me. I regard it as of sufficient value to warrant its insertion in the patient's own words.

When a boy in Scotland, nine or ten years old, I put a pea into my right ear, under the impression it would come out at my mouth. I was immedi-

[1] British Medical Journal, December, 1878, p. 868.
[2] American Journal of Otology, Vol. III., p. 197.

ately seized with excruciating pains, and the doctor was sent for. Of course, I told my father and mother where the great pain was located, but I neither told them nor the doctor the cause. I can remember them holding me in bed, while the doctor was dropping some liquid into my ear to try and relieve the pain. The doctor who attended me was the uncle of Professor William Darling, of New York, and I remember many expedients were tried to relieve my agony. Suppuration ensued, and after a time I got better, but the ear was a continual trouble; if I got wet or cold it went to that sore ear. After coming to Montreal, I requested the late Dr. W. P. S—— to try and remove the pea, but he would not believe there was any foreign body in the ear, and it was only after urgent solicitations that he at last extracted what appeared to me to be the half of the outer skin of the pea, but which the doctor said was only "hardened wax." After any violent exertion I felt as if the pea was displaced, until I got a night's sleep.

Before the opening of the Atlantic, now the Montreal and Portland railway, and before the road was ballasted, I rode from Sherbrooke to Montreal (100 miles), with only an engine and tender, and the jolting on the rough road so displaced the pea, that at night it was impossible for me to sleep. I knew the pea was the trouble, so with as long a pin and as small a head as I could find, I determined to try and remove the pea which had now been in my ear over thirty years. After cautiously introducing the pin into the ear, a grating sound was felt, and with some trouble the pin head was got over the pea, and by slowly working the pin back and forward, gradually the pea was brought to the opening, when unfortunately the pin then slipped out. At this point, the narrator states, he awoke his wife, who in attempting to remove a "black thing" which she saw at the meatus, pushed it back. The patient, however, soon, by careful manipulation with the pin, removed the pea from the ear.

The writer then continues: Half of the skin still adheres to the pea, but the division and germinating points are as plainly marked to-day as they were upward of fifty years ago. I am now sixty-one years of age. Previous to getting the pea out, I could never sleep on my right side, I was continually bothered by a most annoying singing when the pea was in. The hearing is unimpaired.

Dr. Ludwig Mayer[1] has collected the cases of foreign bodies in the ear that he has been able to find in the literature 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 pha-

[1] Monatsschrift für Ohrenheilkunde, Jahrgang IV., No. 1.

ryngeal 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 occurred 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 with 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."[1]

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.[2] The patient, a young woman of eighteen 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

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[1] Lincke's Sammlung, Bd. I., p. 154.

[2] Text-book, American translation, p. 490.

was inserted. (See latter part of this chapter for a full account of this case.)

Handfield Jones[1] saw a case in which hemiplegia with convulsions arose from the presence of insects in the ear.

Wederstrandt[2] 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 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,[3] reports a very instructive case from the *Lancet*, in which surgeons of a London hospital attempted to remove from the ear of a child of seven years of age, the head of a nail, which they never saw, but which they felt with a probe.

The first surgeon to whom the child was brought said he saw the head of the nail, but he did not attempt to remove it because four men could not hold the boy's head still. A director, 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

[1] Sydenham Society Year-book, 1861.

[2] American Journal of the Medical Sciences, Vol. IX.

[3] Treatise on the Ear, American edition, by George Pilcher. Philadelphia, 1843. Reprint, p. 219.

that he had seen three or four cases which had terminated in this manner. Of course the little victim died, and that too on the third day after these operative attempts.

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

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

The following case, also belongs in this sad category of great damage done by unwise attempts to extract a foreign body.[1]

*Extraction of a Foreign Body from the Tympanum, with Resection of the Tympanic Ring.*—The following case is related in the *Norsk Magazin for Laegeridenskaben*, vol. xii., No. 11. A little girl, aged four, while playing on the seashore had a stone pushed into her ear by her sister. A few days later, upon the sister's confessing her trick, the mother attempted to dislodge the stone by means of a hair-pin, but not succeeding, she took the child to several physicians, one after the other, all of whom made repeated unsuccessful attempts to extract the foreign body. It was then, two and a half weeks after the accident, that the child was sent to the Rigshospital in the service of Dr. J. Nicolaysen. Examination showed numerous erosions in the external auditory canal, the outer two-thirds of which was swollen and ecchymotic, the inner third entirely denuded of skin and periosteum. The drum-head was gone, the tympanic ring bare, and the cavity of the tympanum filled up by the foreign body. The stone seemed to be wedged tightly in the anterior part of the cavity. There was some purulent secretion from the tympanum and meatus. The first efforts at extraction were unsuccessful, and the operation was put off till the following day to give time for the manufacture of some strong hooks. When these were procured they were slipped past the stone, but were broken off and their points left in the cavity of the ear. As the child had several times stopped breathing the chloroform was withheld and the operation again interrupted. The third attempt was successful. A very fine saw was introduced and two notches made in the tympanic ring, one directly forward and the other downward. Then the intervening section of bone, about one-fourth of an inch in length, was knocked off with a chisel. The stone was now readily extracted and with it the broken hooks and ossicles. The stone measured 8.75 mm. in length, 5.5 mm. in width, and 4.75 mm. in thickness. The well-meant efforts at extraction had succeeded only in wedging it in the tympanic orifice by its largest diameter, thereby destroying the drum-head and the ossicles.

The fact has already been alluded to in this chapter, that persons sometimes suppose there is a foreign body in the ear,

[1] Medical Record, vol. xxv., p. 208.

when there is actually none in it, and when there probably never has been one there. At times 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 of life, supposed that pins were in the auditory canal. No amount of reasoning, nor the subterfuge of pretending to remove a pin from the ear, by syringing, could satisfy these females.

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[1] 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 lie on the drum-head, and thus become irritating foreign bodies.

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

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

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[1] Chapter on Chronic Non-suppurative Inflammation.

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

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

3. If this fail, use a Daviels' spoon, a wire loop, a bent probe, a cystotome used by oculists, or the like, and attempt to change the position of the foreign body, so that the stream of water can get behind it and force it out. This displacement should generally be done under ether, especially in the case of children who have been frightened by previous attempts at removal.

4. If the foreign body be so wedged in that this method fails, Lowenburg's gluing procedure, Elsberg's instrument, or some one of the numerous aural forceps, are worthy of use.

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

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

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

### FOREIGN BODIES IN THE EUSTACHIAN TUBE.

Among the cases whose statistics are 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 practise rhinoscopy, and see the feather, and he failed with various kinds of forceps to remove it.

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

Politzer[1] also relates two cases, quoted from Urbantschitsch and Schalle, where foreign bodies have reached the cavity of the tympanum from the pharynx. The first was an oat husk, which had stuck in the throat in chewing an ear of grain. It entered the Eustachian tube and the tympanic cavity, and came through the external meatus.

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

## EAR-COUGH.

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

Certain other reflex symptoms from irritation of the walls of the canal have been observed for centuries. Such are sneezing and vomiting, and even epileptic seizures. For example, Tröltsch[2] quotes from Pechlin, who, writing in 1691, says he

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

[2] Lehrbuch, Sechste Auflage, p. 522.

knew a man in whom contact with the external auditory canal always caused vomiting. Arnold,[1] also quoted by Tröltsch, tells a story of a now famous girl, who suffered for a long time from a severe cough and expectoration, who besides often vomited and gradually became very thin, and who was finally relieved from all her symptoms by the removal of a bean from each ear. Arnold relates another case where a "disease of the chest" was cured by the removal of a foreign body from the ear. Toynbee[2] also records the case of a patient, who suffered from a cough which no treatment subdued, until a portion of dead bone was removed from the auditory canal. The most important of all the cases of reflex symptoms from irritation of the external canal of the ear yet reported, is that of Fabricius, of Hilden, whose case Tröltsch also quotes. A girl of ten years of age put a small glass ball in her ear. Many attempts were made to remove it, but they were unsuccessful. Finally she was seized with hemicrania, anæsthesia of the entire left side of the body, alternating with severe pain, until at last epileptic attacks occurred, with atrophy of the left arm. At eighteen years of age she came under the care of Fabricius, who drew out the story of the glass bead, which had been well-nigh overlooked, since she never complained of earache. He removed the foreign body and cured the patient of all her troubles, as he writes to his friend Bauhinus, "*Restituum est quoque brachium.*"

Schwartze and Koeppe[3] also speak of reflex phenomena from foreign bodies in the canal. Koeppe,[4] in an article upon "Reflex Psychosis from Aural Diseases," relates two cases where treatment of the nose, throat, and ears restored the patients to sound mental condition. In the first case there was ozæna and catarrh of the ears; in the second hardened blood was removed from the auditory canal, where it had remained for years, as the result of a hemorrhage from a fall, or several falls, upon the head. These cases are exceedingly interesting.

Dr. Kupper[5] reports a case of epilepsy from a foreign body in the auditory canal, and also a case of cerebral irritation from inspissated cerumen.

A young woman of eighteen was admitted to the hospital with the following history: She had had severe pain in the right ear, and suppuration had finally occurred. Toothache also set in later, when she put a piece of a root in the

[1] Loc cit.
[2] Treatise on the Ear, English edition, p. 39.
[3] Archiv für Ohrenheilkunde, Bd. V., S. 283.
[4] Ibid., Bd. IX., p. 220.
[5] Ibid., Bd. XX., p. 167.

suppurating ear to relieve the pain. She was not able to remove it, and since that time she had suffered from epileptic seizures. They often occurred daily and sometimes several times a day. An examination showed the young woman to be well except as to the right ear. The tuning-fork was heard better on that side, the watch was only heard when laid upon the ear. The auditory canal was sensitive on pressure, and full of pus. Careful syringing caused vomiting and vertigo. The canal was filled with polypi that were very sensitive. The patient was put under the influence of chloroform, and the polypi were removed. On the next day the foreign body was removed with a blunt hook and syringing, the patient being again under the influence of chloroform. The piece of wood was 1 cm. long and ¼ cm. thick. Only two attacks of epilepsy occurred after the operations, one within a few hours of the last operation, the other two days after. The patient also recovered full hearing power.

The second patient was a woman of seventy-six, who suddenly began to have cerebral symptoms, headache, vertigo, vomiting, severe spasm of the muscles of the face and of the extremities. She especially complained of pain in the right ear, and it was found to be sensitive on contact. The organs of the old lady were found to be in good condition, except the right auditory canal, which was completely stopped by wax. The mass was removed with great difficulty in about two days, after softening it. The necessary manipulations caused serious symptoms, but as soon as the wax was loosened they disappeared. The membrana tympani was found to be the seat of old disease, and was adherent to the promontory. There was no hearing-power on that side. In six weeks the patient, who was much run down by her symptoms, had fully recovered and was able to go out.

Wilde[1] also, quotes from Dr. Maclagan "a case of epilepsy and deafness, dependent on the presence of a foreign body in the ear." After the seed of a sycamore, which had been in the ear ten years, was removed, the epileptic attacks ceased, and the deafness declined. Sir William seems to have been somewhat skeptical about this case, and he says: "I must confess that I am inclined to bring in the Scotch verdict of 'non proven,' as far as the seed is concerned. The state of the ear, either before or after the removal of the foreign body, has not been recorded; nor whether the seed ruptured the membrana tympani, or caused any disorganization of the parts." Wilde goes on to say, that if the introduction of a foreign body into the canal causes epilepsy, it must be by pressing upon the sensitive part which he had met in some persons, in syringing the ear. He was not able to explain the phenomenon, but later on in his book he quotes another writer,[2] who explains it by hyperæsthesia of the auricular branch of the pneumogastric. Strange to say, there remains a doubt, from the varying statements of anatomists, as to whether the *auditory canal* is or is not sup-

[1] Aural Surgery, p. 189.
[2] Loc. cit., p. 326.

plied by the pneumogastric. Quain [1] only speaks of the auricular branch of the pneumogastric as supplying "the integument of the back of the ear."

Sappey [2] describes it as supplying the canal, as do other authors, for example, Gruber,[3] who says: "The auricular branch of the vagus extends not only to the posterior surface of the auricle, but also to the cartilaginous part of the auditory canal.

Tröltsch [4] also describes an auricular branch of the vagus which, as he says, enters the posterior part of the osseous canal. This acceptance of Arnold's discovery of the auditory branch of the pneumogastric is usually accepted, although the most complete article on ear-cough of which I know, that by Cornelius B. Fox,[5] agrees with Quain, that the auricular branch of the pneumogastric only supplies the posterior part of the pinna (auricle). In about twenty per cent. of the persons examined by Dr. Fox there was found a hyperæsthetic state of the nerve supplying the auditory canal, that is, they were persons in whom any slight titillation of the nerve produced a sense of tickling in the throat. These are the persons alluded to in the opening sentences on this subject in this book. Dr. Fox also believes, that when this condition exists, it is a congenital peculiarity, and that the connection between the nerves involved takes place in the brain. The cases of ear-cough cited by Fox are similar, and in some instances identical, with those I have enumerated. There is no attempt made to trace cough to evanescent or temporary influences, such as cold upon the face and auditory canal. In the two cases of his own cited by Fox, in the one instance the cough was caused by wax and an ulcer of the canal; in the other, by an inflammation of the canal produced by the use of a spirituous irritant. Lockart Clarke [6] supports Fox's view as to the origin of ear-cough, "in the fibres of the fifth cerebral nerve distributed to the auditory canal." Mr. John Wood,[7] an examiner in anatomy of the University of London, states positively that he has traced a branch of the vagus into the auditory canal, "passing through a minute foramen between the jugular fossa and the glenoid."

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[1] Elements of Anatomy, eighth edition, p. 560.

[2] Traité d'Anatomie, Tome III., p. 842. 1877. "La peau du conduit externe est extrémement sensible. . . . soit enfin au rameau auriculaire de pneumogastrique, qui vient se perdre dans la peau de la portion osseuse du conduit."

[3] Lehrbuch, p. 144.

[4] Ibid., VI. Aufgabe, p. 29.

[5] British Medical Journal, December 18, 1869, p. 650.

[6] Ibid., 1870, p. 51.

[7] Loc. cit., p. 328.

From the facts so well established since the time of Fabricius, theoretical writers have made the most possible. Woakes[1] seems hardly to consider them exceptional, and argues with ingenuity, but I cannot think soundly, that there may be quite a large class of cases of affections of the larynx, that are due to auditory irritation. He suggests spasmodic croup as *occasionally* owing its origin to a draught of cold air falling upon the ear. He also attempts to explain "derangement in the innervation of the laryngeal muscles" as possibly due to reflex influence from the auditory branch of the vagus. He instances the coachman exposed to east wind and rain, and who finds his voice "husky, shrill, or faltering" in the evening, and he argues that the exciting causes are draughts of cold air and wet upon the surface "the impression of which, is conveyed by the afferent vaso-motor nerves associated with the cerebro-spinal nerves of the surface receiving the chill, to the sympathetic ganglion with which they communicate: in this instance, the superior cervical ganglion." Dr. Woakes traces the irritation, 1, from the vaso-motor fibres associated with the auricular branch of the pneumogastric; 2, to the secondary vaso-motor centre, the ganglion of the pneumogastric, whence he says it is deflected through a sympathetic fasciculus to the first cervical ganglion; 3, thence by the *nervi molles* to the vessels distributed to the mucous membrane of the larynx. He rejects the simple idea that the morbid impression is conducted along the sensitive fibres, from one region to another.

Orne Green[2] suggests in a review of Dr. Woakes' book quoted by Woakes himself, that the mechanical commotion of the larynx caused by the cough, is the cause of the local inflammatory mischief in this organ. The subject is an interesting one, but the cases of reflex phenomena from irritation of the canal are too infrequent, in my opinion, to justify the deductions of Woakes in regard to laryngeal paresis, and subsequent inflammation. Dr. Woakes quotes an amusing story, from Miss Edgeworth's tales, which will bear repetition: This author relates that a choking Norwegian clergyman at a feast, was relieved by a blast of air from a bellows, which a friendly companion blew into his ear. "The effect was magical: the expulsive action of the laryngeal muscles, called into play by this novel method, speedily got rid of the food which the gluttonous haste of the pastor, had caused to go the wrong way."

Woakes[3] points out that sneezing caused by irritation of the

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

[2] Boston Medical and Surgical Journal, 1879, p. 911.

[3] Loc. cit., p. 93.

auditory canal, cannot be due to or explained by referring it to "an irritation of the third branch of the fifth nerve exciting the motor laryngeal branches of the vagus, through communications existing between the roots of these nerves," as claimed by Fox, Clarke, and Russell, because with the act of sneezing, the vagus, as a motor nerve, can have nothing to do.

These cases are, I believe, rare and exceptional, and I am not ready to accept Dr. Woakes' theories of laryngeal paresis and cough, or to believe that we have any but very infrequent occasion, to refer to the auditory canal for the explanation of coughs. When this theory was first promulgated in this country, I was called to see a child of six months of age, who suffered from persistent cough. I was asked to examine the ear to explain the trouble. But while the history showed that the child had recently had pleuro-pneumonia, the ears revealed nothing abnormal. The cough in this case may easily have been due to pleural adhesions. I only mention the case, to show how ready we all are to give up obvious and simple explanations, to search for those that are recondite.

Ear-cough is a very uncommon disease; when it does occur, we may usually find an obvious local cause for it in the auditory canal, as in the classical cases, such as a foreign body or inspissated cerumen. To trace any considerable number of laryngeal affections to transient impressions on the auditory canal, to impressions that act more directly upon other parts of the surface of the body, is to go beyond the bounds of what seems to me logical reasoning. To produce ear-cough, we must have a continuously acting irritant. I do not deny that a blast of air upon an auditory canal, in cases such as make up the twenty per cent. contingent of Dr. Fox's tables, may produce ear-cough, but withdraw the draught, and the cough will cease, just as it does when the bean, or wax, or probe is removed from the ear. It seems to me, very unlikely that a permanent lesion is produced by such a temporary influence.

# THE MIDDLE EAR.

# CHAPTER IX.

## ANATOMY OF THE MIDDLE EAR.

Statistics of Diseases of the Middle Ear.—Membrana Tympani.—Shrapnell's Membrane.—Rivinian Foramen.—Light Spot.—Layers.—Blood-Vessels.—Nerves.—Lymphatics.—Cavity of the Tympanum.—Scheme for Studying Boundaries of this Cavity.—Ossicula Auditus.—Blood-Vessels.—Nerves.—Mastoid Process.—Eustachian Tube, Historical Account of.—Physiology of the Middle Ear.

By far the greater number of aural diseases affect what is known as the middle ear. Of 4800 cases, occurring in my private practice, 3673 were diseases that involved these parts chiefly.

Bürkner, in his statistical tables, already quoted, in a total number of 58,645 cases, places 39,238 in the category of diseases of the middle ear. This makes a percentage of nearly 70. My own statistics exhibit a percentage of more than 70. Those of the Manhattan Eye and Ear Hospital for thirteen years, more than 76 in a hundred. Of a total of 10,335 cases, 7957 were affections of the middle ear. It is probable that a more exact knowledge will in the future diminish this proportion somewhat. I believe that it will yet be found, that diseases of the labyrinth and of the trunk of the acoustic nerve, are more frequent than is now supposed. However this may be, the diseases of the middle ear, will probably always far exceed in number those of the other parts of the organ. The anatomy of this region, therefore, demands a careful and exact study.

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

### THE MEMBRANA TYMPANI.

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

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

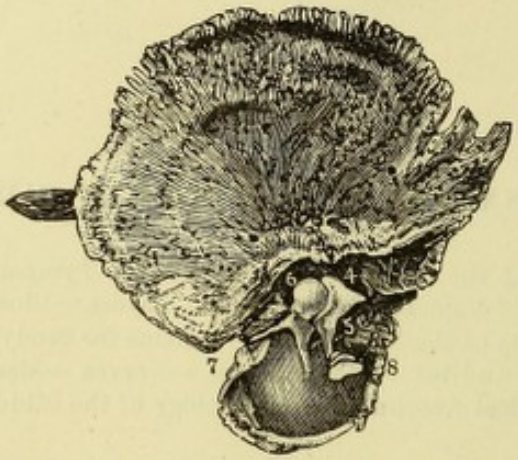


FIG. 52.—The Right Temporal Bone, without the Petrous Portion, in connection with the Ossicula Auditus of a Newly-born Child, seen from within (after Rüdinger).[1] 4, Is above the incus, whose short process is directed nearly horizontally backward; 5, the long arm of the incus, which extends freely into 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.

makes with the axis of the auditory canal, is one of about 55°. The inclination of the two membranes to an angle opening upward is one varying from 130° to 135°. In the newly born it was formerly supposed, that the membrana tympani lies more hori-

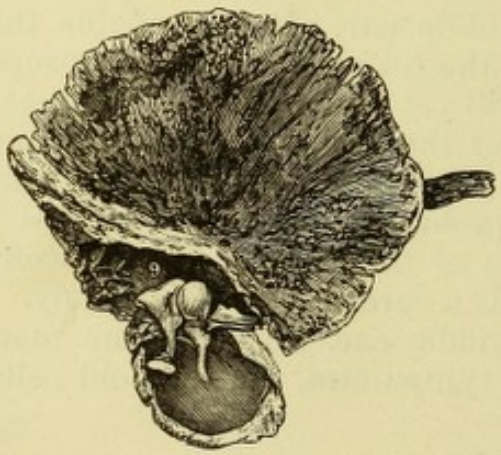

FIG. 53.—Left Temporal Bone of the same Subject as preceding Figure.

zontally than in the adult, and that it is almost in the same line with the upper wall of the external auditory canal.

According to Pollak, quoted by Politzer,[2] this is incorrect.

[1] Atlas des Menschlichen Gehörorganes. München, 1867.

[2] Text-book, translation, p. 20.

Pollak has made numerous measurements, and he states that there is no perceptible difference between the inclination of the membrane of the newly born and that of the adult.

The peculiar manner in which the membrana tympani is placed in the canal, causes it to form an acute angle with the lower and anterior wall of the auditory canal, but an obtuse one with the upper and posterior wall.

The general shape of the membrane is elliptical; but the

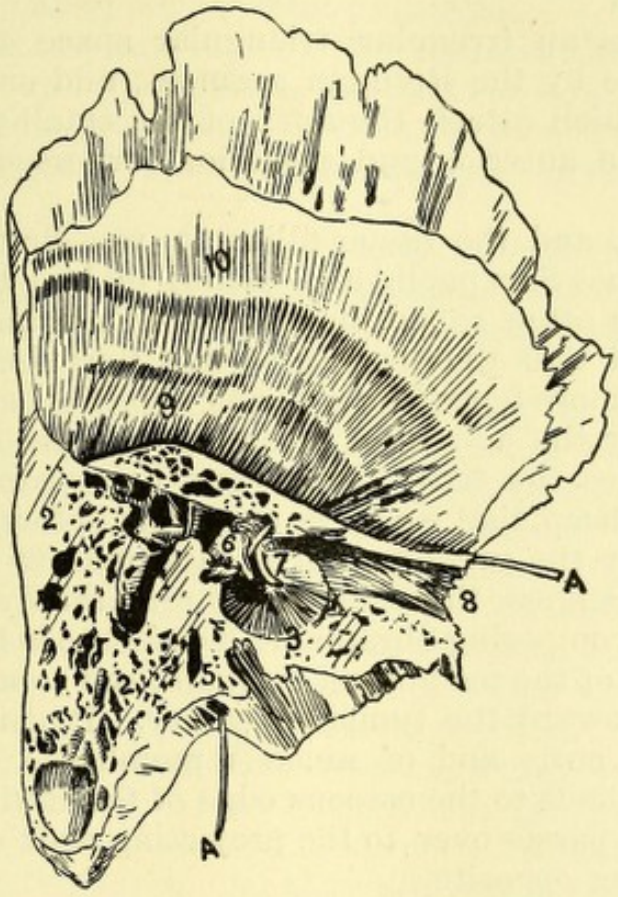


FIG. 54.—Section through Tympanic Cavity, Left Side (actual size, anterior half). 1, Squamous portion of temporal bone; 2, mastoid cells; 3, membrana tympani; A, A, chorda tympani; 5, aqueductus Fallopii; 6, incus (body); 7, malleus (handle); 8, Eustachian tube; 9, fossæ (middle cerebral); 10, groove for meningeal artery.

regularity of the ellipse is broken in upon by the incompleteness of the bony ring surrounding the membrane. In the upper part of this bony ring an oval section is wanting; this space is known as the segment of Rivini.

The long axis of this ellipsoid runs downward and forward, the shorter backward and downward. If the diameters of the membrane are measured in the direction of the axis of the ellipsoid, that of the long axis is 9.5–10 mm., and the horizontal is

8 mm. Measured in the usual manner, the horizontal diameter is 8–8.5 mm., and the vertical 8.5–9 mm.

The Rivinian segment is filled by the tissue of the cutis and the mucous membrane of the tympanic cavity. The greater part of the fibres of the tendinous ring of the membrana tympani bend from their former course, and at this point turn toward the short process of the malleus, which lies more deeply where it is inserted. The remainder of the tendinous fibres of the ring pass 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,[1] 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 toward 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,[2] a professor in Leipsic, until the present day. Professor Patruban,[3] 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

[1] 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 here given.

[2] 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.

[3] Monatsschrift für Ohrenheilkunde, Jahrgang III., No. 1.

into the so-called canal, and it always appeared on the other side of the membrana flaccida.

Professor Joseph Gruber[1] has also found the foramen in many specimens. Inasmuch as he oftener found it in pathological specimens, he thinks that its 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.

Politzer[2] thinks that the Rivinian foramen is a constant appearance, not an anomaly or result of disease.

Hyrtl[3] denies the existence of the foramen, 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-fourths of a line 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[4] 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.

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[1] Loc. cit.

[2] Loc. cit.

[3] Anatomie des Menschen, p. 520.

[4] Prag Viertel. Jahrschrift, January, 1866.

Kessel[1] 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.

I believe in the existence of the foramen of Rivinus, from the clinical fact that I have heard a whistling sound, seemingly through the membrana tympani, in several cases, when the Valsalvian experiment was made, when neither myself 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 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, therefore, 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[2] described the circular and radiating fibres of the membrana tympani in his article on the organ of hearing.

Sir Everard Home[3] 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, 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. It is interesting to note that nearly all the cases of double hearing are observed as occurring in musicians.

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

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[1] Stricker's Hand-book of Histology, p. 953.

[2] Cyclopædia of Anatomy and Physiology, vol. ii.

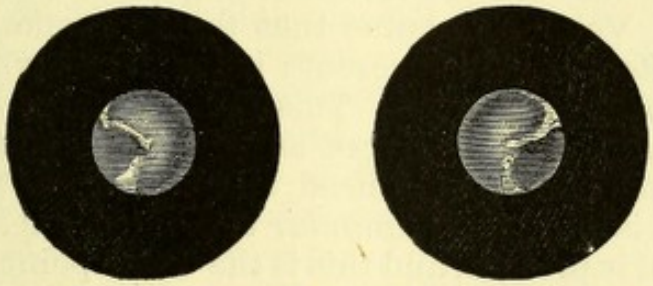
[3] Philosophical Transactions of the Royal Society of London, 1800. Part I.

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 smaller 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 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.



FIGS. 55, 56.—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 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 in 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,[1] are the inclination of the membrane to the axis of the external auditory canal, and the concavity produced by the traction of the handle of the malleus.

If light be thrown upon a dried preparation of the human ear, as in the examination of the living subject, through the auditory canal, the light spot will be found in the same position as it is seen in life. It is also displaced very little by moving the eye in

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

different directions, because the axis of vision corresponds so nearly to the axis of the meatus, that the light spot can change very little with respect to the inclination to the membrana tympani.

No light would be reflected to the eye, if the membrane were a plane surface; for, with its inclination to the auditory canal, all rays thrown upon it would be reflected against the anterior and lower wall of the canal. In consequence, however, of the inward curvature from the traction of the handle of the malleus, its parts undergo such a change of inclination that the anterior portion stands directly at right angles to the axis of vision of the observer, and the light thrown upon it is reflected back to the eye.

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

Helmholtz[1] also states that the triangular spot of light is due to reflection. Voltolini[2] 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 this part of the membrane 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.

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 centre.

III. Its polish or brilliancy.

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[1] Monatsschrift für Ohrenheilkunde, Jahrgang VI., No. 8. [2] Loc. cit.

## THE LAYERS OF THE MEMBRANA TYMPANI.

The membrana tympani is not quite 0.1 mm. in thickness (Henle)—about as thick as very fine letter-paper or gold-beaters' skin. 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 integumentary layer may be easily separated from the fibrous layer, but the mucous membrane is so closely connected to it that it is impossible to separate them.—(Politzer.)

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

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.

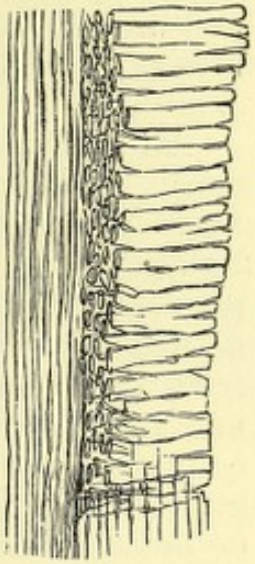

FIG. 57.—Vertical Section of Fibrous Layer of the Membrana Tympani (after Henle). 1 × 300.

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

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

The majority of the fibres run to the malleus in a radiating or circular direction. A small number of them, however, run in different directions between these two sets of fibres. The radiating fibres are external, beneath the 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 mm. to 0.0108 mm. in thickness. Some-

times 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. Tröltsch called these cells the corpuscles of the membrana tympani, and they are named Tröltsch's cells. The larger spaces contain encapsulated nuclei, and are frequently filled with 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.*

All the layers of the fibrous portion 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 toward the meatus externus, giving the membrane a general convexity. The circular fibres do not exist on the lower third of the handle of the malleus and the adjacent parts.

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

The handle of the malleus is attached to the fibrous layer between the radiating and circular fibres. According to Gruber, there is a cartilaginous formation, which begins over the short process of the malleus, and extends ½ mm. below the handle. This is firmly united below; but above, at the short process, there is a kind of a joint, the cavity of which is filled with synovial fluid.

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

[1] Stricker's Hand-book, p. 955.

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 are a great number of glistening nucleated cells under the periosteum and in the duplicature of tissue. These elements remain through life as cartilage cells, and form 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 framework beneath it. On the inner side of the membrane, at the upper part of its posterior half, is found an irregularly triangular fold, 3 mm. to 4 mm. high and 4 mm. broad, which arises close behind the annulus tympanicus, and extends to the handle of the malleus. A cavity is thus formed which opens below, which is called by Tröltsch,[1] who described it, "the posterior pouch" of the membrana tympani.

The best view of this duplicature is seen by viewing the membrana tympani from the inside, while it is still in position, after the roof of the tympanic cavity has been removed, and the incus detached from the malleus; but it may even be seen from the outer surface, by a good illumination, in the living subject. The tissue of the pocket is the same as that of the fibrous layer.—(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 toward the neck of the malleus, by the mucous membrane that lines the tympanic cavity, and by all the parts that enter and leave the Glaserian fissure, that is to say by the long process of the malleus, by its anterior ligament, the chorda tympani nerve, and the inferior tympanic artery.

Villous processes are found on the edge of the mucous membrane, especially in children. These processes are also found

[1] Von Tröltsch: Lehrbuch der Ohrenheilkunde, Vierte Aufgabe, p. 38. 1868.

on the pouch of Tröltsch and on the malleus. They are covered by flattened epithelium, and are composed of connective tissue in which there are capillary loops.

### BLOOD-VESSELS.

According to the 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[1] 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 network in the fibrous layer communicates with the cutis and the mucous membrane.

The blood-vessels that pass from the auditory canal down upon the membrana tympani, come from the deep auricular artery, which is a branch of the internal maxillary.

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

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

[1] Loc. cit., p. 958.

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.

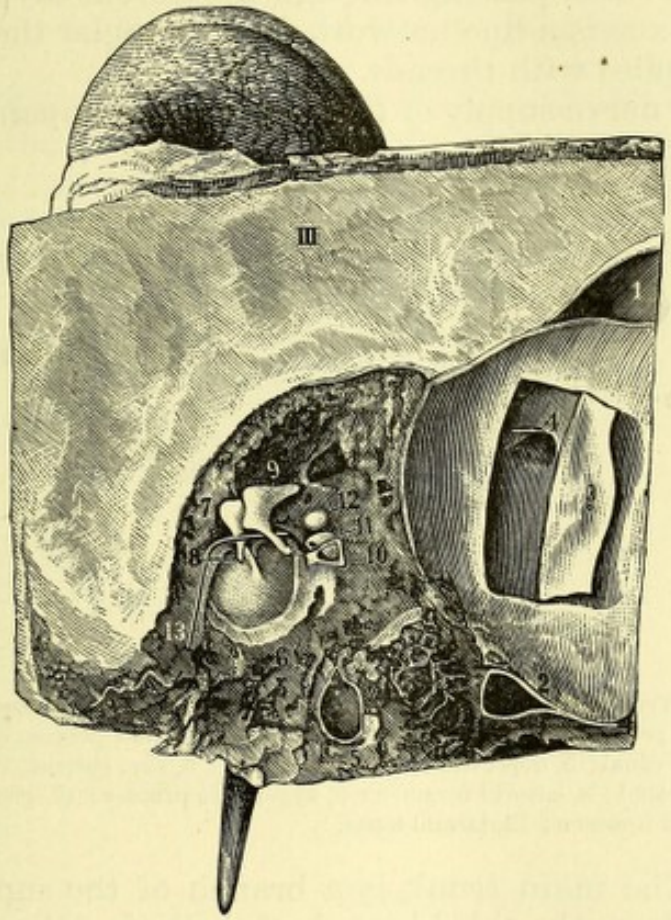


FIG. 58.—The Membrana Tympani, in connection with the Ossicula Auditus of the Right Temporal Bone (from a photograph—Rüdinger). 1, Transverse section of the fossa sigmoidea, in which is the transverse sinus; 2, lower section of the transverse sinus; 3, inner side of the transverse wall thrown back, which 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.

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.[1]

[1] Kessel, in Stricker's Hand-book, 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-epithelial plexus. The former accompanies the lymph- rather than the blood-vessels. Its receives its fibres, in part, from threads of the tympanic plexus, which pass on to the membrane, with the mucous membrane, from different parts of the periphery, and partly from the nerves of the cutis, passing through the fibrous layer. The sub-epithelial plexus is a fine network directly under the epithelium, which it supplies with threads.[1]

The outer nerve-supply of the membrana tympani is from the

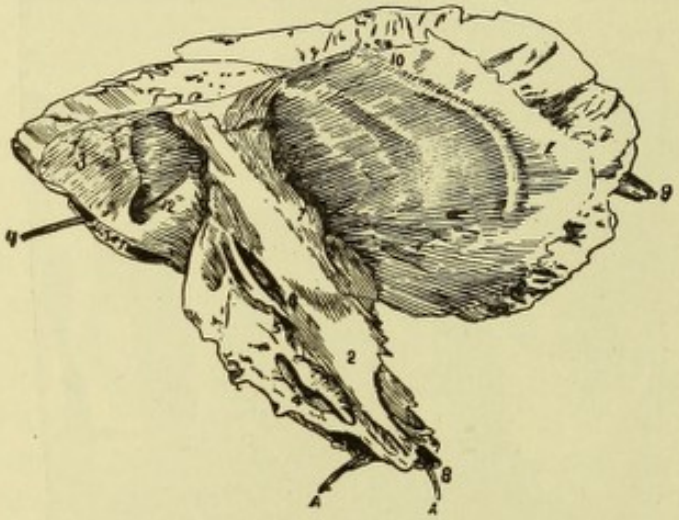


FIG. 59.—Left Temporal Bone (two-thirds of the normal size). 1, Squamous portion of temporal bone; 2, petrous portion of temporal bone; 3, mastoid portion of temporal bone; 4, internal auditory canal; 5, depression from dura mater? 6, sup. petrosal sinus? 7, eminence from semicircular canal; 8, carotid foramen; 9, zygomatic process; 10, groove for meningeal artery; 11, mastoid foramen; 12, lateral sinus.

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

[1] Kessel, p. 963.

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. These vessels are distinguished from the blood capillaries of the same width by their manifold dilatations.[1]

## THE CAVITY OF THE TYMPANUM.

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

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

THE TYMPANUM *presents for examination its*

- 1. DIMENSIONS.
- 2. WALLS.
  - the Anterior.
  - the Posterior.
  - the Outer.
  - the Inner.
  - the Upper.
  - the Lower.
- 3. OSSICLES.
  - Malleus.
  - Incus.
  - Stapes.
- 4. LIGAMENTS.
  - Ligaments of movable joints.
    - *Malleus—Incus.*
    - *Incus—Tympanum.*
    - *Incus—Stapes.*
  - Ligaments of immovable joints.
    - *Obturator Stapedis.*
    - *Mallei Superior.*
    - *Mallei Anterior.*
    - *Incudis Superior.*
- 5. MUSCLES.
  - Tensor Tympani.
  - Stapedius.
- 6. MUCOUS MEMBRANE.
- 7. VESSELS.
- 8. NERVES.

[1] Kessel: Handbuch der Lehre von den Geweben, p. 851.

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 Tröltsch :[1]

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

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.

The measurements of a cast of the tympanic cavity represented on page 93, are as follows :

Distance from attachment of upper part of the membrana tympani to the superior margin of the opening of the Eustachian tube, 1⅓ line ; from opening of mastoid cells above to the superior margin of the opening of Eustachian tube, 3½ lines ; from opening of mastoid cells below to the inferior margin of the opening of the Eustachian tube, 6½ lines ; vertical diameter of the tympanic cavity, 6 lines ; distance from the membrana tympani to upper inner wall, 2 lines ; to lower inner wall, 1 line ; opening of Eustachian tube, vertical diameter, 1½ line ; horizontal diameter, 1 line. A plaster of Paris cast contracts somewhat, so that these measurements are actually too small.

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.

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

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

[1] Text-book, translation, p. 171.

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*

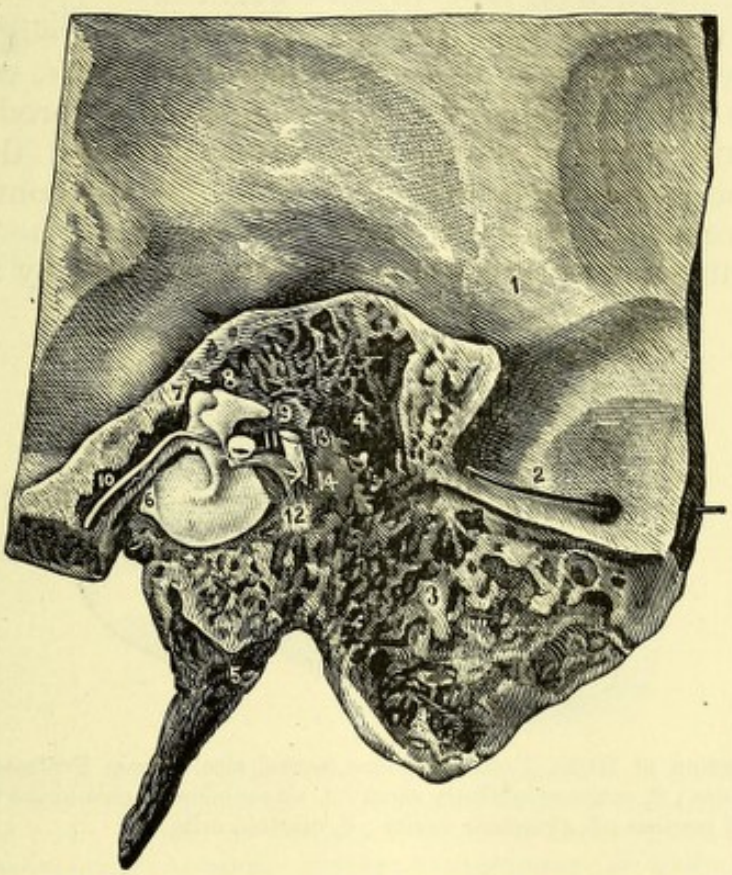


FIG. 60.—The Right Temporal Bone, with the Membrana Tympani and Ossicula Auditus of an Adult. 1, Squamous portion—under figure 1 the sulcus of the transverse sinus runs downward; 2, a bristle passes through the mastoid foramen; 3, mastoid cells; 4, antrum of the mastoid, communicating both with the mastoid 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.)

*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 first whorl 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

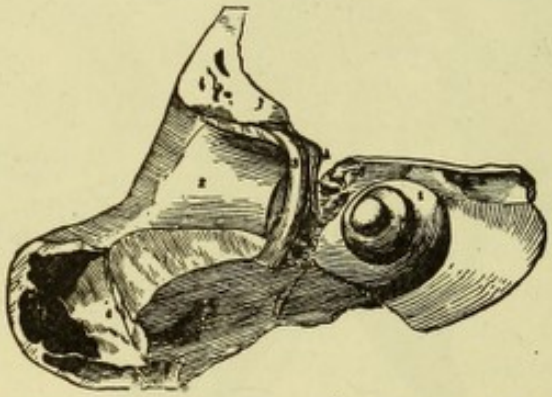

FIG. 61.—Section of Right Temporal Bone (actual size. From Professor Darling's museum). 1, Cochlea; 2, external auditory canal; 3, attachment of membrana tympani to bony ring; 4, head of malleus; 5, tympanic cavity; 6, mastoid cells.

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

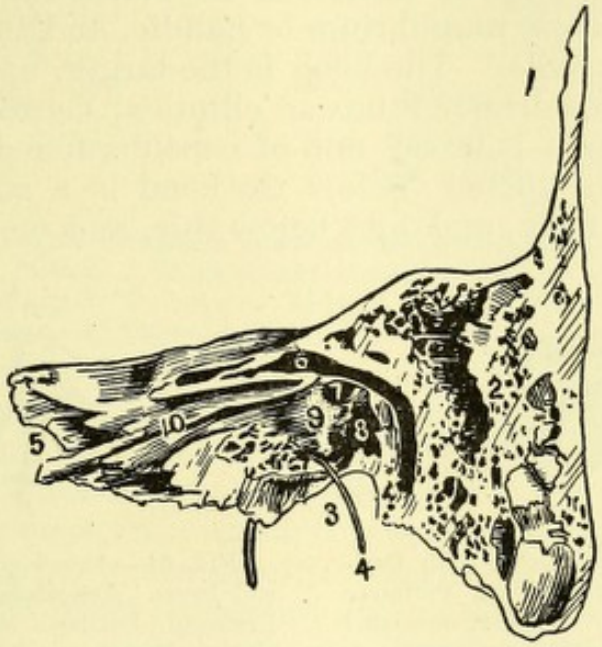


FIG. 62.—Section through Tympanic Cavity, Left Temporal Bone (posterior half, actual size. From Professor Darling's museum). 1, Squamous portion of temporal bone; 2, mastoid cells; 3, jugular fossa; 4, canal for Jacobson's nerve; 5, carotid foramen; 6, aquæductus Fallopii; 7, fenestra ovalis; 8, fenestra rotunda; 9, promontory; 10, Eustachian tube.

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 only by 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.

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

The *malleus* may be described as consisting of the head, neck, short process, manubrium or handle, and the long process or processus gracilis.[1] The head is the larger, upper extremity of the bone. Posteriorly it has an elliptical depression, twice or thrice as long as it is broad, and of considerable depth for articulation with the incus. Below the head is a constricted portion called the neck, and just below this, and on the upper end

FIG. 63.—Tympanic Cavity, with Ossicles in situ (actual size. From Professor Darling's museum). 1, Fenestra rotunda; 2, promontory; 3, annulus tympanicus; 4, incus; 5, handle of malleus; 6, stapes; 7, head of malleus.

FIG. 64.—Anterior Surface of Malleus and Incus. Articulated (twice size. From Professor Darling's museum). 1, Short process of malleus; 2, head of malleus; 3, handle of malleus; 4, broken processus gracilis; 5, long process of incus; 6, short process of incus; 7, body of incus.

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,

[1] Some writers call the handle of the malleus 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 is the innermost and smallest of the bones of the ear, and in-

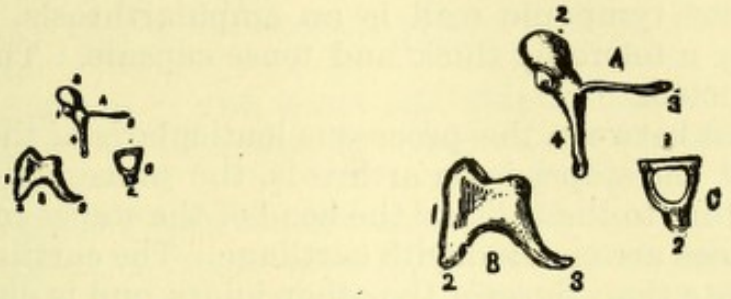


FIG. 65.—Ossicles of the Tympanum (actual size and twice the size. From Professor Darling's museum). A, Malleus. 1, Short process, processus brevis; 2, head; 3, processus gracilis; 4, handle, manubrium. B, Incus. 1, Body; 2, short process, processus brevis; 3, long process, processus longus. C, Stapes. 1, Head; 2, base.

deed 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 inward, to be inserted into a thin plate constituting the base, which lies upon the membrane of the fenestra ovalis. On the outer side of the base is a delicate ridge running from the extremities of the crura and into which is inserted the obturator stapedis.

FIG. 66.—Posterior Surface of the Malleus, Incus, and Stapes. Articulated (twice the natural size).

The dimensions of the ossicles are: length of *malleus* from summit of head to short process, about 4½ mm.; from short process to the end of the handle, 4 to 5 mm. Long process or handle, about 2 mm. Length of the *incus* from summit of head to the end of the long process, about 6½ to 7 mm.; to the end of the short process, about 5 mm. Length of the stapes, about 3 mm. Greatest distance between the crura, about 2 mm. Length of the base, about 3 mm.; width, about 1 mm. The long process, or processus gracilis, is sometimes called the processus *Folianus* (Cœlius Folius, Venice, 1645), and also the process of Rau, after Professor Jacob Rau, of Leyden.

4. Of the *ligaments of the ossicles* we have two classes: the

ligaments of the movable joints and those of the immovable joints.

The *malleo-incus joint* may be classed with the gynglimus articulations on account of the character of the articulating surfaces. These surfaces are covered by cartilage about 0.04 mm. in thickness. The capsule is tense. This joint is provided with synovial membrane.

The articulation between the short process of the incus and the posterior tympanic wall is an amphiarthrosis, and is surrounded by a tolerably thick and tense capsule. The motion is quite restricted.

The joint between the processus lenticularis of the incus and the head of the stapes is an arthrosis, the processus lenticularis corresponding to the ball and the head of the stapes to the socket. Both surfaces are covered with cartilage. The cartilage is much more delicate than those of the other joints, and is characterized by being rich in elastic fibres.

The *ligamentum obturatorium stapedis* is a thin membrane inserted into the ridge on the outer side of the base of the stapes and into the inner edges of the crura, closing the opening formed by these parts.

The head of the malleus sometimes lies in contact with the roof of the tympanic cavity. More frequently it is connected with the roof by the cylindrical *lig. mallei superius* (Soemmering). The neck of the malleus is held in place by the cartilage which sometimes takes the place of the long process, and by the *lig. mallei anterius* (Arnold), which goes from the spina angularis of the sphenoid parallel with the fissura petro-tympanica, to be inserted upon the head of the malleus.

The incus, when not in immediate contact with the roof of the tympanum, is attached to the roof by means of the *lig. incudis superius* (Arnold), and is inserted into the posterior border of the body of the bone.

The posterior surface of the head of the malleus is oblong, and it extends in spiral form from above downward and inward to the boundary of the neck. It consists of two surfaces, which meet in an almost vertical edge. The incus has an articular surface corresponding to this. These surfaces are covered by a thin layer of hyaline cartilage. The capsular ligament connecting the bones allows of considerable motion. A fold, described by Pappenheim (1840) and Rüdinger, projects into the cavity of the joint.

The mechanism of the joint between the malleus and incus is compared by Helmholtz to the *cog* contained in certain watch-keys, where the handle cannot be turned in one direction without

carrying the steel shell with it, while in the opposite direction it meets with only slight resistance. When the handle of the malleus moves inward, the inferior cog of the malleus catches the inferior cog of the incus, and causes the long process of the incus to follow the motion of the handle of the malleus inward. When the handle of the malleus moves outward, a strong movement of the articular surfaces follows, the inferior cog of the malleus recedes from that of the incus, and the incus will consequently only follow the motion of the malleus outward to a slight extent.[1]

The articulation of the incus and stapes does not admit of much separation of the bones, but they can move sideways to a greater extent.

The articulation between the stapes and the margin of the fenestra ovalis has been the subject of much microscopical study by Eisell, Buck, and Brunner. The tissue connecting the margin of the fenestra ovalis with the margin of the foot-plate of the stapes consists of elastic fibres, which run in a radiating direction, converging toward the margin of the foot-plate. These margins are covered with a thin layer of cartilaginous tissue. Voltolini denies that there is cartilage in this articulation.

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

Although it has been a matter of discussion as to whether the lining membrane of the tympanic cavity is a mucous or serous membrane, Politzer, from his own investigations, has no doubt but that it is a mucous membrane. He thus agrees with Krause, Tröltsch, and Wendt, who found mucous glands in the tympanic cavity. According to Politzer, vascular folds of mucous membrane extend from the walls of the tympanic cavity to the ossicles. These folds are the means of connecting the vessels in the coverings of the ossicles and those of the walls of the cavity. Besides these folds, Politzer found a number of inconstant prolongations of connective tissue, which were formerly supposed to be pathological products, but which, as he was the first to prove, are the remains of the gelatinous connective tissue which fills the middle ear of the fœtus.

Sometimes the anterior portion of the tensor tympani is connected with the tensor veli palati. According to Politzer, in

[1] Lehre von den Tonempfindungen, p. 217.

the new-born infant there is an immediate communication between the lower portion of the muscular cavity and the facial canal. In adults, there are one or more oblong fissures between the *eminentia stapedii* and the facial canal. In these fissures the fibrous coverings of the connective tissue of the muscle and the nerve come in contact and amalgamate.[1]

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 is inserted on the inner margin of the handle of the malleus, at the anterior edge of the rhomboidal surface, obliquely to the longitudinal axis of the malleus.

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 framework which separates it from the periosteum, and passes from one projection of bone to another through the free space of the cavity. One such bridge has frequently been observed to pass from the eminentia pyramidalis to the processus cochleariformis, while many are seen on the floor of the tympanum.

### BLOOD-VESSELS.

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

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

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

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

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[1] Diseases of the Ear, translation, p. 43.

Politzer[1] has shown that there is a vascular communication between the middle ear and the labyrinth, through the osseous wall separating them. He says that the blood-vessels of the middle ear can be seen proceeding from the deeper layers of the lining membrane, accompanied by numerous prolongations of connective tissue and penetrating almost perpendicularly into the bony substance. The blood-vessels of the bony wall thus connect the blood-vessels of the mucous membrane of the middle ear with the vessels of the labyrinth.

This vascular connection readily explains the easy transferrence of disease of the middle ear to the internal ear, a frequent clinical experience. Yet the communication is not so easy as to make it certain to occur in every case.

## 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,[2] 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 palati 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.

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[1] Archiv für Ohrenheilkunde, vol. xi.

[2] Treatise on the Ear, translation, p. 97.

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

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

The chorda tympani nerve seems to pass through the tympanic cavity without being in any physiological relation to it. Division of this nerve in operations upon the tensor tympani muscle usually has no effect upon the functions of the ear.[1]

Prussak's experiments on dogs show that irritation of the cervical sympathetic by the galvanic current causes contraction of the blood-vessels. When the irritation ceased considerable expansion occurred.

## 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 a vein passes 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[2] 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

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[1] See Chapter X. for an account of the functions of the chorda tympani.

[2] Lehrbuch, p. 32.

attached the sterno-mastoid, the splenius capitis, and trachelo-mastoid muscles.

On the inner side of the mastoid process is a deep groove, called the fossa sigmoidea. In this groove is a part of the lateral sinus, and the mastoid foramen opens into it. The mastoid

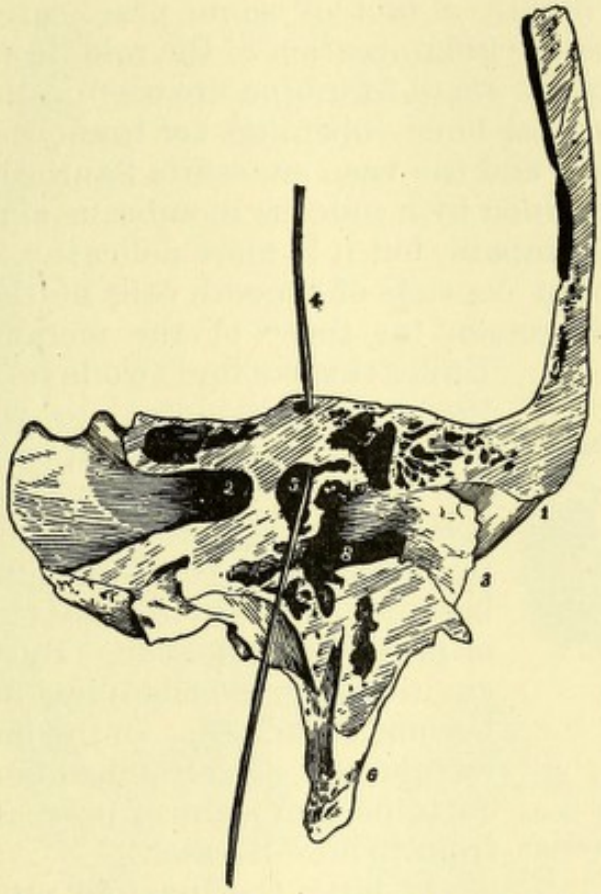


FIG. 67.—Vertical Section through Right Temporal Bone (anterior surface of posterior half, two-thirds size. From Professor Darling's museum). 1, External auditory canal; 2, internal auditory canal; 3, tympanic process; 4, sup. semicircular canal; 5, vestibule; 6, styloid process; 7, mastoid cells; 8, tympanic cavity.

process is hollowed out into a number of spaces of various size, which are called the mastoid cells.

### THE MASTOID CELLS.

The upper or horizontal part of the process, called also the *antrum mastoideum*, is in communication with the tympanum by means of one or more openings in the posterior tympanic wall; 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.[1])

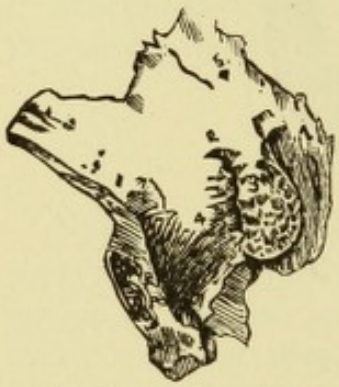

FIG. 68.—External Surface of Left Mastoid Bone (from Professor Darling's museum). 1, Groove for occipital artery; 2, mastoid emissary vein; 3, mastoid process; 4, external auditory canal; 5, minute foramen leading into mastoid cells.

At birth the mastoid process is but the rudiment of what it is afterward to be. It is a small tuberosity, and contains but one cell of any considerable size, which afterward becomes the mastoid antrum.

Dr. E. Zuckerkandl[2] was induced, by finding what seemed to him a remarkable specimen, taken from a man who died in middle life, to reinvestigate the anatomy of the mastoid process. In the first specimen that attracted his attention he found the cells even into the antrum filled with diploetic tissue, and the adjacent ones to this latter part also containing fat. The fat and diploe were just the same in appearance with that of other fresh bones. The other parts of the ear were sound. There was no trace of a pathological cause. His subsequent exami-

[1] Handbuch der Lehre von den Geweben. Vierte Lieferung, p. 864.

[2] Monatsschrift für Ohrenheilkunde, vol. xiii., No. 4, 1879.

nations showed him that in many cases the mastoid process was entirely diploetic in structure or fully plugged with fat, and that these tissues appeared together and in connection with air-cells. Zuckerkandl examined 250 ears. He found that the external appearance gave no positive indication of the internal structure.

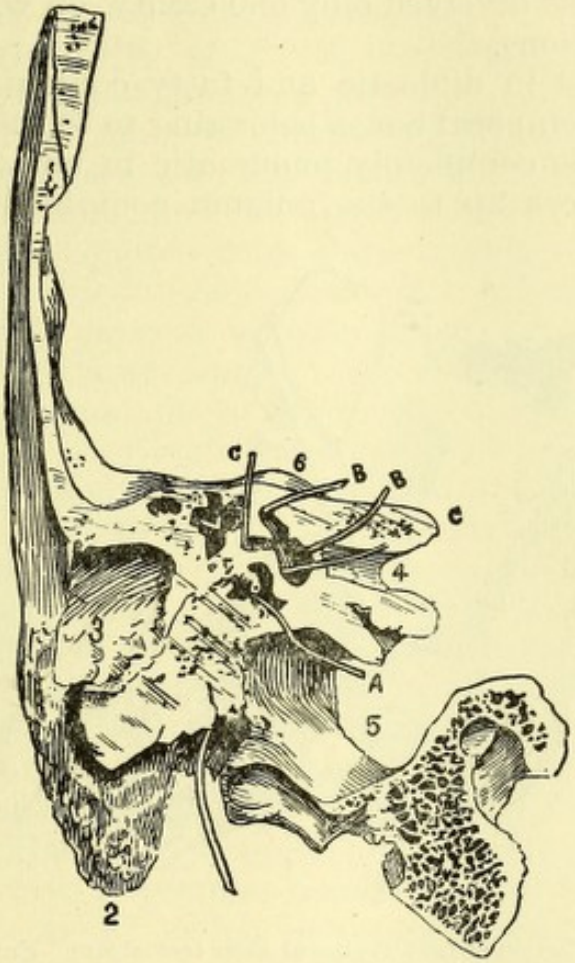


FIG. 69.—Vertical Section through Right Temporal Bone (posterior half, actual size. From Professor Darling's museum). 1, Squamous portion of temporal bone; 2, mastoid process; 3, external auditory canal; 4, internal auditory canal; 5, carotid canal; 6, eminence of sup. semicircular canal; A, A, aquæductus Fallopii; B, B, sup. semicircular canal; C, C, horizontal semicircular canal; 7, mastoid cells.

He found the following varieties in the examination of 250 temporal bones:

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

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

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

4. The process entirely an air-chamber (*in toto lufthaltig*).

The cells are large and extend to a line drawn from the lower wall of the auditory canal through the mastoid process.

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

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

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

The varieties in diploetic and fatty contents were equally great. Of 100 temporal bones belonging to 50 subjects, the mastoid process was completely pneumatic in but 40 cases. In 22 cases, the process up to the antrum contained red or yellow

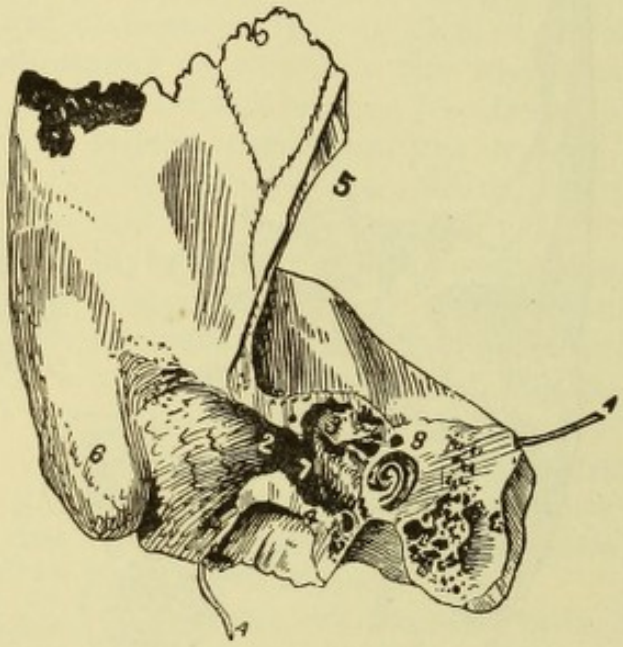


FIG. 70.—Vertical Section of Left Temporal Bone (actual size. From Professor Darling's museum). 1, Cochlea with lamina spiralis; 2, external auditory canal; 3, opening of mastoid cells; 4, plate of bone separating the tympanic cavity from carotid canal; 5, squamous portion of temporal bone; 6, mastoid process; 7, tympanic cavity; 8, aquæductus Fallopii.

adipose tissue. Nine times the lower half of the process was diploetic or contained fat, while the upper part was pneumatic, and in the remaining 29 cases only the apex, of from 3 to 5 mm. was narrow-celled, diploetic; otherwise it contained air-cells. In 8 of the 100 cases the mastoid processes of the same person were different in structure. In 150 macerated temporal bones the results were as follows: Fifty-two times the process was completely filled with pneumatic spaces. Twenty times only the lower half contained diploetic spaces, while the upper was pneumatic. Thirty-eight times the apex only of the process was diploetic from 3 to 5 mm. Seven times the diploetic structure

extended only to the *pars petrosa* of the process. In summing up, there are found to be entirely pneumatic processes in 36.8 per cent. Completely diploetic, 20 per cent. In 42.8 per cent. diploetic and pneumatic cavities existed together in the same bone. These investigations make it probable that many, if not all, of the reported cases of hyperostosis or sclerosis of the mastoid were really only normal conditions.

Dr. Giovanni Zoja,[1] 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 mm., its thickness 13 mm., and its length 12 mm. 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 membrane that has been described. In several cases there were cells only in the base of the process. Occasionally these cells extended to the side of the skull, or even to the middle of the petrous part of the temporal bone.

Dr. Zoja thinks that the development of the cellular structure goes on in a kind of system. They become gradually larger, and 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.[2]

## 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.

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

[2] 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 meas-

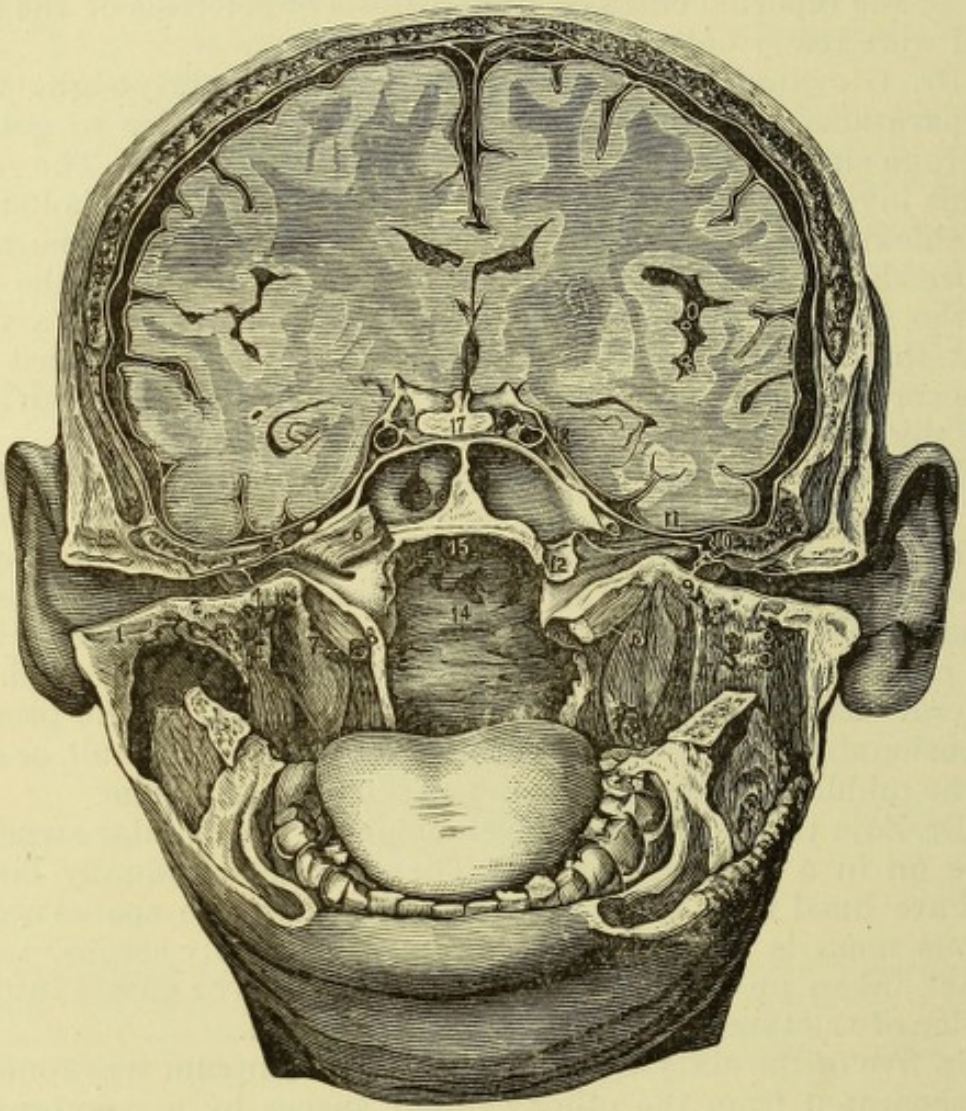


FIG. 71.—Section of the Head, showing the Divisions of the Ear and the Naso-pharyngeal Cavity (after a photograph—Rüdinger). 1, Cartilage of external auditory canal; 2, osseous auditory canal; 3, 4, membranæ tympanorum; 5, cavity of the tympanum; 6, dilator muscle of the Eustachian tube; 7, levator palati 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.

ures 11 mm., the latter 24 mm., so that the whole length of the tube, from its opening into the tympanic cavity to its pharyngeal orifice, measures 35 mm. The tube, from its tympanic end,

runs forward, inward, and downward. Its axis makes an angle of 135° with the axis of the external auditory canal, and an angle of 40° with the horizontal plane.

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

The shape of the anterior extremity of the osseous tube is very irregular, the inner wall extending forward much further than the lateral wall. This part, "the isthmus," is the narrowest portion of the tube. Here the tube gradually widens, and ends anteriorly in a trumpet-shaped orifice 9 mm. high and 5 mm. broad, which projects slightly into the post-nasal space, and lies a little above the level of the floor of the nostril.

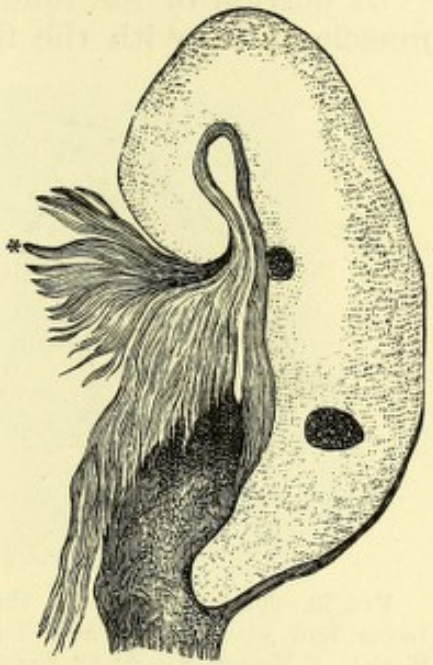

FIG. 72.—Transverse Section of Upper Part of the Eustachian Tube (after Henle). *, Fibres of the spheno-staphylinus muscle.

The cartilage of the tube is made up of two plates—a median and a lateral. The median plate, which is much the larger, is triangular, and into its upper and outer part is inserted the hook-shaped and smaller lateral cartilage. But most of the lateral wall and all of the lower is formed of membrane instead of cartilage, the membrane forming nearly a half of the circumference of the tube.

The median wall of the cartilage of the tube is below 1 mm. in thickness on its posterior extremity, but increases in size gradually to 2½ to 3 mm., and on its free anterior border may even reach 7 mm. The tissue of the cartilage is chiefly hyaline, but it has a fibrous base substance at various spots; sometimes on the surface, sometimes on the interior, and especially near the edges.

The mucous membrane which fills up the concavity of the cartilage, and which changes the calibre up to the vicinity of the pharyngeal orifice to a plane surface, is 0.6 mm. thick at its densest portion. It is connected to the perichondrium by loose connective tissue. It is made smooth by numerous acinose glands of about 0.6 mm. in diameter and 0.15 mm. in thickness.

These glands form a continuous layer backward from the pharyngeal orifice for some distance. Toward the cavity of the tympanum they are less numerous, yet, according to Von Tröltsch, they are found on the tympanic orifice. Toward the pharyngeal orifice large mucous glands appear lying on the outer side of the cartilage.

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

A portion of the tendinous origin of the spheno-staphylinus muscle unites with the firmer portion of the wall, and for some

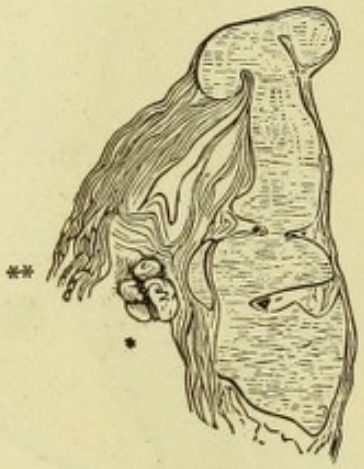


FIG. 73.—Transverse Section through the Lower End of the Eustachian Tube (after Henle). *, Mucous glands; **, fibres of petro-staphylinus muscle.

FIG. 74.—Transverse Section through the Lower End of the Eustachian Tube (after Henle). *, Mucous glands; **, transverse section of the petro-staphylinus muscle.

distance this origin runs in a thin layer between the upper border of the soft wall of the tube, and unites with the convex surface of the latter.

The spheno-staphylinus muscle being thus attached to the tube has the power of rolling over the upper inverted border of the cartilage, and of enlarging the angle which the lateral wall forms with the median. The opening or gaping of the tube depends upon this action, which occurs with the act of swallowing.

At the 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. 75).

Since the inner wall of this canal projects into the calibre of the naso-pharyngeal space, the mouth of the tube lies more in a

frontal than sagittal plane. It has a puffy median border, while the lateral wall passes without any distinct line of separation into the nasal cavity. The width of the mouth of the tube varies in different persons, and has the general shape of a funnel.

According to Rüdinger,[1] the minute differences in form of the Eustachian tube in animals are 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

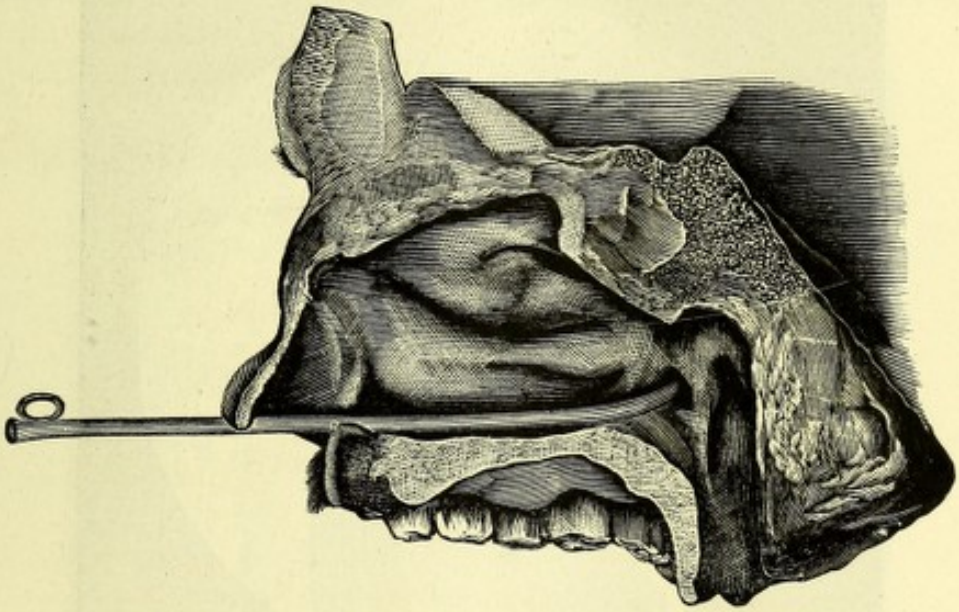

FIG. 75.—Vertical Section showing the Mouth of Eustachian Tube and Rosenmüller's Fossa.

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 toward 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.

[1] Stricker's Hand-book, p. 973.

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, 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

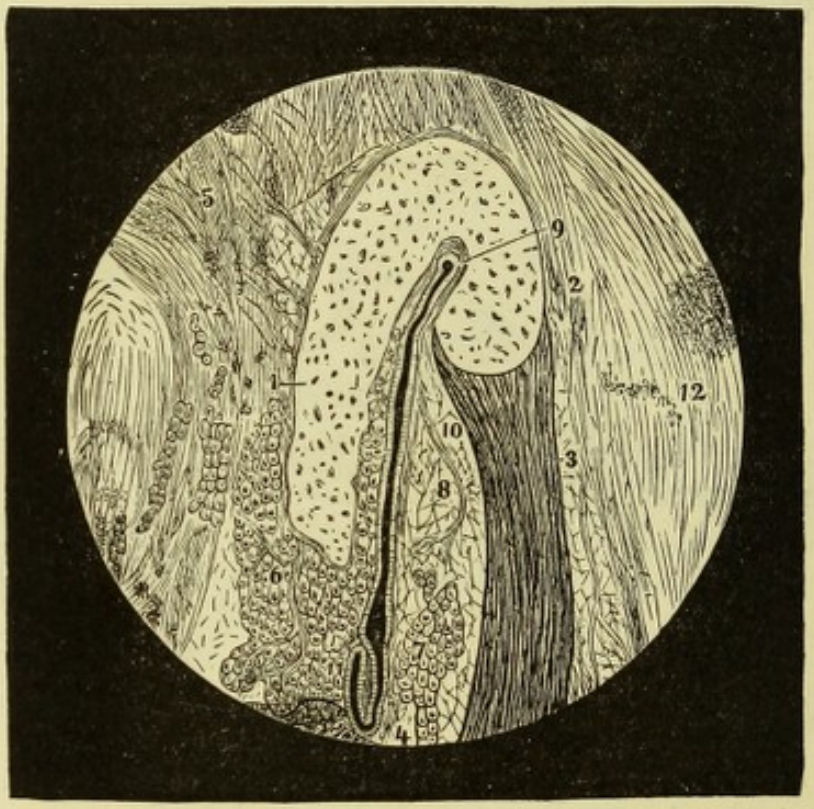


FIG. 76.—Transverse Section of Eustachian Tube and Surrounding Parts (after Rüdinger). 1, Median cartilaginous plate; 2, lateral cartilaginous hook; 3, dilator of the tube; 4, lavator of the soft palate; 5, basilar fibro-cartilage; 6, 7, acinous glands; 8, fat in the lateral wall; 9, safety tube; 10, accessory fissure; 11, fold of mucous membrane; 12, adjacent tissues.

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. 78.

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

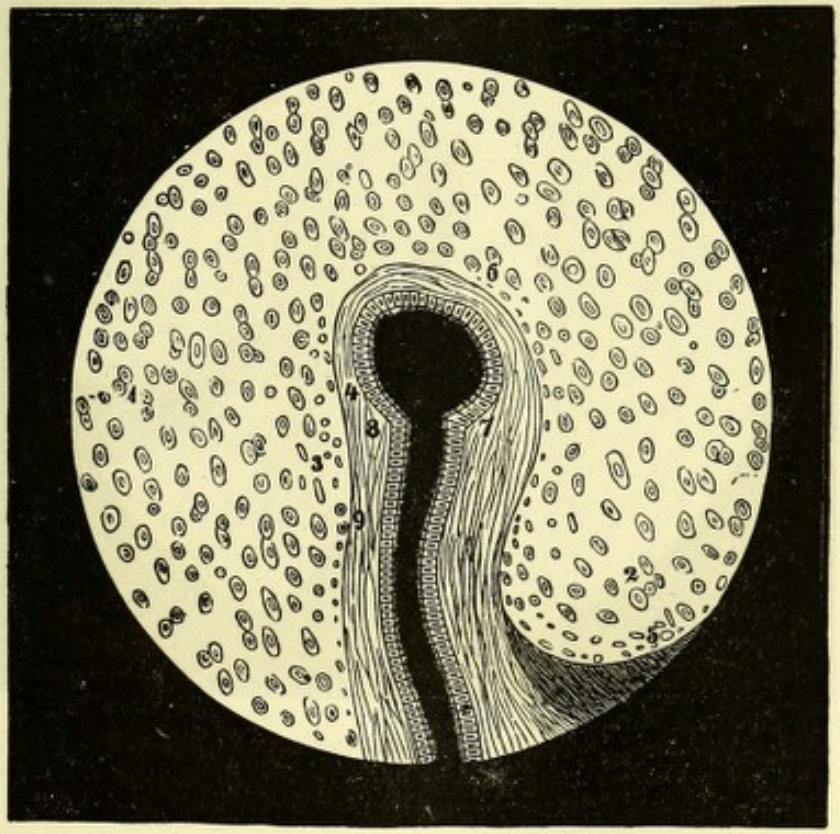


FIG. 77.—Section of the Upper Third of the Eustachian Tube (after Rüdinger). 1, Median cartilage; 2, lateral cartilage hook; 3, perichondrium; 4, submucosa; 5, insertion of the dilator of the tube; 6. safety tube; 7, lateral projection of the mucous membrane; 8, median projection of the mucous membrane; 9, accessory fissure.

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 calibre of the tube by drawing the hook of the cartilage forward and a little downward.

FIG. 78.—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.

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

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

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

When this muscle contracts, by its becoming thicker, the membranous floor of the tube is pressed forward, and thus the long diameter of the tube is shortened, and the transverse diameter is enlarged, that is to say, it is made to gape very widely.[1] The salpingo-pharyngeus muscle also assists in this action.

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

The opening of the Eustachian tube is the result of a combination of muscular action. If the three muscles are innervated simultaneously, and their contractions occur at the same time, the hook-shaped cartilage is fixed by the dilator of the tube and drawn 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.[2] 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

[1] Rüdinger: Beiträge zur vergleichenden Anatomie und Histologie der Ohrtrompete.

[2] Rüdinger, loc. cit., p. 7.

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.
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,[1] from whose writings I have already quoted in the chapter on "Foreign Bodies."

As has been said on page 4, 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.[2]

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 arteriæ in durã cerebri membranã distributæ aditum

[1] Studien über die Anatomie des Canalis Eustachii. München, 1866.

[2] Bartholomæi Eustachii Opuscula Anatomica.

patefacit: internum denique fissura quædam circumscribit, quæ à cuneum referentis ac lapidei ossis extremis partibus, oblique infra et anteductis, fit. Cæterum hunc meatum, de quo sermo est, arbitrabitur fortasse quispiam eo loco desinere; res autem non ita se habet, sed alterius generis substantia auctum, inter duos faucium seu gulæ musculos, à paucis hucusque bene cognitos secundum, paulo ante me moratæ fissuræ ductum ulterius procedit; et juxta radicem internæ 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 fissuræ ossi temporum et cuneo simili communis tangit, cartilaginea est ac admodum crassa; huic vero appositæ 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, quæ plurimum extuberat, mucosaque; narium tunica obducitur, ac fini ejusdem meatus quasi canitor præferta esse videtur, figura teres non est, sed aliquantum depressa duos efficit angulos: latitudo cavitatis calamum, quo scribimus, fere adæquat, sed in fine duplo latior est, quam in principio, quæ similiter mucosa sed tenui induitur tunica. Hoc callidissimum naturæ 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 sæpius 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, quæ 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 an idea is wanting, a word can be put in its place.

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 Unter-

suchungen über den Bau des menschlichen Schlundes und Kehlkopfes"), 1861, afterward described the canal. Von Tröltsch,[1] 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 calibre 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.

## PHYSIOLOGY OF THE MIDDLE EAR.

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

### *Functions of the Membrana Tympani.*

The presence of the membrana tympani, in whole or in part, is not essential to fair hearing power. This was first clearly proven by Sir Astley Cooper,[2] in a case of which more will be found in the discussion upon paracentesis of the drum-head, in a subsequent chapter; but, that it is very important to good hearing in some cases, is shown by the numerous instances in which an artificial membrana tympani raises the hearing power from a very low degree to a high one. The membrana tympani is perhaps more properly considered as the outer expansion of the *ossicula auditus*, for it is so intimately connected with the malleus, as to be essentially a part of the chain of bones that conducts sound to the endolymph of the labyrinth. Very great thickening of the drum-head, that is to say, of its fibrous and mucous layers, must of necessity involve the insertion of the malleus which is in its layers, so that we can hardly speak of the functions of the membrana tympani without including those of the ossicles. Yet there are a few points in its physiology that may be mentioned by themselves. Wollaston[3] showed that

[1] Archiv für Ohrenheilkunde, Bd. I., Heft i., p. 15.
[2] Philosophical Transactions, p. 155. 1800.
[3] Ibid., p. 306. 1820.

if the membrana tympani be rendered very tense, the ear is rendered insensible to low sounds, but those of a high pitch are made more intense. Blake[1] also found that in two cases of voluntary contraction of the tensor tympani muscle, the perception increased from 3000 to 5000 vibrations during the contraction of the muscle. Blake also showed that in a membrane slightly opaque and not very concave, but with a number of small calcareous deposits on a line with the lower end of the process of the malleus, the perception of high tones was greatly increased by an opening made in the drum-head.

The peculiar formation of the membrana tympani, it being of the shape of a funnel with a depressed centre, surrounded by sides somewhat convex, make it, according to the physicists, peculiarly susceptible to sonorous vibrations, and it is easily thrown into corresponding movements when waves of sound enter the auditory canal and strike upon it. The membrana tympani probably has no fundamental tone of its own, or that tone has not been exactly determined. It is not thrown into vibrations by waves of a particular length more readily than by others.[2] Had the membrane its peculiar fundamental note, we should be distracted by its prominence in the ordinary sounds of life. Hensen[3] says, and has proven by experiment, that the membrana tympani is toned to a relatively deep note as the result of its funnel-like shape. Hensen also states that perhaps the peculiar note of the drum-head, may be produced by blowing air into the auditory canal. This tone, he says, cannot be exactly determined, but it is certainly not higher than 700 vibrations. But, he adds, it is doubtful if a precise tone can be assigned to such an unsymmetrical membrane.

Seebeck and Mach, quoted by Hensen,[4] say that the regularity of our perception of tones is due to the deadening of sounds produced by the ossicles and the fluid of the labyrinth. It is probable that the membrana tympani can only be properly considered as a sound conductor in connection with the ossicles. It has one function entirely its own, however, which is of the highest importance. It is the protecting membrane of the tympanic cavity, although its complete destruction or great thickening of its layers, may not destroy the power of hearing. Even if a fair hearing of speech and music remain when it is removed, the tympanum is deprived of a covering which is essential to its continuation in health. As is seen in the study of chronic sup-

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[1] Transactions of the American Otological Society, p. 77. 1872.

[2] M. Foster's Physiology, p. 575.

[3] Hermann's Handbuch, p. 42.

[4] Loc. cit., p. 43.

purations of the middle ear, when the membrana tympani is destroyed or even partially removed, the tympanum is exposed to a series of dangers, any one of which may be destructive not only of the hearing but of the life. To preserve and quickly restore an ulcerated membrana tympani, becomes therefore a very important duty.

### *Ossicula Auditus.*

Many observations have been made upon the vibrations of the ossicula auditus by Politzer, Blake, Buck, Mach, Kessel, Hensen, Burnett, Helmholtz, and others.[1]

The action of the malleus and incus has excited considerable attention. Helmholtz[2] has shown, as has been already noticed, that when the malleus is carried inward, the incus also moves inward, and when the malleus returns to its position, the incus returns with it. Its saddle-shaped joint with cog-teeth permits this movement, while it prevents the stapes from being pulled back when the membrana tympani and the malleus are pushed out more than usual. The joint then separates, so that the malleus may be moved alone. The ligaments also serve to keep the malleus in place. The bones conduct vibrations as a single solid lever, the fulcrum of which is situated at the attachment by ligament of the short process of the incus to the posterior wall of the tympanum.

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

### *Tensor Tympani Muscle.*

Even when the tensor tympani muscle is not in action it is of use in preventing the drum-head from being pushed out too far. When it contracts the membrane becomes more tense. It has been supposed[3] to act either as a damper, lessening the vibration of the drum-head in the case of two powerful sounds, or as having an accommodative power in attuning the membrane to sounds which fall upon it. According to Hensen,[4] this action

[1] For a good digest of these see Hensen's article in Hermann, loc. cit., p. 47 et seq.
[2] Die Tonenpfindungen, loc. cit. [3] Foster, loc. cit. [4] Loc. cit., p. 65.

is excited in a reflex way by the vibrations of the drum-head. The contraction of the tensor tympani is produced at will by some persons, and is accompanied by a crackling sound.

### *Stapedius Muscle.*

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

Lucae, quoted by Hensen,[1] found this contracted when the *orbicularis palpebrarum* muscle was strongly excited. He found with this a weakening of the power of hearing all musical notes, but an increase in the capacity of hearing those of 10,000 and more vibrations.

Hensen, in one experiment carried a needle through the tendon of the stapedius muscle. The point of the needle was in the facial nerve. As long as the tensor tympani was intact, the stapedius contracted energetically upon the reception of all tones, as Hensen believes in consequence of a mechanical movement of the ossicle produced by the tensor. When the tendon of the tensor was divided, the needle in the stapedius moved only upon the production of higher tones, from about 7000 vibrations and upward. In lower tones, the movements were indistinct, and the tones of the great and contra octaves did not produce any effect at all.

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

### *Eustachian Tube.*

This passage serves to maintain an equilibrium of pressure between the external air and the tympanum, and as a means of exit of the secretions of that cavity. The physiology of the Eustachian tube has been most accurately studied by Toynbee and Politzer. It is to their studies and experiments, that we are indebted for that most valuable means of treatment, Politzer's method of inflating the middle ear. Politzer[2] concludes that—

1. The tube is not constantly open. Its permeability varies in different persons. In some cases, even in quiet respiration, an interchange of air from the pharynx toward the tympanum

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

[2] Lehrbuch, original, p. 77.

takes place; in others the act of swallowing or a powerful expiration becomes necessary.

2. The tube is especially opened by the action of the muscles, during the action of swallowing, as shown by Toynbee and Politzer.

3. A difference in the pressure of the air, is more easily equalized from the tympanum to the pharynx, than from the pharynx to the tympanum.

# CHAPTER X.

## INJURIES OF THE MEMBRANA TYMPANI.

Diseases of the Membrana Tympani not Independent Affections.—Vascular, Nervous, and Lymphatic Supply, a Part of that of the Canal and Middle Ear.—Drum-head Subject to Injury by Explosions, Blows, and so forth.—Effects of Condensed Air.—Serious Injuries of the Head.—Fracture of the Handle of the Malleus.

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. There is probably no independent disease called myringitis, in the sense that we speak of a keratitis or a retinitis.

Dr. A. H. Buck[1] has 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 renders it probable that the case was one of extension of disease of the canal to the drum-head.

The vascular, nervous, and lymphatic supplies of the partition wall between the auditory canal and the middle ear, belong also to those parts which it separates. Neither the integumentary nor the mucous layer of the membrana tympani can be fully separated from it. These facts show that the drum-head has no independent existence. In the vast majority of instances the diseases of the membrana tympani are of a secondary character. It is possible, however, that there may be a primary inflammation of the membrana tympani in exceptional instances, for example, from a draught of air blowing upon the membrane. Yet, even in these cases, the inflammation, even if it begins in the drum-head, advances so rapidly to the contiguous tissue, that

[1] Medical Record, vol. vii., p. 572.

the inflammation becomes one of the middle ear almost in an instant. For these reasons, the term *myringitis* was discarded in the earlier editions of this work, and this example has been followed by most of the recent writers on aural medicine and surgery. Sir William Wilde, when using the term myringitis, did not mean an inflammation of the membrana tympani alone, but he used it to describe an inflammation of the middle ear, as careful reading of his work will show.

Politzer, in his work upon the ear, so recently translated into English, describes a primary myringitis, occurring "after the action of a cold wind upon the ear, after a cold bath, after sea-bathing, or in the course of acute naso-pharyngeal catarrhs." He also describes the formation of one or more blisters of the size of a hemp-seed, and filled with serous fluid, as well as minute abscesses. He thinks, however, that the abscesses of the membrane described by Boeck, were secondary formations, occurring in the course of acute or chronic affections of the middle ear. After a careful consideration of the views of Politzer, and my own experience, I am still unconvinced that primary myringitis is anything more than an extremely rare affection. If indeed it occurs at all, I am doubtful.

The membrana tympani is, however, subject to injury from explosions, or sudden and violent movements of the atmosphere, which cause the undulations to be condensed and forced inward 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 excavating for the foundations of bridges, or the making of tunnels under rivers. The membrana tympani may also be ruptured by blows or falls 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, by violent sneezing or coughing, by the use of appliances for washing out the nostrils, 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 calibre of the tube, is also a source of protection. Besides this, the structure of Shrapnell's membrane, made up as it is of fibres, much more loosely woven together than those of the remainder of the drum-head, assists it to yield to great shocks of sound. Those persons who suffer a rupture of the drum-head from external concussions, probably have some catarrhal affection which prevents the air from freely circulating in the tubes and the cavity of the tympanum; for we can scarcely believe that so few would suffer this accident, were all drum membranes equally liable to it. During the heavy fighting of 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[1] 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 143 ctm. 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, 168 ctm. high, was used. Here again the rupture occurred on the anterior segment.

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[1] Lehrbuch, p. 332.

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.

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 line 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 Königsgrätz, 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."[1]

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.[2]

[1] 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.

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

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

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

Dr. Green notices an interesting phenomenon observed in coming out of the lock, which Dr. Smith also observed. There was a spontaneous escape of air through the Eustachian tubes in a succession of puffs, succeeding each other at intervals of fifteen or twenty seconds, independently of respiration, and absolutely without the concurrence of any muscular action. The phenomenon suggested to Dr. Green "the action of a lightly resisting valve, necessitating a slight but perceptive increase of pressure within the tympanic cavity, to open the passage to the 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,[2] of Königsberg, 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

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

[2] Archiv für Ohrenheilkunde, Bd. I., p. 270.

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.[1]

The membrana tympani is perhaps more frequently injured by mechanical violence to the head or to the membrane itself. Professor Robert F. Weir,[2] formerly surgeon to the New York Eye and Ear Infirmary, has seen four such cases. In one the 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,

[1] The effects of compressed air upon the hearing power will be again alluded to in the chapter on "Chronic Non-suppurative Inflammation."

[2] Verbal communication.

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[1] 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 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-wool is brought in contact with the cavity of the tympanum and with the nerve.

I lately saw a man of thirty-eight years of age, who stated that at sixteen, he ruptured the right drum-head in the following manner: While in the woods engaged in securing sap for making maple sugar, he bent down over some underbrush, so that a twig entered the auditory canal. Immediately "he felt as if half his tongue were paralyzed." He does not remember whether the ear bled or not, whether there was any pain or suppuration from it, but he does remember the loss of sensation in half his tongue. He has never heard with the ear since the accident. He has chronic inflammation of the left ear. There is no aërial conduction whatever on the right side. There is a distinct opacity in front of the handle of the malleus.

This patient is a highly educated man. While there are sev-

[1] Text-book, p. 28.

eral negative points in the history, since he cannot remember whether he had pain, or bleeding, or suppuration from the ear, there is enough that is positive in the history and in the appearances to enable us to believe that this is a case of rupture of the membrane, followed by proliferous inflammation of the tympanum. Since the patient has a chronic inflammation of the middle ear of the uninjured side, we may believe that we cannot ascribe all the morbid changes in the tympanum to the injury of the drum-head, unless we suppose that there may be *a sympathetic inflammation of the middle ear*, just as there is a sympathetic inflammation of the uveal tract of the eye. This supposition is not wholly groundless, although as yet apparently having only an analogical foundation. Sympathetic inflammation of the eye usually, if not always, has its origin in the uveal tract, and involves the muscle of accommodation; why may not a traumatic inflammation of one ear, especially an injury of the ossicles and middle ear, produce a sympathetic, plastic inflammation of its fellow?

The case is inserted here, chiefly to show the effect of an injury to the chorda tympani nerve. In thinking it over, however, the possibility of a sympathetic otitis has occurred to me. Reasoning from analogy, it is possible to suppose such a condition of things.

The function of the chorda tympani is probably chiefly in connection with that of taste, and not of hearing.

Professor Flint[1] 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 downward at the back of the tympanum, about a quarter of an inch before its exit from the stylo-mastoid foramen. It ascends from below upward 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

[1] The Physiology of Man, The Nervous System, p. 157.

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 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-fibres in the submucous tissue.[1]

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.[2]

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.

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[1] Monatsschrift für Ohrenheilkunde, No. 1, 1873, from Comptes Rendus, Hebdom. des Seances de l'Academie des Sciences, T. lxxv., No. 27. Paris, 1872.

[2] 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.

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-bathing, is an occasional 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 so that the waves do not strike the side of the head in full force, and 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. Burnett,[1] of Philadelphia, has reported a case of evulsion of the membrana tympani, from the splashing of mud into the ear by a horse while the patient was crossing the street. The patient was thirty-nine years old, and consulted Dr. Burnett three days after the accident. He stated that his ear was sound until the mud came into it. Upon returning to his shop—he was a machinist—he was examined by some of his comrades, who said they saw foreign objects in the meatus, which they proceeded to extract *with chips and mechanics' small tools.* Several "little white pebbles" were taken out, which were probably the ossicles. Great impairment of the hearing of the ear followed. The patient was very pale, anxious and bathed in cold perspiration when he visited Dr. Burnett. A watch that should have been heard 40 feet was only heard 5 ctm. The tuning-fork placed on the vortex was heard very distinctly in the injured ear.

On examination, Dr. Burnett 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 tympanum was fully exposed to view. The mucous membrane was healthy, but slightly abraded on the promontory. Twenty days after, without treat-

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

ment, 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.

Dr. J. Orne Green [1] reports a case where the explosion of a bag of gas near the ear caused a rupture of the membrana tympani. The patient, who was preparing for an exhibition in which an oxy-hydrogen light was to be used, was standing a few feet from the bag, and with his left side toward it at the time of the explosion. The immediate effect was some slight confusion of intellect, which soon passed off; but the next day the left ear began to be painful, and on blowing the nose, air whistled through it.

Dr. Green saw the patient twelve days after the accident, and found the membrana tympani red and swollen, and on the posterior segment just behind the umbo, a rupture 1½ line 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 râles in his ears. Most 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 $\frac{18}{48}$.

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 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.[2]

If a person be a sufferer from catarrh of the middle ears, the drum-head, as has been already intimated, is much more likely to be ruptured by blows, falls, exposure to the surf in bathing,

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

[2] 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.

or the like. In fact, I am inclined to doubt if persons with well ventilated tympanic cavities, and normally acting drum-heads ever suffer a rupture of the membrana tympani, except from very great direct violence.

In 1875 I saw a little boy who was thrown from his pony a few hours before he consulted me. He struck upon his right side, and he had a free discharge from his right ear immediately afterward. His hearing distance was $\frac{1}{40}$ when examined, and he heard the tuning-fork better on the injured side. Blood was found on the walls of the auditory canal, and the membrana tympani was ruptured in the centre. The ear was let alone very carefully, and the drum-head soon healed. There remained, however, a depression in the centre at the site of the rupture. This little fellow had nasal and pharyngeal catarrh at the time he received the fall, or I suppose it is not likely that the membrana tympani would have ruptured from what was a slight injury, for he fell upon the lawn of a country place, and from a very small pony. At any rate, in spite of the best of care from his family and from a distinguished expert in aural disease, with whom I have occasionally seen him professionally, he has gone on with a catarrhal or proliferous inflammation in the middle ears, until now, as he is growing into manhood, his hearing is very much impaired.

I once saw a case of hemorrhage from the auditory canal in a boy of three and a half years, who fell from a rocking-horse. He had had a discharge from the same ear a year before which had ceased. Some hard wax and a large blood-clot were removed from the auditory canal, but the membrana tympani was uninjured and looked natural.

In 1881 a young gentleman of nineteen consulted me in regard to an injury to his left ear, of which he gave the following account: Two days before it was hit by the flat surface of a boxing-glove in the hands of his antagonist. He became dizzy and felt a sense of pressure upon the ear. He did nothing to relieve these symptoms and they passed away. But on consulting me, he states that he has now a feeling of tightness and pain in the ear, and noise causes discomfort. He once had a discharge from the ear after scarlet fever. His hearing distance is $\frac{8}{48}$ on the injured side, $\frac{40}{48}$ on the other. The tuning-fork is heard better in the affected ear. There is a red line through the anterior segment of the membrane, beginning at the end of the malleus. The ear was inflated by Politzer's method, and this was repeated every few days. The patient was also advised to wear cotton in the meatus of that side. The ear gradually recovered its normal sensations.

Here, again, we had to do with an ear that was probably not entirely sound when the accident occurred. It is probable, from the history, that the drum-head was at one time injured by ulceration, and that it was a cicatricial membrane when the canal was struck.

In the following case the drum-head was so badly injured by direct violence, that it will never be a perfect membrane:

F. N——, aged forty-one years. Five days ago his infant child, while he was playing with it, pushed a button-hook into the right auditory canal. A momentary pain occurred, attended by bleeding. The patient's wife washed out the ear, and great pain followed. Since then the pain has diminished, and he has a purulent discharge from the ear. He never had a disease of the ear before, as far as he knows. The hearing distance is R. E., $\frac{3}{48}$; L. E., $\frac{24}{48}$. The tuning-fork placed on the vertex is heard better in the right ear. The bone conduction is better than the aërial on the right side. The upper wall of the osseous canal is red and swelled. Pus lies upon the right drum-head. It is red in the periphery and along the handle of the malleus. It is perforate in the inferior and the posterior quadrant. *The left membrana tympani is opaque and neoplastic.* The patient was treated for two months. The suppuration nearly ceased. He had no pain, and slight tinnitus, when I last saw him, but the perforation in the drum-head remained.

Although this patient had no recollection of ever having had a disease of his ears, I am sure, he must have one day had some affection of his uninjured ear. The impairment of hearing ($\frac{20}{48}$), and the neoplastic drum membrane cause me to believe this. He may also have suffered in his right ear, so that it may have been more susceptible to injury than a normal drum-head. Yet it must be admitted, that a thrust with a button-hook is capable of rupturing a drum-head whose tissue has never been injured by ulceration.

At a recent meeting of the New York Ophthalmological Society, Dr. Loring reported a case of rupture of the drum-head on each side, with bleeding, from a fall upon the forehead upon the fender. The patient was a child, and the strictest inquiry, according to Dr. Loring, failed to elicit the history of catarrh of the nares or middle ears.

In this case the rupture occurred, as Dr. Loring thinks, from *contre-coup*, the ears not being directly affected by the fall, but the full force came upon the region of the frontal sinus. The child, according to the statement of Loring, has since suffered at times from aural catarrh.

Very severe injuries of the head, such as those suffered by laborers falling from scaffoldings used in building, or by being hit by "falling planks" (Buck), falls, gun-shot wounds in the

auditory canal, serious beatings or pummellings upon the head, especially over the temporal bone, may produce fractures of the temporal bone, as well as other bones of the skull. Bleeding from the ear, or a serous discharge from the ear, are among the prominent symptoms of such an injury. These cases are usually seen by general surgeons, who do not give the ear a critical examination in determining the nature and extent of the injuries. It was formerly supposed[1] that a severe and long-continued bleeding from the ear was positive proof of a lesion of one of the sinuses. But as Buck[2] has shown, a bleeding from the tympanic artery may cause this, without necessarily involving the sinuses. When an injury to the head is followed by bleeding from the ear, even if it be trivial, we may, as stated by Buck, diagnosticate a fracture of the temporal bone in the vicinity of Shrapnell's membrane, and probably in the line of the Glaserian fissure, but we cannot state that a deeper and a more extensive injury has occurred. A fracture of the temporal bone may occur, however, without hemorrhage from the ear. Buck quotes a case from Dr. Geo. L. Peabody; which proves this. A man fell twenty feet from a scaffolding, striking his head upon the pavement. He died two days after the injury. There was no evidence of fracture of the bones of the skull. "There was a thin watery discharge from the nose, but there were no aural signs except deafness." There were several fractures of the skull. There was one on the right side extending from the foramen lacerum posterium through the middle of the petrous portion of the temporal bone, and terminating in the roof of the tympanic cavity. The ossicles were found imbedded in a clot of blood. There was no blood in the mastoid cells. On the other side, there was a more extensive fracture of the same parts with a clot around the ossicles and also in the mastoid cells. The fracture extended into the semi-circular canals of both sides, and the right cochlea contained a clot.

It is certain also, that patients recover from fractures of the tympanic portion of the temporal bone. A prominent physician of a neighboring city was attacked by ruffians one night, a few years since, and severely beaten over the head, so that he was unconscious for a short time. A large hemorrhage occurred from one ear, but he recovered perfectly, except that his hearing power was nearly destroyed upon that side. The membrana tympani a few months after the injury was without a cicatrix or other evidence of a rupture, as I found on examination.[3]

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[1] Prescott Hewitt in Holmes' Surgery, vol. ii., p. 128. Edition of 1861.
[2] Diseases of the Ear, p. 278 et seq.
[3] Loc. cit., p. 29.

This gentleman having died some year or so after the injury, it was supposed by some that his death resulted from it. But I have very good authority for stating that he died from chronic renal disease.

Dr. J. D. Rushmore, surgeon to the Brooklyn Eye and Ear Hospital, also reports[1] with great care a case bearing on this subject. A man of sixty-eight years, after a peculiar and uncomfortable feeling in his head for a few minutes, fell backward and toward the left side, and lost in a few minutes, by the estimate of a physician, about sixteen ounces of venous blood from his left auditory canal. He became unconscious for a few hours, and complained of headache and vertigo. The man had been a busy but well man. There was no renal disease. Dr. Rushmore saw the patient four days after the injury. There was then tenderness around the left auricle and dulness of hearing on that side. There was slight œdema of the mastoid and a narrow ecchymotic spot extending toward the styloid process. The auricle was hyperæmic. A soft clot filled the canal, and this was swollen and tender after the clot was removed. There was no hemorrhage and no serous discharge. Hearing distance for the watch, 0; tuning-fork better through the bones, and it was heard better on the sound side. The drum-head could not be seen. The ear was treated by cleansing, leeches to the mastoid, oleate of morphia in front and behind the auricle. Sleeplessness was relieved by opium, bromide of potash, and alcohol. The result was that the patient finally heard the watch in contact with the ear, and the voice fifteen feet. The bone conduction remains better than aërial. In all respects, except the dulness of hearing, the patient, ten months after the injury, was as well as before he received it. When the membrana tympani was first seen, fully six weeks after the injury, there was a red irregular line, broad on the periphery, and narrowing toward the centre of the membrane, extending from the apex of the light spot to the end of the handle of the malleus. Five days after, the red line had nearly disappeared, and the light spot began to be mapped out. There was a purulent discharge from the ear for sixteen days after the injury.

Dr. Rushmore concludes, that there was a fracture beginning in the external auditory canal, and extending downward and forward. The origin of the bleeding he is at a loss to explain. I think there is no reasonable doubt, however, that it was from the vessels of the tympanic cavity.

The tuning-fork located the situation of the hemorrhage.

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[1] Archives of Otology, vol. ix.

Had there been a hemorrhage into the labyrinth, the bone conduction would not have been better than the aërial. A careful examination of an osseous specimen will convince any one of the possibility of rupturing the tympanic vessels only, by such a fall. The healing of the membrana tympani with scarcely a trace of the rupture, explains those cases of reported bleeding from the ear, when the drum-head shows no cicatrix in a few weeks after. That such a perfect healing may occur, I have been able to demonstrate on several cases.

A profuse watery discharge from the ear, occurring *immediately* after the injury, is good evidence of a fracture of the petrous portion of the temporal bone, but a watery discharge may set in a short time after the accident, and be merely inflammatory in character and by no means be the cerebro-spinal fluid, even though it be excessive. The facial canal and the motor filaments of the fifth nerve may be injured in fracture of the temporal bone, and paralysis occur.

Our knowledge of these cases would be greatly increased, if a careful examination of the membrana tympani were made in each case of supposed fracture of the base of the skull.

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

The prognosis in a case of rupture of the membrana tympani depends very much upon the nature of the injury that caused it. An accident of this kind, when produced by the concussion of a heavy explosion or of a severe blow upon the side of the head, is much more serious in its nature than an injury to a drum-head from the forcing through it of any sharp body, such as a knitting-needle, pen-holder, twig of a tree, a blade of straw, or the like. The former class of injuries are apt to produce a fracture of the temporal bone, a concussion of the labyrinth, or a fracture or dislocation of the 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, and the bone conduction will be better than the aërial, 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 mistakenly 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.

A large clot in the canal should be removed with gentleness and care, but syringing the ear immediately after a minute hemorrhage from a superficial injury is bad practice. Union by first intention, is favored by letting the drum-head absolutely alone. It is meddlesome surgery to do very much to such cases.

When inflammatory symptoms occur, they should be met by leeches, the warm douche, and by the other means that will be detailed in the chapters 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 Ménière, Von Tröltsch, and Weir.[1] 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 an 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.

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[1] Von Tröltsch on the Ear, second American edition, p. 151.

Dr. Weir's case is one of ununited fracture.[1] A man, aged thirty-two, came to Dr. Weir's clinic, 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 area-way, 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. 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 dated from the time of the injury, continued 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

FIG. 79.

FIG. 80.

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.

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.

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[1] Transactions American Otological Society, 1870.

# CHAPTER XI.

## ACUTE CATARRHAL INFLAMMATION OF THE MIDDLE EAR.

Nomenclature.—Statistics.—Symptoms.—Treatment.—Leeches.—Paracentesis —Sub-acute Catarrh.—Hemorrhagic Inflammation of the Middle Ear.—Aural Hemorrhage in Bright's Disease.—Vascular Tumors of the Drum-head.

THE practitioner or student, who is entering upon the study of aural disease, will find, I think, some advantage in beginning with an outline map of the territory which he is about to traverse. For this reason, at this point as at the beginning of the discussion of diseases of the external ear, a list or classification of the diseases of the middle ear is given :

I. Acute catarrhal inflammation.
II. Sub-acute catarrhal inflammation.
III. Hemorrhagic inflammation.
IV. Acute and sub-acute suppurative inflammation.
V. Acute serous inflammation.
VI. Chronic non-suppurative inflammation.
VII. Chronic suppurative inflammation, with its consequences.
VIII. Neuralgia of the middle ear.

If we were to form our estimate of the frequency of acute catarrhal or suppurative inflammation of the middle ear, simply from the number of cases that are found in the statistical tables of writers on these diseases, we should come to an erroneous conclusion as to the number of persons who suffer, at one time or another, from them. Acute catarrh of the middle ear, is actually a very common disease in our northern climates. It is rather difficult to find a grown person who has not, at one time or another, suffered from "earache." Earache is the popular name for acute catarrh of the middle ear. My own statistics show that of 4800 cases of aural disease, seen in my private practice, 174 were cases of acute catarrh of the middle ear, 137 of acute suppurative, and 3 of acute hemorrhagic inflammation of the same part.

Bürkner's tables,[1] in a total of 43,730, only exhibit a total of 6180 acute affections of the middle ear. This table includes *acute myringitis* and *acute inflammation of the Eustachian tube* —diseases that are properly included among those of the middle ear.

The following table, also illustrates the comparative infrequency with which acute affections of the middle ear, are seen in hospitals. It will be found, however, that the proportion of acute aural diseases increases, year by year, when special hospitals are provided.

The advance of otology has been greatly hindered by the notion quite prevalent in the profession, as well as among the laity, that while a nurse or mother is quite competent to treat an *acute* aural disease, a physician, and perhaps a specialist, is needed when it becomes chronic.

*Table showing the Proportion of Acute Cases of Disease of the Middle Ear to the Whole Number of Aural Cases.*[2]

| Hospital. | Year or period. | Whole number. | Acute inflammation of middle ear. |
|---|---|---|---|
| Manhattan (New York) Eye and Ear Hospital | 20 years | 20,103 | 3,049 |
| New York Eye and Ear Infirmary | 1889 | 3,738 | 469 |
| New York Ophthalmic and Aural Institute | 1889 | 983 | 142 |
| Brooklyn Eye and Ear Hospital | 21 years | 23,729 | 3,203 |
| Massachusetts Eye and Ear Infirmary | 1889 | 3,952 | 362 |
| Salem Hospital | 15 years | 1,276 | 306 |
| St. Michael's Hospital (Newark, N.J.) | 1888 | 615 | 183 |
| Newark Eye and Ear Infirmary | 1889 | 1,296 | 81 |
| Illinois Eye and Ear Infirmary | 1885–1886 | 1,971 | 124 |
| Buffalo Eye and Ear Infirmary | 1889 | 171 | 28 |
| | | 57,834 | 7,947 |

It will be seen from the above table, that acute affections of the middle ear were about one-seventh of the whole number. This corresponds pretty accurately with Bürkner's statistics.

That this disproportion does not arise from an actual rarity of the affection, I think a little thought will show. These painful diseases very often never reach a practitioner, and are treated at home, a fact which accounts for their relative infrequency in statistical tables.

[1] Archiv für Ohrenheilkunde, Bd. XX., 1883.

[2] Sub-acute cases are not included in this table.

Every general practitioner will at once recall the fact, that it is often incidentally mentioned, when perhaps he is visiting a family suffering from other diseases, that one of the children has had a severe earache 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 the fact upon the minds of my readers that the commonly neglected earache 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 in 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, or of a neuralgic character, and passing from the throat to the ear.
2. A sense of fulness in the same part.
3. Noises in the ear.
4. An unnatural, hollow sound of one's own voice.

*Objective.*

1. Vascular injection.
2. Bulging outward 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 feels thickened and full, and that the throat is sore, a short time before the pain in the ear begins. I am inclined to believe that most patients are aware of what, for the want of a better name, may be termed a thickness of hearing, a fulness in the ears, before the attack of pain occurs. This pain is described by some patients as beginning in the throat and crawling along the Eustachian tube. It is a disease, however, which may be said to be sudden in its origin, and one which jumps at a bound to its height. It will pass over the acme, in most cases, unless at once arrested, into acute suppuration of the middle ear; a disease which, strangely enough, some practitioners seem to invite, judging from the expression once at least commonly heard, "It is a 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 usually lasts 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. When we remember the anatomy of the ear, especially that of the tympanic cavity, we can readily appreciate the fact that an acute inflammation of the middle ear, may easily cause hyperæmia of the membranes of the brain through the roof of the tympanic cavity, or of the labyrinth, through the fenestræ of the thin wall

separating the tympanum from the cochlea and semicircular canals. When we also consider, as shown by Politzer, that the vascular communication is direct, through vessels situated in this partition, we are not surprised that a congestion or inflammation of the middle ear, especially in infants and young children, may cause very serious head symptoms. 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 class 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.

Pouring warm water into the auditory canal will usually temporarily relieve an infantile earache; and in this procedure we have a means of diagnosis which is always at hand. I have seen children who were crying with pain from inflammation of the middle ear, go to sleep in a few moments after warm water has been poured into the canal. Sometimes, however, this procedure will fail to give relief, and we must depend for a diagnosis upon the objective symptoms, found in the color of the membrana tympani, of which I shall soon speak.

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 an inflammation of the mucous membrane; but adults usually locate the seat of trouble with exactness and accuracy. The pain is indeed neuralgic, and a moment's consideration of the rich supply of nerves to the cavity of the tympanum, will give the reason for the fact that the pain follows the course of the fifth nerve.

This mistake in diagnosis is very similar to the one made when acute glaucoma is thought to be neuralgia. Neuralgia of the tympanic cavity is a very rare affection. When it does occur, the absence of the symptoms of inflammation will indicate the true diagnosis.

The objective symptoms are chiefly to be sought in the membrana tympani. There is sometimes a pinkish hue to the whole membrane, again the vascular injection is around the periphery of the drum-head, and along the handle of the malleus, while the other parts of the membrane remain 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 an infant. The membrane has, however, at times the appearance of glass that has been breathed upon, without any evident increase in vascularity, even where there is acute inflammation going on in the middle ear.

The impairment of hearing is not always marked in the stage of pain. The hearing power may even be augmented and be painfully acute during the first stage of the disease. In cases of chronic aural catarrh, in which an acute inflammation had supervened, I have known many instances where the acuteness of hearing was found on accurate examination to be markedly increased. It may be increased also in acute cases occurring in persons whose ears had been previously healthy ; that is to say, sounds may seem very loud to them. In such a case there is probably hyperæmia of the vestibule or cochlea, besides that of the tympanum.

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 this membrane. It is sufficiently marked to be detected by any one who is at all familiar with the examination of the normal membrane. In rare cases—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 from the pressure of the blood column or of mucus behind it when this occurs. Increased secretion from the pharynx and region of the posterior nares is almost always observed in

cases of acute catarrh; but it requires but a mere mention at this point.

Febrile symptoms are almost always present in cases of the disease under discussion. The temperature is usually considerably increased in a severe case, 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.

In completing this description, it should also be said, that there are cases of acute catarrh of the middle ear in adults as well as in children, where while the symptoms of impairment of hearing, a sense of stuffiness in the head, redness and bulging of the drum-head, a peculiar hollow sound of one's own voice, are marked, there is no considerable pain, or if there has been, it has passed away before the physician has reached the patient. These, however, are exceptional cases.

*Causes.*—The causes of this disease are manifold. Any undue exposure to the influence of cold may produce acute catarrh of the middle ear. Getting the feet wet, the surface of the body chilled by standing or walking in the cold, are frequent causes of earache. A draught of air blowing, for instance, through the window of a railway carriage in rapid motion, is sometimes a cause of acute catarrh.

Ducking the head under water, and allowing the water that enters the auditory canal to remain there, is another cause.

Surf-bathing, especially in those people who habitually suffer from catarrh of the nares and pharynx, thus may become a cause of acute inflammation of the middle ear, as well as of the auditory canal. The salt-water may enter the nostrils and Eustachian tube and cause the disease, or a wave may deluge the auditory canal and injure the drum-head, and thus affect the middle ear. Yet, considering the great extent to which surf-bathing is practised in the United States, the number of cases of inflammation of the ear caused by it is very small. I have spent several summers where surf-bathing is extensively enjoyed, and I have heard very little of its evil effects. I believe the cases of disease of the ear caused by it, occur chiefly among careless and ignorant bathers, or in those who already suffer from chronic aural or naso-pharyngeal disease. Prolonged bathing and diving in still water, are much more apt to cause congestion of the middle ear than surf-bathing.

Many cases of aural disease are said by those who suffer from them to have originated in the following way. "I got my ears full of water and never could get it out," is the fanciful statement of many patients who mistake the feeling of fulness in an inflamed middle ear, for that from water remaining in it. Surf-bathing is of such value as a tonic to many debilitated systems that I do not hesitate to advise it, even to patients with aural disease, under proper precautions, such as :

1. Take a bath of not more than five or ten minutes in duration.
2. If the ears are affected by chronic suppuration, close the meatus with cotton.
3. Never allow a wave to strike the side of the head.
4. Indulge very sparingly, if at all, in swimming or diving through the breakers.

Constitutional diseases, such as small-pox, scarlet fever, and measles, in which the pharynx is affected, are very common sources of acute aural catarrh. Pneumonia and bronchitis very often have this affection as a 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 pathognomonic evidences of syphilis in the character of the pain or the appearance of the membrana tympani in such cases.

Cerebro-spinal meningitis, is also a prolific source of acute inflammation of the middle ear.

The origin of acute catarrh, is chiefly to be sought for in the faucial extremity of the Eustachian tube, and not in the auditory canal. This explains the fact, that it is much more important for patients liable to aural disease, to protect the external surface of the body and the extremities from the cold, than the meatus and auricle.

Yet it is not to be denied, that inflammation of the middle ear does occasionally extend from the canal, through the membrana tympani, and not through the Eustachian tube, for a draught of air upon the side of the head will produce acute aural catarrh, and if cold water enter the ear through the meatus externus, and remain for a considerable time, it may also produce acute catarrh of the middle ear.

The use of the nasal douche for the treatment of naso-pharyngeal catarrh, may also produce acute inflammation of the ear, as I first showed.[1] My experience has since been confirmed by many other observers.

[1] Archives of Ophthalmology and Otology, vol. i., No. 1.

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.

The occurrence of acute catarrh of the ear, in scarlatina, measles, naso-pharyngeal catarrh, and pneumonia, is, I think, favored, by the common practice of giving large, or comparatively large, doses of sulphate of quinine in these cases. This invaluable remedy should, in my opinion, be given with great caution in these diseases, since the disposition to extension of the inflammation to the middle ear, exists strongly in all these constitutional affections. Quinine is quite sure to aggravate aural symptoms, if they already exist, and in young children it may excite them. I have several times seen children suffering from acute aural catarrh, in whose ears the administration of quinine had, from the very first dose, steadily aggravated the pain, until the discharge of pus from the tympanic cavity explained the high temperature, which should have been combated by local antiphlogistic remedies, instead of by an *antipyretic*.[1]

What has been said of quinine refers also with equal force to the various newly found drugs for reducing temperature—antipyrine, phenacetin, and so forth. Winter-green and salicyne should be used with caution in cases with sensitive ears.

*Treatment.*—The proper treatment of acute aural catarrh is predominantly an antiphlogistic one. The disease is an inflammation of the severest form, and can only be successfully combated by such means as local blood-letting, quiet, warmth, and opium. As has been said, a neuralgia of the middle ear, that is to say, pain without other symptoms of inflammation, is extremely rare, yet an inflammation of the middle ear is very often treated as would be a case of facial neuralgia; or we might even say, that the ordinary treatment for acute aural inflammation is 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 earache. 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 Haarlem 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

[1] See Medical Record, February 8, 1883, and Transactions of the Medical Society of the State of New York, 1883, as well as an article on "Colds in the Head," in the Transactions of the same Society of 1880, p. 242.

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 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. The fountain syringe or the Fayette douche (see illustration on page 129) 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 in the beginning of an attack of acute aural

catarrh, by breathing into the affected ear for a very few minutes. If leeches cannot be had, and the use of warm water or of steam does not subdue the pain, cups—wet or dry—applied around the auricle, are sometimes of use, as well as blisters.

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, and one may also be placed around the ear, leaving the auricle free; 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.

Scarification of the drum-head, as recommended by Blake, is also of service in mild cases. It requires a much more practised hand for its performance, however, than a paracentesis.

Paracentesis of the drum membrane is a very efficient remedy 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 shown on the next page,

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 generally to be in Shrapnell's membrane, and in the posterior and inferior quadrant of the membrane.

I have tried the instruments with an angular handle, but I have, after much experience, concluded that a straight instrument is so much more easily managed, that this facility in use much more than completely balances any value from not shutting off the light from the canal, said to belong to the other instruments. A needle, such as is used in the operation of discission of a soft cataract, is a very good instrument for making an opening into the membrana tympani.

The operation causes so little pain and it is so brief, 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. 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

FIG. 81.—Paracentesis Needle.

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 often 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 acute or sub-acute 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 forty-eight hours. If employed with gentleness, there need be no fear of aggravating the subdued inflammation into a relapse. Indeed, inflation often relieves pain by emptying and ventilating the tympanum.

The 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 bedtime. It is somewhat remarkable, however, that opium has very little effect, when used without local depletion, to quiet the pain from inflammation of the middle ear. 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.

A daily sponge-bath in a warm room, using cool water in summer and tepid in winter, followed by vigorous rubbing with a coarse towel, will be found of real service in preventing relapses of aural disease. Not every patient, however, can tolerate cold water, although I think every moderately well person will be the better for a daily bath of the whole surface of the body. A little discretion must therefore be allowed the individual as to the temperature of the water used. The shower-bath and the plunge, as well as the habit of pouring water into the ears, should be discouraged.

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 neg-

lected 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.

I was very much interested in a complaint made by a distinguished surgeon of New York, who, in a discussion upon the effects of scarlet fever and measles upon the ear, stated that while writers on aural surgery said much about the neglect of diseases of the ear, occurring during the course of the exanthemata, he had found no means of doing anything to prevent the breaking out of such disease while the measles or scarlet fever were going on, and he did not know, after all the warnings, that there was anything really to be done. Now, in answer to this, it may be said that it is not claimed that *otitis media* may be always averted in the course of scarlatina or rubeola, but sometimes, if the physician be on the lookout for it, it may be aborted, so to speak. If a child begin to toss its head about as if in pain, or if it become hard of hearing, the tragus may be at once examined to see if pressure upon it cause or increase pain, the drum-head may be looked at and a diagnosis made. If there be congestion of the ear, the warm douche will often relieve it at once. If not, we have blisters, leeches, and paracentesis of the membrana tympani. If, however, the attack cannot be aborted and goes on, certainly we may by these same means alleviate or stop the pain, and modify the course of the disease, so that recovery of the ear will usually go on step by step with the general convalescence, and the patient will not barely recover of the exanthem, to suffer the horrors of chronic suppuration of the middle ear. All that writers on aural surgery ask that general practitioners shall do in cases of acute inflammation of the middle ear, occurring in the exanthemata, is, that they treat them as they would the same disease occurring independently.

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.

It is unfortunately true, however, that an acute catarrhal inflammation of the middle ear, even under judicious management, may go on to be a suppurative one, from which death may occur from extension of the inflammation to the brain. More will be said of this, however, in the chapter upon acute suppuration.

It is sometimes stated that the treatment as described in the preceding pages is too heroic, and that milder means than leeches, paracentesis, scarifications, an incision down to the periosteum of the mastoid, may be employed, not only with safety, but with benefit to the patient. The use of leeches has been especially objected to, on account of the local irritation and even inflammation they are said to frequently cause. Paracentesis of the drum-head, it is said, is a dangerous operation, and often performed unnecessarily, and so forth. To all this, I can only say that *acute* catarrh, or acute suppuration of the middle ear, are serious and rapidly progressing diseases that admit of no temporizing, of no delays in active antiphlogistic treatment. I have not been speaking of subacute inflammatory affections, of neuroses in hysterical and anæmic subjects, but of a sthenic inflammation, with its pain and its possibilities of rapid advance from the tympanic cavity to the membranes of the brain, to the general circulation, or when its progress takes a more favorable turn, to the membrana tympani. To combat this disease, only local antiphlogistic treatment will be of avail. Those who wish to arrest pain quickly, to prevent dangerous consequences from an extension of an inflammatory process, will find the active treatment that has been here described will not disappoint their expectations. Some of the arguments against the means now in vogue among the modern otologists, have been based on the incorrect assumption that they are employed in mild cases when less active means will be more agreeable, and equally efficacious. I have been careful, however, as I believe, to show that local blood-letting, paracentesis, and cutting down to the periosteum, with confinement to a room, are chiefly to be employed in severe cases. That an acute inflammation of the middle ear is a severe case, certainly no one will deny who has been called to treat it, or who has unfortunately experienced it.

I believe as fully as any of my professional brethren, in the natural course of diseases, which it is often better not to attempt

to check; in the *vis medicatrix naturæ;* in the danger of doing too much for many cases, but the disease now under consideration is one which I believe from a long and large experience can only be successfully combated by what are known as local antiphlogistic means, among which leeches and the warm douche take the first position.

### SUB-ACUTE CATARRH OF THE MIDDLE EAR.

There is a variety of catarrh of the middle ear, very common in young persons and in children, although it also occurs in adults, which differs in so many respects from the ordinary type of acute catarrh, that it seems to require a more extended notice than the references that have been made to it in discussing the latter-named affection. 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. Others classify it among acute affections. While the former 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.

In spite of some adverse criticism, especially by German authorities, I think we may justly draw a distinction between an acute and a sub-acute affection. If we do so, we shall be less likely to fall into the error of treating all recent cases of catarrh of the middle ear, as vigorously as we do those that only differ from them in being attended by great pain and injection of the drum-head. Acute catarrh demands vigorous treatment, while the sub-acute form will get on very well with mild measures.

*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, or 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 inward 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 toward the speaker, is heard.

This impairment of hearing in children is very often attributed to "absent-mindedness" by parents, and to "stupidity" by teachers. Children are not usually absent-minded, and when they are stupid, there is always a cause, which should be traced out, and the poor child not treated as if it were responsible for the disease that has rendered it so. Again and again, will the practitioner find that he is obliged to correct the false ideas of parents and teachers, who do not know that children always prefer to hear, if they can. Malingering as to deafness is a deception which children rarely understand, and which they can never successfully maintain. A child that does not habitually answer at once when addressed, should be at once carefully examined as to its hearing power, before it is scolded for absent-mindedness.

*Treatment.*—It is 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 exhibi-

tion 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 in the second chapter—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.[1]

The pathological changes in these cases, which cause the impairment of hearing, are probably in some cases simply plugging of the faucial orifice of the Eustachian tube, in others of the calibre of the tube and the tympanic cavity by mucus. Structural changes, such as thickening of the mucous membrane, adhesive bands, rigidity of the ligaments of the ossicles, and so forth, have not occurred. Hence I would not class these cases among those of chronic catarrhal inflammation.

It is probable also that the mobility of the ossicles is interfered with in some cases by the accumulated mucus as well as by the swelling of the articulations. The restoration of the normal vibrations of the chain of bones, and the removal of the mucus explain the sudden increase of hearing power by inflation.

I append three cases, two of which have been before published;[2] 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.

[1] Professor Hermann Schwartze claims priority in this procedure.

[2] American Journal of the Medical Sciences, vol. vii., p. 64.

## CASES.

Case I.—F. S. B ——, aged sixteen, New York, September 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 practice 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. 1890.—The patient is now a practitioner of medicine, and has no impairment of hearing.

Case II.—Girl, aged sixteen, 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, January 21, 1873), aged fourteen. 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, $\frac{2}{4}$; 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 involuntarily makes, 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 ends in deaf-muteism. Where any doubt exists, the little patient should have the benefit of it, by the use of Politzer's method, which can do no harm, and may do a vast deal of good. The existence of a naso-pharyngeal catarrh in an infant, should be carefully considered by the attending physician, lest it result in one of the tympanic cavity, and there cause changes which must leave permanent impairment of hearing.

The evil consequences of neglected colds in the head are not always sufficiently appreciated by our profession. It is from the children who suffer frequently from this affection, that the large class of persons, whose hearing is greatly and permanently impaired, is annually recruited. It is of the utmost importance that all cases of impairment of hearing, should be under early supervision, lest a permanent defect occur. Inflation of the ear, with general hygienic means, will generally relieve these cases promptly.

## HEMORRHAGIC INFLAMMATION OF THE MIDDLE EAR.

I believe I was the first to report[1] cases of acute aural catarrh which had an unusual course and termination—that is to say, cases in which the course was very acute and terminated rapidly in perforation of the membrana tympani without suppuration, but with quite an abundant 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 de-

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

scribe 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 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 earache as a child or adult. I saw him on November 7, 1871. His history was as follows: About 10 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 con-

sisted in the instillation of sweet oil and tincture of opium. There was no relief, however, until about 6 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.

It may be of interest to note that this gentleman died some thirteen years afterward of cerebral hemorrhage. I lately treated a gentleman in his eighty-fourth year, who suffered simultaneously from hemorrhagic retinitis and hemorrhage into the middle ear. Absorption of the blood in the tympanic cavity and the drum-head was followed by great improvement to the hearing. I have also lately seen a case of hemorrhage into the drum-head, after the escape of fluid into the tympanum while gargling. This latter case, however, is hardly like a true hemorrhagic inflammation of the middle ear which I first described, and which is now generally recognized. Not only have cases been reported by eminent authorities,[1] but in one hospital[2] it is reported that 19 cases have been observed in thirteen years. Hemorrhagic inflammation of the middle ear is usually a very tractable inflammation whose violence is spent with the hemorrhage. The history of such cases, especially with regard to the abatement of the pain as soon as the hemorrhage occurs, furnishes another argument for an early perforation of the drum-head, when great pain is experienced and the drum-head bulges.

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 I have related, and Dr. Hackley's case occurred in a young woman who had just passed through the menstrual period, and the menses reappeared after

[1] Guide to the Study of Ear Disease, by T. McBride, M.D., p. 50. Edinburgh, 1884.
[2] Brooklyn Eye and Ear Hospital Report, 1883.

the aural hemorrhage ceased. Dr. Pomeroy also reports such a case, as follows :[1]

A woman of fifty-five was seized with a chill at ten o'clock in the evening, which was followed by fever and great pain on the left side of the head and in the left ear. The pain continued with more or less severity for five days, when Dr. Pomeroy saw the patient and found the membrana tympani intensely red. Posteriorly and above it bulged somewhat. The right membrane was also red, but did not bulge. The left membrane was opened, and after inflation the auditory canal was nearly filled with blood. Two days after the membrane, which seems to have closed, was again punctured and a few drops of blood evacuated. The patient made an entire recovery without suppuration from the ear. The patient had no renal disease and no cerebral symptoms.

### 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[2] in 1868.

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 January 16, 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 inch 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 January 23d. 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

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[1] Transactions American Otological Society, p. 86, 1875.

[2] Archiv für Ohrenheilkunde, Bd. IV., p. 12.

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 cavity 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, Dr. Gouverneur M. Smith read a paper before the Academy of Medicine,[1] 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. I once treated a case of obstinate suppuration in the middle ear, in a man of sixty-one 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.

In a thesis for the degree of Doctor in Medicine,[2] Paul Pissot enumerates three forms of diseases of the ear as arising in Bright's disease, viz., tinnitus aurium, half deafness, and complete deafness. This classification is so unscientific that it gives no real information. The only important part of this thesis is that in which it is stated that Delacharrière has found rupture of the membrana tympani, vascularity along the handle of the malleus, and sclerosis of the tympanum in cases of impairment of hearing occurring in Bright's disease. The supposition is then made that the aural symptoms may be due to an œdema of the sheath of the auditory nerve. This, it is needless to say, is a purely theoretical view. Even the occurrence of aural symptoms in Bright's disease of the kidney has as yet attracted but little attention, and, as far as I know, they are somewhat rare, and have not as yet been accurately studied. A certain proportion of the few that seem to occur, probably depend upon hemorrhage from degenerated blood-vessels in the tympanic cavity.

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[1] On the Etiology of Bright's Disease, with Remarks on the Prophylaxis. Transactions of the New York Academy of Medicine, vol. iii.

[2] American Journal of Otology, vol. i., p. 136.

## VASCULAR TUMORS OF THE MEMBRANA TYMPANI.

Todd,[1] of St. Louis, reports a case of somewhat alarming hemorrhage from the depth of the auditory canal, after the puncture of a small swelling that hid the membrana tympani. The patient had suffered twenty-two years previously from suppuration of both middle ears. As a result of this disease, his hearing was impaired, and he had a throbbing noise in his left ear. The arterial bleeding was stopped by a tampon, but it was renewed on removing it, and the sac filled with blood as soon as it was removed. Under the use of a compress of cotton moistened with glycerate of tannin, the sac was found, two years later, to be of a whitish color and thickened. It was about the size of a split pea. Dr. Todd was not able to see the membrana tympani in any of his examinations. It is possible that the hemorrhage was from a tumor of the drum-head or tympanum, rather than from one having an origin in the auditory canal.

Buck[2] reports a case of vascular growth on the drum-head. In the posterior superior quadrant, just behind the short process of the malleus, was found a bright red fleshy mass, about a millimetre or a millimetre and a half in diameter. It was soft and freely movable. The patient was a lady of twenty-two years of age.

I am now treating a Sister of Charity of about thirty-five years of age, who has an affection of the right middle ear, with a vascular growth in the drum-head. The patient was first seen in the spring of 1883, about one year since. Her symptoms were impairment of hearing and tinnitus. A red growth was found to involve the centre of the membrana tympani, and with it the handle of the malleus. It formed a ridge nearly across the whole surface of the membrane. It was of a bright red color. I incised it with a paracentesis needle. The tissue was rather hard, and although the opening was full and bled freely, the tumor did not fully collapse. Since then four incisions have been made, with relief to the tinnitus, and the tumor, although still existing, is quite small and is less vascular, especially at the lower extremity. The patient has also been treated by inflation of the tympanum. The incisions into the tumor were formerly followed by more bleeding than is now experienced, and the patient expresses a sense of relief of the fulness in the ear after the paracentesis. This tumor seems to me to communicate with the tympanum. It may be a growth between the in-

[1] American Journal of Otology, vol. iv., p. 187.

[2] Treatise on the Ear, p. 372.

tegumentary and fibrous layer. The tuning-fork is heard better by bone conduction. The hearing distance varies from $\frac{1}{4}$ to $\frac{1}{48}$, according as the tympanum is free from mucus.

Buck[1] also reports a second case of vascular tumor of the membrana tympani. This case was seen in a lady of sixty-five years of age, who consulted Dr. Buck on account of a slight impairment of hearing, that had existed but for a few days. In the central portion of the posterior superior quadrant of the left drum-head was a dark colored tumor, measuring about a millimetre at its base. It was not particularly sensitive. In the right there was a similar tumor, in a corresponding situation, but it was smaller.

Weir's[2] first case of intra-tympanic vascular tumor, is very similar to the one of which I have just given a sketch. Repeated incisions, followed by cauterizations and inflation of the middle ear, finally effected a cure. Weir's second case[3] was also greatly alleviated by incisions and cauterizations with chromic acid, but the patient, a colored woman, finally died of phthisis. She was greatly troubled by tinnitus, which was usually relieved by a paracentesis.

It is evident from the history of these cases that paracentesis or incision of vascular growths of the drum-head, or tympanic cavity, as well as inflation of the middle ear, are generally indicated. By these means we may hope ultimately to secure shrinkage of the growths and a return to a normal condition.

The causes of these vascular growths are not evident to me. Those related by Buck appear to be of the nature of nævi, while those of Weir and myself seem to be consequences of inflammation of the tympanum.

## DIPHTHERITIC INFLAMMATION OF THE MIDDLE EAR.

The origin and course of diphtheritic inflammation of the middle ear, are so different from what obtains in an ordinary acute inflammation of the middle ear, caused by cold, or even from this disease occurring in the course of the exanthemata, that I feel justified in devoting a few paragraphs to a special discussion of it. While assisting in the case of a child of about eleven years of age, who died of diphtheria, and about whose hearing before his illness I had accurate knowledge, I observed that he became very hard of hearing in the course of the diph-

[1] American Journal of Otology, vol. iii., p. 283.
[2] Ibid., vol. i., p. 120.
[3] Loc. cit.

theria which affected the fauces and nostrils. The impairment of hearing continued as long as he lived. It may have been caused, as the fuller experience of other writers shows, by simple catarrh of the middle ears, or by the formation of a croupous membrane in the Eustachian tube or tympanum.

The principal writers upon the subject of diphtheria of the ear are Wendt,[1] Wreden,[2] and Blau.[3]

In most of the post-mortem examinations made by Wendt, of diphtheritic inflammations of the ear, there was merely a coincidental hyperæmia or catarrh of the tympanum, in connection with laryngeal and pharyngeal diphtheria.

Wreden, however, has reported 18 cases of diphtheritic inflammation of the middle ear, occurring in the course of pharyngeal and nasal diphtheria, *complicated with scarlet fever.* Diphtheritic inflammation generally causes great impairment of hearing when it involves the ear, according to Wreden. His report indicates that the internal ear was also affected in his cases, for the tuning-fork was not heard through the bones. The drumhead was half destroyed in all the cases examined by him. The prognosis is worse in infants than in older children. Wreden speaks well of leeches and douches of solutions of tannin, in the treatment of diphtheritic inflammation of the middle ear and internal ear.

Dr. C. E. Billington, who has contributed essentially to our knowledge of diphtheria, by a report of a large number of cases to the New York Academy of Medicine, informed me, and also stated in a public discussion, that the ear had not, in his experience, been affected in diphtheria, except in such cases as were complications of scarlatina. Billington considers the difference between the two diseases to be so marked, as to make it a diagnostic point. He has been able to trace cases of apparently simple diphtheria with complicating otitis, back to a scarlatinal origin. He thus agrees with the observations of Wreden just quoted.

Jacobi[4] states that the ear, in the same manner as the eye, may become affected with diphtheria by continuity with the naso-pharyngeal space. He says a slight swelling of the mucous membrane of the orifices of the Eustachian tubes in children, or a moderate diphtheritic deposit may close them, and hardness of hearing be the result. In such cases the patient not infrequently

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[1] In Schwartze's Pathological Anatomy of the Ear.

[2] Monatsschrift für Ohrenheilkunde, No. X., 1868.

[3] Berlin. Med. Wochenschrift, December, 1881, p. 729.

[4] Treatise on Diphtheria, p. 74.

complains of intense pain behind the angle of the jaw and ear. Jacobi also recognizes the fact, that perforation of the drum membrane may result from diphtheritic inflammation of the middle ear.

Wendt[1] found a tubular croupous membrane or a solid cast in the cartilaginous part of the Eustachian tube. Once, the membranous formation involved both tympanic cavities and the antrum and cells of the mastoid, and even covered the ossicula. With this exception Wendt, found only hyperæmia or hemorrhage in the osseous parts of the middle ear.

Kupper[2] and Gottstein[3] also report cases of diphtheritic otitis. The former author gives an account of a post-mortem, in which it was shown, that croupous inflammation of the mucous membrane of the tympanum, and of the tube had occurred with an intact drum-head.

Blau,[4] of Berlin, reports in full, a case of diphtheritic panotitis, occurring after an attack of scarlatina, upon the heels of which, as observed by Wreden and Billington, the diphtheritic pharyngitis and otitis may quickly follow. In Blau's case the hearing was completely gone. When he first saw his patient, neither the tragus nor mastoid process was sensitive to pressure. A membrane was found in each auditory canal. Paralysis of the facial nerve and great redness of the membrane of the tympanic cavity soon followed. Periostitis and abscess of the mastoid also occurred. Blau was not able to follow the case to its termination. He used a douche of lime-water very frequently with good effect in the removal of the membrane. It will be seen, that it is a perfectly well-established fact, that a croupous membrane may form in the middle ear, during diphtheria. It is also true that the labyrinth may be involved. The evidence leans toward the truth of the view of Dr. Billington, that diphtheria of scarlatinal origin is the only form in which otitis occurs. The reader is also referred to the report of a case in the next chapter of an adult dying from meningitis consecutive to aural disease, in which a croupous membrane was found in the middle ear.

Of 147 cases of deaf-muteism lately examined by me, not one was ascribed by the family or friends to diphtheria. It is probable that the cases of diphtheria in which severe otitis occurs, are generally fatal.

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[1] Quoted by Blau, loc. cit.

[2] Archiv für Ohrenheilkunde, Bd. XI., p. 19.

[3] Ibid., Bd. XVII., p. 16.

[4] Berlin. Wochenschrift, loc. cit.

Diseases of the middle and internal ear (panotitis—Politzer) occurring in the course of diphtheria, should be energetically treated, if the general condition allows. At any rate, the mouth of the Eustachian tube should be freely sprayed with lime-water, or solutions of tannic acid, and Politzer's inflation practised, so that, if possible, the tympanum may be ventilated, and the tubal muscles kept at work. Poultices over the mastoid and in front of the auricle, with repeated douches of the auditory canal, are also to be earnestly recommended. The violence of the aural symptoms in diphtheria are only equalled by what occurs in severe cases of scarlatina, where I have seen the course so violent in an inflammation of the tympanum, that the drum-head and ossicles were swept away a few hours after the first symptoms appeared in the faucial extremities of the Eustachian tube. Urgent as the general symptoms will undoubtedly be, those relating to the ear should not be left unrelieved if possible to mitigate them.

### ACUTE DISEASE OF THE MIDDLE EAR IN CEREBRO-SPINAL MENINGITIS.

The examination of deaf-mutes shows that, according to the testimony of their friends and attending physicians (see chapter on "Deaf-Muteism"), many of them became deaf while suffering from cerebro-spinal meningitis. In my opinion, the chief seat of the lesion, in a majority of these cases, is to be found in the *middle ear*. I am sorry that I am seldom called to see a case of acute cerebro-spinal meningitis, but when I am, I advise the use of leeches, blisters, and mercury to combat the formation of an exudation or purulent formation in the middle ear. If I may venture to advise my professional friends, who see this disease, accompanied by impairment of hearing or deafness, I would say, treat the aural affection as if it were one of acute catarrh of the middle ear. The prognosis as to the hearing will then not be altogether hopeless, although it is usually so considered. That the disease of the ear is commonly situated chiefly in the tympanum, I hope to be able to prove in the discussion of the causes of deaf-muteism in a subsequent chapter of this volume.

# CHAPTER XII.

## ACUTE SUPPURATION OF THE MIDDLE EAR.

A Consequence of Acute Catarrh.—Symptoms.—Causes —Course.—Cases of Meningitis Consecutive to Acute Catarrh and Suppuration.—Criticisms upon the Modern Antiphlogistic Treatment.—Neurotic Cases.—Treatment and Cases.—Acute Serous Inflammation 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 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, while this may occur from the tympanum. It is my belief 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, and so forth ; but that the failure to notice them is usually to be attributed to carelessness in observation, and that it is to be regarded as another indication of the common indifference to an inflammation of the ear, when it 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, or to a neuralgia, instead of an inflammation.

It is not to be denied, however, that there are cases of acute suppuration of the middle ear, where the initial symptoms of swelling of the lining membrane of the Eustachian tube and

cavity of the tympanum are so quickly passed over, in a few hours, or even minutes, as to be practically unrecognizable.

Such a course of the disease is frequently observed in 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 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, who have acute suppuration of the middle ear, 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 distention of the little space called the cavity of the tympanum by mucus, blood, serum, or pus.

*Symptoms.*—The symptoms, then, of this disease are usually pain in the ear and head, fever, 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 normal distinguishing marks—the light spot and the 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. Politzer has given the name of *panotitis* to these cases.

*Causes.*—The causes of acute suppuration of the middle ear are the same as those that have been enumerated in the chapter on "Acute Catarrh." The important ones are comprised in exposure to wet, draughts, and cold—inflammation of the naso-pharyngeal mucous membrane being the usual starting-point.

The violent use of the posterior nares syringe in an acute or subacute 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 instance as follows: A physician, aged twenty-seven, 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, or nostrils and Eustachian tube from the entrance of water, may produce acute suppuration.

Scarlet fever, measles, diphtheria, tonsillitis, bronchitis, pneumonia, typhoid fever, whooping-cough, and cerebro-spinal meningitis, play an important part in the production of acute aural disease, and usually, except in pneumonia and cerebro-spinal meningitis, the suppurative form is the one first recognized, although as has been said, there is probably almost always an unobserved stage of the milder variety of inflammation.

Injuries of the side of the head, and of the membrana tympani, are causes of acute suppuration of the middle ear of a very severe nature. This subject has, however, been discussed in the chapter on "Injuries of the Membrana Tympani."

*Course.*—The course of acute suppuration is usually violent until perforation of the drum-membrane occurs; when it gives way—at times with quite a loud explosion—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 blood-vessels. It may pass through the thin, and sometimes porous lamella of bone which forms the roof of the cavity of the tympanum, or it may go 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. There are probably but few, if any, cases of suppuration that are limited to the tympanum. 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 chapter upon consequences of chronic suppuration. Under appropriate treatment, however, the secretion of pus usually soon ceases, the membrane closes up, the hearing is restored, and scarcely a trace is seen, either in the anatomical structure or the functions of the organ, of the disease which has raged so violently.

With a want of logic 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 and distressing, for it protracts the duration of the disease very much.

Acute catarrh and acute suppuration of the middle ear are exceedingly amenable to judicious treatment. There are no important parts of the body which more certainly in the large majority of cases recover from serious inflammations than those that make up the middle ear. Indeed, it should not be forgotten, that acute catarrh and acute suppuration very often run their entire course, and end in perfect recovery with no especial treatment. Any one who is in the habit of hearing the histories of patients and of examining the membrana tympani, soon convinces himself that young children often recover from acute suppuration of the middle ear under very crude but not meddlesome treatment, received from nurses and parents. This becomes an important consideration in the physician's treatment of acute inflammations of the ear, for it will lead him to a wise conservatism in certain cases, and a healthy skepticism as to the value of drugs which therapeutic enthusiasts praise so highly

and with which they claim to avert a suppuration process. There are, however, painful exceptions to the rule that acute suppuration of the middle ear is under proper guidance, usually a tractable and not fatal disease. In 1877, I attended a case in which meningitis followed acute purulent inflammation of the middle ear. Death occurred in about twenty-eight days from the appearance of the acute aural symptoms.[1] The history of the case is as follows :

*Meningitis following Acute Purulent Inflammation of the Middle Ear—Death in about Twenty-eight Days from the Appearance of the Aural Symptoms—Post-mortem Examination of the Brain and Temporal Bone.*—On March 23, 1877, Mr. A. H. B——, aged forty-one, whom I had treated for syphilitic iritis some two years before, sent for me, on account of a severe pain in the right ear. I found the patient, who was a well-developed man, apparently in robust health, sitting up, but giving evidences of great pain. The pain was referred to the depth of the right ear. There was a profuse discharge of blood and pus from the auditory canal ; blood predominated, however. The membrana tympani was perforated. The outlines of the ossicles were not seen on account of the swelling of the lining membrane of the tympanic cavity and of the remains of the drumhead. There was some sensitiveness of the tragus and auditory canal, but no especial tenderness of the mastoid process.

The patient stated that on a return from a visit to Memphis and Mobile, or about five days before, he had a bad cold in the head, with severe neuralgic pains in the same region.

Three or four days after the "neuralgia" he consulted Dr. Royal Prescott, through whose courtesy I am able to present the history from that time.

Dr. Prescott says, in a note to me : "Mr. B—— came to my office on the evening of March 20th, complaining of pain in the right ear, and deafness on the affected side. He thought that his hearing had been affected for some time on that side. On examination I discovered a quantity of inspissated cerumen, which I removed by gently syringing with warm water. . . . I inserted a few drops of warm glycerine and morphine, put in a pledget of cotton, gave him an anodyne, and directed him to take a saline cathartic. He came in on the following morning and reported that he had passed a tolerable night, that the pain was somewhat abated, but had not wholly disappeared." Dr. Prescott then ordered an infusion of opium, and directed him to remain in the house for a few days.

On March 22d, according to Dr. Prescott's note, the pain had increased, when hot fomentations to the ear and an anodyne were ordered. The patient exposed himself in a severe storm in his last visit to Dr. Prescott's office, and became worse. At this stage I saw the patient. I ordered the application of two leeches to the tragus and the warm douche every hour. My associate, Dr. E. T. Ely, called at nine the same evening, and found him so comfortable that a hypodermic injection of morphia which I had proposed was not administered.

On the 24th, the patient was quite comfortable and free from pain, *but he was very restless and did not sleep well.* He said that his sleeplessness was not on

[1] Medical Record, July 7, 1877.

account of pain in the ear, but on the 25th two more leeches were applied. The discharge from the meatus continued to be very abundant and bloody. The warm douche was continued, and bromide of potassium was given at night. On the 26th there was no pain in the ear, and no especial tenderness about it, but his head was very uncomfortable and restless. The patient's tongue was heavily furred, his pulse 96, and temperature 101°. He was sleepless and without appetite. Cerebral hyperæmia was diagnosticated, and ten grains of calomel were ordered at 11 P.M. From the 28th to the morning of the 30th the symptoms were about the same. By the aid of morphia tolerable sleep was secured, but the patient showed great anxiety and discomfort. On that morning, at my request, Dr. Lewis Fisher saw him in consultation, and continued to see the patient with me until his death. Dr. Fisher concurred in the diagnosis, and inasmuch as the patient had suffered from syphilis, he suggested the use of iodide of potassium in addition to the warm douche and morphine. On March 31st the patient had a severe chill at noon, which lasted for an hour, and which was not followed by sweating. The temperature was 100° at about 12 noon; at 9½ P.M., 103¾°. The patient stated that he never had had a malarial attack, although he had spent much of his life in a malarious country. The formation of pus was supposed by Dr. Fisher and myself to be indicated by this chill. There was, however, no tender spot about the ear, and there seemed no chance of getting at the abscess, if one was forming. There continued to be a free discharge from the meatus. We therefore decided to administer quinine, as an antipyretic. We accordingly gave him twenty grains of sulphate of quinine and thirty grains of bromide of potassium, following it up in four hours after with fifteen grains of quinine. On April 1st the patient appeared much better. His temperature was 98°, his pulse 72, and there was no pain in the ear, and scarcely any in the head. The quinine treatment was kept up. Mr. B—— began to sit up and converse on business matters, and became very cheerful, although we had given him a gloomy prognosis immediately after the occurrence of the chill. He did not, however, sleep quite as well as a convalescent should, and on April 12th he suddenly complained of severe pain in his right knee-joint, and his temperature ran up to 103½°. He slept scarcely at all; he also complained of pain in his head, which was not localized. The discharge from the ear diminished very much. The pain in the knee disappeared in about twenty-four hours, and occurred with great severity in the back and left thigh. The mastoid process was cut down upon on the 9th or 10th, but no disease of the bone or periosteum was detected. On the 15th the temperature was 103½°, the pulse 84, and a low muttering delirium occurred at intervals. Professor John T. Metcalfe saw the patient on this day, and gave his opinion that it was a case of cerebral disease extending from the ear, and although he regarded the prognosis as very unfavorable, suggested the use of mercurial inunctions and iodide of potassium, with a very faint hope that syphilis was causing some of the symptoms. On the 16th the patient was scarcely ever conscious, his temperature continued at 104° to 104½°, and on the morning of the 17th he quietly died.

The autopsy was made by Dr. W. D. Spencer, five and one-half hours after death.

*Head.*—The bones, except the right temporal bone, were normal. The dura mater was normal. The sinuses were filled with dark, soft coagula.

*Brain.*—The vessels on the surface were markedly hyperæmic. The vessels at the base appeared normal. In the meshes of the pia mater, most markedly

at the base, and equally on both sides, was seen quite an extensive fibrino-purulent exudation, which was thicker along the course of the larger vessels; this exudation extended anteriorly to the surface of the right hemisphere, when it was more sero-purulent. The lateral ventricles were markedly dilated and filled with blood-stained serum. The brain substance was firm and markedly hyperæmic, otherwise normal as far as examined. The connective tissue posterior to the external ear and coating the mastoid bone was somewhat œdematous. (This was the site of the incision down to the bone, an incision that was kept open by tents.)

Description of the temporal bone:

*Mastoid.*—There are two discolored spots on a line running outward from the meatus auditorius externus.

*Petrous portion.*—Just in front of the elevation made by the semicircular canals the bone is exceedingly soft. In washing it was broken down, and the whole structure here, or the roof of the tympanic cavity, is found to be in a state of ulceration. An opening through the squamous portion of the bone, or in the temporal fossa would be about on a line with this ulcerated point.

*Lateral sinus.*—The bony wall of this venous canal is discolored, thinned, and softened throughout about one-half its extent.

*Tympanic cavity.*—The ossicula are intact, but the whole of the membrana tympani is gone.

We are all familiar with cases of meningitis resulting from disease of the middle ear of long standing, but cases of this kind following acute aural disease are fortunately more rare. Indeed, we generally expect to subdue an acute inflammation of the ear, if we are able to treat it antiphlogistically within a few days of the outbreak of the disease. Nowhere does rational therapeutics avail more than in acute affections of the ear. In this case there was never a discharge from the ear, according to the patient's statement, until a few hours before I saw him. The affection began as an acute *otitis media catarrhalis*, with impaction of cerumen, which the patient, until corrected by Dr. Prescott, thought was a facial neuralgia—a not uncommon, but dangerous error. It ran a violent course, as is shown by the bloody discharge and great pain.

The purulent process in the middle ear extended to the tissues of the roof of the tympanic cavity, and to the labyrinth and to the membranes of the brain, where the hyperæmia soon became an exudative inflammation of the base, extending very slowly to the upper surface, and consequently leaving the intellect unimpaired for a long time. The disease of the bone went on slowly at the same time. The pyæmic symptoms are explained by the disease of the lateral sinus. The circumstances of the patient—for he lived in a crowded boarding-house—were not favorable to the quiet that should always be secured for a patient with cerebral hyperæmia, and I fear that I did not lay

stress enough upon this requisite in the first few days. My suspicions as to cerebral hyperæmia were somewhat lulled, however, during the first forty-eight hours, by the fact that the pain in the ear nearly entirely disappeared from the first application of the leeches. The only part of the case that now seems obscure to me, and in this opinion Dr. Fisher agrees, is the reduction of the temperature, and the great improvement in the general condition immediately after the use of the large doses of quinine. We gave quinine, as has been intimated, on the shadow of a hope that we were dealing with a severe case of

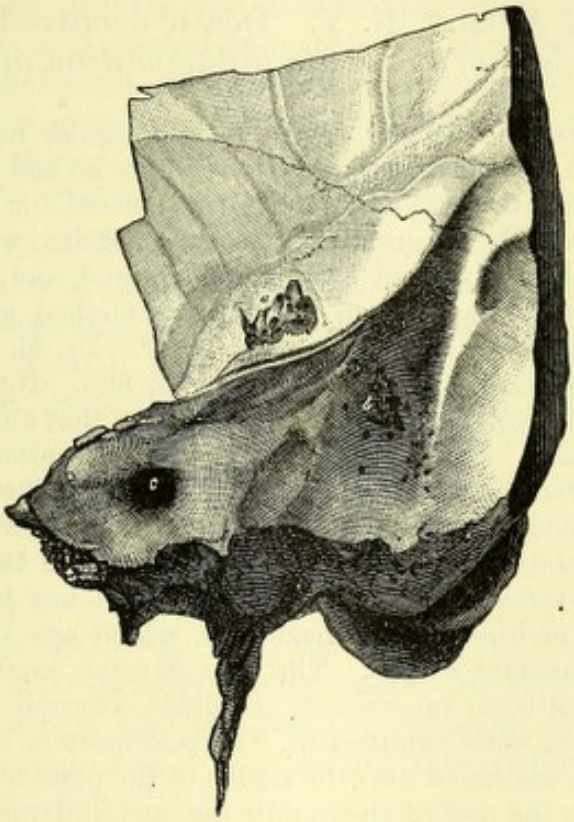

FIG. 82.—Showing Disease of Bone in Case of Meningitis following Acute Suppuration of the Middle Ear. *a*, Caries in front of elevation for semicircular canals; *b*, caries of lateral sinus; *c*, meatus auditorius internus.

malarial fever, instead of one of abscess of the brain or inflammation of the meninges. With a diagnosis of either of the latter-named, we had simply to sit down with folded arms and await the dissolution of the patient. The reduction of the temperature immediately followed the administration of the quinine, and each day, as it showed a disposition to rise, the same remedy seemed to lower it, until the septicæmic pains set in, when it utterly failed. Indeed, so well was the patient for about a week, that Dr. Fisher and I were inclined to change our original diagnosis. Such a lull in the symptoms of cerebral disease re-

sulting from an inflammation of the ear, is, however, not without precedent.

There was always an unbroken bone between the ulcerated tympanic cavity and the membranes of the brain, so that the fatal inflammation must have extended through some of the small foramina, which abound in the temporal bone. This is no new pathological observation, since it has long been known, although not always remembered, that we may have meningitis as an extension of aural disease without the occurrence of caries.

Another case of this unfortunate series was reported by Dr. C. S. Merrill,[1] of Albany, N. Y. Death occurred *on the fourth day after the origin of the acute inflammation of the middle ear.*

The patient was a book-keeper, temperate and regular in his habits of life. He had always been well, but for two or three weeks he had been a little debilitated from overwork. On November 7, 1877, he noticed for the first time a fulness in his right ear. He consulted his family physician, who sent him to Dr. Merrill. The membrana tympani was found congested, and the hearing on that side impaired. The ear was inflated by Politzer's method, and the family physician was advised to apply two leeches to the ear. Dr. Merrill did not see the case again for two days, when Dr. Bigelow sent for him. It was then stated that the leeching had entirely relieved the condition, so that all feelings of fulness passed away, and the hearing became normal. The patient, contrary to Dr. Bigelow's advice, resumed his office duties. But on the 9th, at 5 o'clock in the morning he was attacked with severe pain, and Dr. Bigelow was sent for on the next day at noon and found the pulse 160, temperature 103¼°, respiration 28. The patient was delirious. The membrana tympani was bulging and greatly inflamed. A free incision of the membrane, which was thick and resisting, evacuated a large amount of pus. The next day the local inflammation had greatly subsided, but coma supervened, and death occurred four days from the first manifestation of aural symptoms. The post-mortem examination showed meningitis. "Pus was found over the region of the petrous bone." There was perforation through the roof of the middle ear, and underneath the dura mater and covering the surface of the brain there were a few drops of greenish-colored pus. The bone was perforated by two or three small openings. There was no evidence of inflammation of the internal ear.

Dr. Merrill remarks: "The fatal termination of the case was evidently due to the direct extension of the inflammation to the membranes of the brain through the roof of the middle ear, which in this patient was cribriform in appearance."

I also saw, in consultation with Dr. Loring, a case in which death from meningitis occurred after a few days of symptoms of acute inflammation of the middle ear. This patient, however, had had sub-acute catarrh of the middle ear at various times dur-

[1] Transactions of the American Otological Society, vol. iii., p. 29. 1882.

ing the two years preceding the attack which terminated fatally. It was not a suppurative case. Dr. Welch, who made the post-mortem examination, regarded it as a croupous inflammation of the middle ear. I was present when Dr. Loring made a large free opening in the membrana tympani, and found that it contained no secretion. The dura mater was normal except in one situation. That over the roof of the tympanic cavity and the adjacent portion of bone, was very much congested and showed "numerous small red points, which represent punctate hemorrhages." The roof of the tympanic cavity was found extremely thin and translucent, but "it was not carious. The mucous membrane of the middle ear was found swelled, softened, of a bluish-red color, and *coated in many places with a reddish-gray opaque false membrane, averaging about one millimetre in thickness.* Punctate ecchymoses can be seen in the swollen mucous membrane, but there were no coagula of blood in the cavity of the tympanum." The swelling and exudation were most marked on the membrane of the roof of the tympanum, on the promontory and entrance of the Eustachian tube. There was also exudation in the osseous portion of the tube. The ossicles were movable, the labyrinth and auditory nerve were sound. There was no fibrinous exudation in the pharynx, fauces, or air-passages. After a microscopical examination Dr. Welch, gave as his opinion that the case had been one of *otitis media crouposa* with consecutive septo-meningitis. The "consecutive" was probably placed somewhat in doubt, because at the post-mortem examination it was not easy to trace the starting-point of the meningitis of the convexity of the brain from the right middle ear. The yellowish sero-purulent exudation in the sub-arachnoid space and meshes of the pia mater covering the convexity of the cerebral hemispheres, "was rather more abundant upon the left than the right side."[1]

Added to these exceptional cases of death from acute inflammation of the middle ear, is that of a young man, who was attended by my associate in private practice, Dr. Edward T. Ely, with whom I saw the patient in consultation, who died in a few days from consecutive meningitis, without rupture of the membrana tympani. His first symptoms were from the ear, and there were objective appearances of acute inflammation of the middle ear. Symptoms of meningeal hyperæmia were very early in appearance, and in spite of active treatment he soon died in a comatose state. No post-mortem examination was made.

The reader will observe that the thinness of the bone forming

[1] American Journal of Otology, vol. iii., p. 126.

the roof of the tympanic cavity was marked in two of the foregoing cases. As has been pointed out by all the recent writers on aural surgery, this anomaly is not uncommon, and where it does exist, it must cause a peculiar susceptibility to consecutive meningitis from disease of the middle ear. Since we can never know beforehand in which cases this anomaly is found, and while we do know, that in young children the bone is always thin and porous, we may on reflection realize the possible serious character of *any case* of acute disease of the middle ear.

I can add another case of death from acute suppuration of the middle ear, which occurred in my practice at the Manhattan Eye and Ear Hospital. In this case, however, the rational treatment was undertaken some days after the disease had fully set in, and it is also altogether likely that the fatal termination was hastened by the patient's bad habits. I first saw the young man, who was the victim in this case, when he was pale and haggard from pain and sleeplessness. The drum-head was bulging. I punctured it and evacuated considerable pus. This gave great relief, as he told me two days later, when he again appeared at the clinic. His whole aspect was much better, and he told me that he had slept well for two nights. He died in a few days, just after a drunken debauch. The physician who saw him informed me that he died from meningitis, consecutive to the aural trouble, but I was not able to get an exact account of the lesions, although the death was investigated by the Coroner; and an attempt was made by some of the patient's friends to prove that his death was caused by the operation (paracentesis of the drum-head), which secured him the first sleep he had had for some days. The most appalling evidence was given to show that the "Doctors murdered him by running an instrument into his brain."[1]

*Treatment.*—The moral of the foregoing is plainly to be read. An acute catarrh or suppuration of the middle ear should never be lightly estimated. A case seen early in its course will usually prove very tractable and respond readily to treatment, but if left to itself it may be a serious case. The first step in the treatment is to insure quiet and freedom from care for the patient, if an adult. Patients with acute suppuration should usually be confined to their rooms. If adults, absolute freedom from business or domestic employment should be insisted upon.

[1] The medico-legal reader, may possibly be interested in the verdict given by the Coroner's jury in this case. The following is a copy of it: "We the jury come to the conclusion that —— came to his death by a rupture of the blood-vessels of the small brain or with some instruments used by doctors unknown to the jury."

Each case should be watched as forming a possible starting-point for cerebral meningitis. In the large majority of cases such a deplorable consequence will not occur, but it would, I think, be much less frequently observed, were each patient with acute suppuration carefully guarded from the exciting causes of cerebral hyperæmia, from the beginning of the aural disease until he is fairly convalescing. The room, or ward in which such a patient is, should be kept free from visitors, prolonged conversation, bright light, noise should not be allowed, and an attempt should be made to secure physical and mental quiet. To underrate the gravity of an acute suppuration, or even an acute catarrh of the middle ear, is to invite peril to life.

I have seen at least two cases where, I believe, the life was lost, because the patients insisted that a painful ear and a tender mastoid process, were not sufficient causes to keep them away from business and from active social life.

If the case be seen in the earlier stages—that is, when the pain is still present, and the membrana tympani is intact—two or more leeches should be at once applied, and if the appearance of the membrana tympani indicate that it is about to rupture, or if the pain be not quickly subdued by the use of the leeches, a paracentesis of the membrana tympani should be at once performed in the most bulging portion of the membrane. If the mastoid be red, tender, and swelled, it should be poulticed thoroughly and well, and if relief be not apparent in twelve hours, it should be 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 and poultices will probably subdue the inflammation without an incision.

The ear should be douched very often, say every half hour, with lukewarm or hot water, by means of a fountain syringe or the Fayette douche, 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 pediluvia 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.

The quantity of pus discharged is sometimes enormous. At the same time, Politzer's method of inflating the ear should be practised. This latter procedure gives no pain when carefully done, *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 has found great relief in tonsillitis from the use of the warm douche upon the pharynx, by means of Davidson's syringe, or rubber tubing attached to a water-faucet, and I have confirmed this experience.

Relapses of pain should be combated by leeches, warm water, and the internal administration of opium, or morphia, chloral, and bromide of sodium combined; but opium has very little power in subduing the pain from acute aural suppuration, if used without the local treatment. The administration of calomel or other mercurials, the application of blisters, will not be required. The former kind of treatment is useless, while the latter aggravates the suffering of the patient. Blisters are more applicable to chronic aural disease, but in the absence of leeches they are useful.

If the case go on well, a physician who does not see much of this form of disease, will be astonished at the rapidity with which the suppuration is checked, and the membrana tympani restored. The impairment of hearing will be the last symptom to be fully relieved. The hearing power should be often accurately tested by the watch and tuning-fork in the course of the disease, in order that if possible we may not dismiss the patient until the cure is complete.

The astringent that I usually use in acute suppuration is a solution of sulphate of zinc, which is poured into the ear once or twice a day, after syringing. The solution should be previously warmed. Should the suppuration continue unduly, the nitrate of silver may be applied in strong solutions, say from forty to eighty grains to the ounce. This solution is brushed over the drum-head and in the edges of the perforation. In some cases it may be necessary to drop the solution into the ear, afterward neutralizing it by syringing with a warm solution of salt and

water. 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.

I do not begin the use of astringents in the treatment of acute suppuration, until I have assured myself by careful trial, that the cleansing of the ear is not of itself sufficient to cause the purulent discharge to cease. *In many cases I never have occasion to use an astringent*, but the curative influence of nature, impediments to her action being removed, proves to be sufficient. Dr. Ely, who was for years associated with me, both in private and public practice, called attention to this subject,[1] and published some cases from our practice which I here insert as being of great illustrative value in discussing this subject.

Dr. Ely remarks that "great labor has been required to lead physicians and laymen to consider acute suppuration of the middle ear as of any importance, and it is natural that many practitioners having thus been laboriously awakened to its importance should hold exaggerated ideas as to the remedies required for its cure."

### CASES OF ACUTE SUPPURATION OF THE MIDDLE EAR TREATED WITHOUT ASTRINGENTS.

*Case in which the Use of an Astringent aggravated the Symptoms.*

Miss H——, aged twenty, consulted me November 30, 1877, with acute suppuration of her left middle ear of ten days' duration. There was a free discharge of pus, and no pain or swelling. I ordered syringing of the ear, and the instillation of a two-grain solution of sulphate of zinc twice daily. Immediately after using the zinc-drops she began to have violent pain in the ear. This pain continued all night, and, when I saw her the next day, the auditory canal was so swollen that the drum could not be seen; the whole of that side of the face was swollen and tender, and there was congestion and pain in the eyeball. There was a temperature of 101° and some vertigo. Leeches, hot water, morphine, and rest in bed were prescribed. The pain, swelling, and vertigo did not disappear until the evening of December 4th. I always attributed this attack to the effect of the zinc, although I have no further proof of the fact than the patient's own belief of it, and the history of the case.

*Cases in which no Astringents were Used.*

I.—Susie M——, aged six, came on November 11th with a history of pain in her left ear from 6 o'clock until 11 of the previous evening. The drum-head was found congested and ruptured, and there was a purulent discharge. Syringing of the ear with warm water twice a day was ordered. On the 14th there was no discharge, and the perforation seemed to be healing; the syringing was discontinued. On the 16th the perforation had healed and the hearing was

[1] Archives of Otology, vol. viii., p. 178.

fully restored. II.—Miss J. H——, aged twenty-one, came on March 11th, having had severe pain in her left ear since 3 A.M. The drum-head was found ruptured, and there was purulent discharge. The hearing on that side was $\frac{6}{60}$. Leeches and the hot douche were ordered, and they seemed to arrest the pain at once. After that, the ear was simply syringed occasionally with warm water. On the 13th the perforation was nearly closed. On the 18th it was completely healed, and the hearing was $\frac{15}{60}$. III.—Mrs. M——, aged thirty-five, came on March 17th, saying that she had had a cold in her head for the past week; that two or three days ago, while blowing her nose, she had felt a "cracking" in her right ear, and that since then there had been a discharge from the ear. Before this trouble the drum-head on that side was cicatricial from a suppuration in childhood. A large perforation was found in the posterior part of the drum-head, with a muco-purulent discharge. The hearing was $\frac{6}{60}$. Syringing with warm water, two or three times a day, was ordered. On March 19th the perforation was much smaller; the discharge was still abundant. On March 20th there was no discharge. The next day her cold became worse, and she had some fever. The following three days she had throbbing and tinnitus in the right ear with reappearance of the discharge; also had some vertigo. Was taking quinine during this time. On the 25th the discharge had ceased, and a few days later the perforation was healed. Hearing $\frac{6}{60}$. IV.—Mr. W——, aged forty, came on February 24th with a broken drum-head and acute suppuration, in the right middle ear. The discharge had appeared on the 19th, after eight hours of pain in the ear. Syringing with warm water was prescribed. On February 27th, the discharge was found to be less. On March 2d, the discharge had ceased and the perforation was very small. A few days later, the drum-head was found to be healed and the hearing restored. V.—Master L——, aged five, came June 17th with a history of earaches, both sides, for the previous four weeks. An examination showed perforation of both drum-heads and acute suppuration of the middle ears. No treatment was employed except syringing with warm water. The patient made a perfect recovery. VI.—Master F——, aged fourteen, came on April 7th with acute suppuration of the left middle ear. The use of the warm douche was prescribed. On April 17th the ear was doing well, and the hearing was $\frac{42}{60}$. A few days after this the patient was cured.

In this case and the preceding one the exact date of recovery was, unfortunately, not recorded.

VII.—Miss M——, aged eighteen, came on December 14th with acute suppuration of the right middle ear, of a few days' duration. She had already had a chronic suppuration of that ear, following measles, which had been checked, without restoration of the drum-head. Warm syringing was prescribed. On January 14th the discharge was found to have ceased. VIII.—Master V——, aged sixteen, came on June 20th with an acute suppuration of the left middle ear. The discharge, which was very bloody, had been noticed by the patient a day or two previously, after a night of very severe pain in the ear. There had already been marked deafness on both sides, from chronic catarrh, for many years. The only treatment prescribed was syringing of the ear with warm water two or three times a day. On June 27th the drum-head was found to be healed. There had been no discharge for several days.

The local treatment in all these cases, consisted simply in syringing the ear with warm water as often as seemed advisable. Of course, the throat and the general health received attention when it seemed to be required.

### *Criticisms upon Local Antiphlogistic Treatment in Aural Disease.*

Papers have been written, containing elaborate arguments against the use of leeches, Wilde's incision down to the periosteum of the mastoid, and other active forms of treatment of acute aural disease, as if the writers who advised these means in cases of necessity, always found them necessary. The criticisms upon active treatment in acute aural disease have not always been discriminate, for they have sometimes assumed that the modern writers advised the use of the leeches and the knife in all cases, and that they prescribed a routine treatment without using their judgment as to each individual case. I am of the opinion that the use of leeches, paracentesis of the drumhead, and incision of the mastoid, have all the importance that has been ascribed to them by modern otologists, yet I have never failed to counsel circumspection in the prescription of active means of treatment. I have as yet found no means of internal treatment, that will supersede active antiphlogistic means, such as leeching and incisions of the membrana tympani in severe cases of acute disease of the middle ear. There are many mild cases, however, even of this form of diseases, or cases of an asthenic type. In these the surgeon will soon find that a quiet room, the warm douche, diaphoresis, and so forth, will often be sufficient with no more active means. As an example of cases of acute aural disease which require constitutional rather than local treatment, even when local symptoms are markedly manifest, the following case heretofore published[1] is inserted. It is a striking example of a neurotic, rather than an inflammatory case, a variety which the physician should always be on the look-out for, among hysterical women and overworked men.

*Acute Inflammation of the Middle Ear, with Inflammation of the Muscles of the Neck, and Facial Paralysis of the Same Side.*

May 5, 1879.—Dr. S——, aged forty-five, a busy surgeon and medical journalist, consulted me in regard to uncomfortable and painful sensations in his right ear. He was somewhat anæmic, jaded from overwork, and he had an anxious appearance. He described the pain as extending from the right Eus-

[1] Archives of Otology, vol. viii., p. 255.

tachian tube to the drum, laying great stress upon the pain along the tube. The drum-head was red, the auditory canal normal. There was nothing marked about the pharynx. The hearing distance was not noted. Leeches were ordered to be applied to the tragus. I afterward learned that he had slight nasal catarrh and headache with pain in right lower jaw, on May 4th. The next day I received a note from the patient stating that he did not feel able, on account of the pain, to come to my office, which was a very short distance from his. I found him in bed and apparently suffering very much. He complained of a pain like that from neuralgia, extending over the right side of the scalp, face, neck, the right auditory canal, and the Eustachian tube. Leeches and the hot douche were prescribed. The patient then told me that he had suffered very severely a few weeks before from facial neuralgia; that he then had no aural trouble; that he had had very lately an inflammation of the muscles of the opposite side of the neck. The membrana tympani was vascular, but not bulging. Knowing that this patient had been very much overworked, with an insufficient quantity of fresh air, and seeing that he was pale and hyper-sensitive, I considered the pain as out of proportion to the objective symptoms of inflammation, and I therefore made a diagnosis of non-suppurative inflammation of the middle ear, with neuralgia of the fifth nerve. In other words, I believed that the otalgic symptoms predominated over those of true inflammation. Warm applications behind and over the ear were advised, as well as the use of the hot douche. The hot douche was not well borne, nor was there much relief, except at short intervals, from these measures. It should also be said that I laid great stress upon maintaining the nutrition, and a generous diet was insisted upon. On the fourth or fifth day the auditory canal was somewhat swelled, but not tender. I incised the drum-head, but no pus or mucus was evacuated. The hot douche was now freely used and afforded relief. A very moderate suppuration occurred in the tympanic cavity. Morphia was administered, *pro re nata*. The patient sat sometimes out of bed, but did only tolerably well, complaining at intervals of very severe neuralgic pain which was relieved by morphia. He took nourishment badly, except in the intervals of freedom from pain. He was very much depressed in spirits. There was no tenderness or any other inflammatory symptoms on the mastoid or in the pre-auricular region. On May 15th—ten days after I first saw the patient—I went out of town to fill a professional engagement, and my associate, Dr. E. T. Ely, took charge of the case until May 25th, and his notes are as follows:

"Dr. S—— seems to be a case of acute suppuration of the middle ear, with considerable swelling of the auditory canal; slight discharge; no pain.

"May 16th.—More pain and swelling; no discharge.

"May 17th.—Severe pain in whole right side of face and head and in the ear, not controlled by douche; no discharge; funnel-shaped swelling of the canal, not very tender. Consultation with Dr. A. H. Buck. It was decided to incise the canal and reopen the drum-head. This was done under ether. The opening in the drum-head was very free, and the canal was incised from the bottom to the entrance. Three leeches were then applied to the tragus and one to the mastoid. Hot douche was continued. No pus followed these incisions.

"May 18th.—Pain most of last night. A little easier this morning. Discharge of pus beginning.

"May 19th.—Comfortable until evening, then great pain in ear and head; temperature, 101½°; three leeches to mastoid; douche; morphia.

"May 20th.—Not much pain; weak and depressed. A.M.: Temperature, 98½°; pulse, 88; P.M.: temperature, 100½°; pulse, 88. Slept most of the day.

"May 22d.—No fever yesterday or to-day; one attack of severe pain last night; canal red and swollen; free discharge since incision; four leeches applied, and hot douche, for twenty minutes every two hours.

"May 24th.—Pain part of every day, no fever; severe pain last evening quieted by morphia; slight mastoid tenderness and œdema last evening and this morning; less swelling in canal. Dr. Buck was again called in consultation; he advised opening the mastoid by trephining. Dr. C. R. Agnew was called in the afternoon. He considered the case a typical one of mastoid disease of proliferous nature, but that no suppuration was going on there. He thought the disease was chiefly in the mastoid from the outset, and that there was meningeal congestion. By the ophthalmoscope the veins in the right fundus seemed a little fuller to Dr. A. and to Dr. Ely than in left.

May 25th.—Very slight œdema and some tenderness over mastoid, and although only one dose of the iodide of potassium prescribed the day before was taken, iodism was produced. Patient was awake all night from sneezing, and had some pain in the other ear. He is nervous and hysterical, buries his head in the bedclothes, and refuses to be comforted. He expresses the belief that he will not recover. On this date I met a gentleman with very large aural experience, and we went over the case very carefully. The patient seemed to be suffering very much, and he located the seat of his pain by spreading out his hands like a fan over the right side of the head. The tenderness about the ear was not very great, and was found in the neck and occiput as well. The ear was discharging freely with healthy pus. The mastoid was so slightly œdematous that I thought its condition might be due to the leeches and other applications. It did not seem to me to be a case of mastoid periostitis, nor did I think there was any meningitis or cerebral disease. Although I did not feel so sure of the former point as of the latter, I still thought the pain was neuralgic rather than inflammatory. Inasmuch, however, as Dr. Agnew had on the day before given the opinion that the mastoid was markedly involved, and that there was a meningeal hyperæmia, and as the gentleman now in consultation was much more decided in the opinion that the mastoid was the point of the origin of the pain, and moreover, since my own judgment was a little doubtful and wavering, I advised that a Wilde's incision be made at once. If this incision failed to detect disease of the bone, I resolved to take no further operative steps at this time, although the gentleman in consultation afterward stated to me, that he considered this but a step in the right direction, he believing that the bone should be opened, and that even if no pus were found, the bone-fistula would do no harm. The incision was accordingly made; no disease of the bone was found. The wound was dressed to the bottom with lint, and a poultice was applied.

May 28th.—The pains in the head and neck are not at all relieved except when morphia is used in full doses. The tissues of the mastoid, pre-auricular region, and neck were red, swelled, and tender at various points. These symptoms have increased since the incision. The depression of spirits continues, but at times the patient can be made quite cheerful by light conversation, and after a dose of morphia. He is taking a moderate amount of stimulants, and milk quite freely. Dr. William A. Hammond was called in consultation; his opinion was that there was no disease in the cranium, and that the pain was due to neuralgia largely modified by malaria. He advised that 60 grs. of quinine be given

in twenty-four hours, for two days, and that this treatment be followed up by small doses of arsenic. This treatment was followed by an apparent alteration of the pain, and not so much morphia was needed.

On June 3d the muscles of the neck were so much swelled that we pronounced them in a state of inflammation, and leeches were applied. The arsenic and generous diet, as far as patient would take it, with moderate doses of alcohol, were continued. The neck was especially tender where nerves made their exit. There was no especial tenderness on the mastoid; the patient could scarcely move his head from side to side.

June 7th.—The conjunctiva and outside of lids of right eye are reddened; the ability to close the right eye is impaired.

June 8th.—Conjunctiva and lids less red than yesterday. Slight enlargement of gland at the angle of the jaw on right side. Severe pain in the jaw and mastoid region. Morphine was freely administered hypodermically for its relief. A poultice was kept on the side of the face and the head. Temperature, 101½°; pulse, 100.

June 9th.—Swelling at the angle of the jaw increased; pain severe, and facial paralysis on the right side well marked. The right lid does not completely close in winking. The right side of the face appears rounder and fuller than the left, and the mouth is slightly drawn toward the left. The tongue protrudes in a direct line, and there is no deviation in the uvula. There is apparently no disturbance of the sense of smell. Temperature, 99¼°; pulse, 94. Two leeches were applied behind the ear. P.M.: Severe pain; ℥ x. of Magendie's solution every three hours (hypodermically).

June 10th.—A.M.: Temperature, 98¼°; pulse, 100. Slept well; took about one quart of milk during the night. Facial paralysis increased. Ophthalmoscopic examination by Dr. Roosa. The appearance of the fundus is the same in both eyes, and nothing abnormal is seen in either. The ear discharges freely. P.M.: Longer intervals of freedom from pain. No morphine since the 8th at 9 P.M.

June 11th.—A.M.: Temperature, 99½°. Swelling at the angle of the jaw diminished. No pain since June 10th at 9 P.M. P.M.: Pain recurs; not so severe. Chloral and bromide of sodium are given for its relief.

June 12th.—A.M.: Patient slept badly. Pain returned in the old regions, the jaw, behind the ear, and over the right side of the head. Temperature, 98¾°; pulse, 94. Patient very much depressed in spirits. Morphia again administered. At 5 P.M. a consultation was held, at which were present Dr. Alfred L. Loomis, Dr. Henry B. Sands, Dr. Charles R. Briddon, Dr. W. M. Carpenter, and the attending physician, Dr. Roosa. After Dr. Roosa's statement that the pus was freely discharging from the auditory canal, and that, in his opinion, there was no retained pus in the bone, without claiming to decide the strictly *aural* points of the case positively, the conclusion was reached by the consulting surgeons and physicians that the patient had no symptoms of intra-cranial trouble; that there was no indication for operative interference with reference to the mastoid process, or suppuration in any part of the neck; that supporting treatment was demanded. On the suggestion of Dr. Loomis the stimulant he was receiving was increased to 1½ oz. of whiskey every three hours, and pushed to 2 ozs. as soon as it became evident that it did not disagree with his stomach.

June 13th.—Patient feels very comfortable; has slept well; is taking 2 ozs. of whiskey in a tumbler of milk every three hours, and has not experienced the

slightest intoxicating effect. Takes nourishment aside from the milk. Temperature, 99° in the morning, 98⅘° 6 P.M.; pulse, between 96 and 100. Patient also takes citrate of iron and quinine. A 8 P.M. patient again complains of severe pain. Morphia administered at 9.30 P.M.

At 3 A.M. on June 14th he was seen by Dr. Ely on account of great pain. Morphia was given at that time and one hour later. At 8 o'clock the pain was still unrelieved, and the swelling about the angle of the jaw and the mastoid process was very much increased. Morphia was freely administered *p. r. n.*, and a consultation was held at 1.30 P.M., at which three aural surgeons and one general surgeon were present. The following opinions were given: Dr. ——, an otologist, saw no indication for operative procedure, while he believed there was mastoid disease. Dr. ——, also an otologist, believed that the patient was suffering from mastoid disease, and that trephining should be performed at once. Dr. ——, aural surgeon, thought there was no serious internal trouble, that it was external, and that the patient was probably suffering from some kind of poisoning—malarial? sewer gas? that no operation was advisable. The general surgeon thought that pus would be found somewhere about the stylo-mastoid process, and he thought that nature would relieve the patient by suppuration. He laid great stress on the continued application of poultices, and he was not in favor of operative interference to-day. Dr. Roosa adhered to his original opinion, that the patient had a moderate inflammation of the middle ear, with great neuralgic pain, and that the swelling of the neck and facial paralysis may have been caused by the operative procedures already undertaken, and that trephining was not justifiable, but that it would be injurious. It was decided to continue the alcohol and to make the application of poultices very thoroughly over the neck and mastoid.

An examination of the urine on June 15th gave the following result: Dark straw-color, acid, sp. gr. 1024, albumen in moderate quantity, casts 2, slightly granular, uric acid a little, pus a little, mucus a fair amount, oxalate of lime a little.

June 15th.—The ear is suppurating moderately. The drum-head is granular, canal moderately swelled, ear easily inflated by Politzer's method. The swelling in the course of the sterno-cleido-mastoid muscle, and about the neck, seems to be increased, but the tenderness is not so marked. The symptoms point to abscess forming in the connective tissue, and in the muscles of the neck, and over the mastoid process. Dr. Roosa does not think there is retained pus anywhere in the head, or inside of the temporal bone. There is a particularly tender point, 1¼ in. in a direction directly backward and a little downward from the lobe of the ear. There is scarcely any œdema about the Wilde's incision. Temperature, 99°; pulse, 100. 3 P.M.: The swelling has begun to subside. Dr. ——, a general surgeon who had seen the patient on the 13th, saw the patient this afternoon, and thinks it possible there is pus in the petrous portion of the temporal bone, and that the swelling may be due to a temporary plugging up of the communication with the tympanic cavity.

Dr. Roosa thinks there may be pus in the cellular tissue, but does not think that it is necessarily connected with the tympanic cavity. The treatment was continued.

June 16th.—Pulse, 98; temperature, 99°. Patient slept well. Dr. Roosa opened the track of the Wilde's incision with a probe. The swelling and œdema in the mastoid process and about the angle of the jaw remained the same.

Another consultation was held during the day, at which there were present two general surgeons, two otologists, and Drs. Roosa and Carpenter. One of the surgeons expressed the opinion that the patient's general condition had improved since he last saw him, but he declined to express any opinion in regard to the necessity for operative interference with the ear. He believed it *possible* that the operations already performed might have aggravated the symptoms. The other general surgeon inclined toward trephining the mastoid. This should certainly be done in his opinion if there is a probability that there is not a free opening from the mastoid cells into the tympanic cavity, and this was a point to be decided by the aural surgeons. One of the otologists thought the patient better, and that no operation should be done. The other aural expert believed that the bone should be opened. Dr. Roosa stated that his opinion was unchanged, but that he had so much respect for the opinion of the gentleman who was so decided with regard to the necessity for an operation, as well as for that of the one who was inclined toward it, that he wished for further advice before he declined to open the mastoid. By agreement Dr. Robert F. Weir, who was for some years aural surgeon to the Eye and Ear Infirmary, and who is now surgeon to two general hospitals, was invited to see the patient independently and alone, at 9 o'clock this evening, without knowing any of the opinions that had been expressed, until his own was formed. Dr. Weir gave the following opinion: that the disease is probably an inflammation extending down the external auditory canal, in the angle close to the point where the facial nerve passes, and that it may perhaps involve the mastoid process; he is inclined to think it does not; there is no indication for surgical interference for the present. The general plan of treatment was therefore continued.

June 17th.—An examination of the urine made this day shows specific gravity 1020, and a well-marked trace of albumen. No casts. The general condition of the patient is improving, and the swelling about the neck is subsiding.

June 19th.—Patient is still doing well. Treatment has been continued.

The patient made a good recovery, with fair hearing distance, $\frac{1}{4}\frac{2}{8}$ at the last note, and has been ever since actively employed in his profession.

I regret very much that the early notes of this case are not more full; yet I think they are sufficiently so to give my readers a fair idea of the first symptoms. It is probable, however, that the mere recital has not conveyed to the minds of those who have followed it a full sense of its doubtful features. They were such that, taken in connection with the patient's high professional position, they gave me great anxiety lest I should omit to do my full surgical duty to the case. The more recent of the notes were taken stenographically by Dr. W. M. Carpenter, to whom the patient was indebted for intelligent and assiduous care.

The point to be settled during the course of the disease was this: Is there a hidden suppurative process going on in any part of the temporal bone which causes the pain, œdema, tenderness, cellulitis, myositis, and paralysis of the facial? My answer to the question was, No. The severe paroxysmal pain

did not arouse the suspicion in my mind that there was mastoid disease, because there was absolutely no well-defined tenderness, redness, or œdema until leeches and poultices had been freely applied, and not until two paracenteses of the drum-head and very free incisions of the auditory canal had been made.

On May 25th, when I saw the patient after an absence of ten days, there was certainly a moderate amount of œdema, and this led me, although I suspected it had been caused by the leeching, to advocate a Wilde's incision, especially as I then thought it a harmless procedure, and two otologists, who had seen the patient with Dr. Ely, thought the disease markedly involved the mastoid, although only one of them advocated any operative procedure. I now think that this incision was a mistake, and that to it we owe the increase of the inflammatory symptoms in the neck and the facial paralysis. Indeed I now believe, on a calm looking over of the case, that every operative interference, from my first paracentesis down to the Wilde's incision, was unnecessary, and that the traumatism needlessly aggravated the painful case. The key-note was struck in the proper management of the case, in my opinion, when the supporting, anodyne and anti-malarial treatment, by means of milk, alcohol, morphia, and quinine was vigorously entered upon.

I believe, furthermore, that the disease would have been more easily subdued if I had gotten the patient out of his house and by the seaside, before the graver symptoms set in. This I urged upon the patient and his friends, but without avail. It was simply a case of sub-acute, non-suppurative inflammation of the Eustachian tube and tympanic cavity, occurring in an anæmic, and, consequently, neuralgic and hysterical subject. That he was anæmic was not only noted by me at my first interview, but when Dr. Loomis was called in consultation, he stated that he had noticed the doctor's anæmic condition for a year.

Neuralgic he certainly was, for he had barely gotten through with a severe attack of facial neuralgia when the trouble occurred in the ear. The character of the pain during the whole course of the disease was not that arising from deep-seated trouble in the middle ear, but rather of a disease like neuralgia, in which there is an intensity at different times, and which has intervals of complete cessation. It was sometimes easy to divert the patient by light conversation or an anecdote, for quite a long time, and on some few occasions the use of water in the hypodermic syringe was followed by as much effect as the employment of morphia. Now, the character of a pain caused by severe inflammatory action in the tympanic cavity or mastoid process is such that no physician who has seen much of it would

attempt to alleviate it by any diversion of the patient's spirits or by a placebo. Only positive means, such as local blood-letting or division of the periosteum, will subdue this. I have long since recorded my experience [1] that morphia alone will not mask the severe pain of an acute inflammation of the middle ear. As Von Tröltsch aptly says, an inflammation of the tympanic cavity is essentially a periostitis, and every surgeon knows of what little avail are drugs against the pain of this disease, except when it occurs as a result of the deposition of syphilitic poison. It should have been said before that this patient had no syphilitic taint whatever.

I considered the patient to be nervous and hysterical, because he bore his pain very badly, and because he suffered from very great depression of spirits. It is not usual, in my experience, for a patient suffering from acute inflammation of the middle ear, to dwell very much on his prospects of recovery, or to be greatly depressed about his future. He is generally taken up so much with the severity of his pain as to have room for nothing else. Then there was something in the history of the house in which the patient lived, which I failed to impress upon some of the gentlemen who saw him with me, which led me to believe, as was once independently suggested by Dr. Noyes, who saw him two or three times, that there was an element of blood-poisoning in the case, perhaps from sewer-gas. Two members of the family had suffered from acute aural disease a few months before, and an examination made by competent authority late in the course of the case, showed that there was an escape of sewer-gas in the cellar. I do not know that any special significance is to be attached to the presence of albumen in the urine, but so far as it goes, it indicates a somewhat deteriorated general condition. In analyzing the case, I come over and over again to the conviction that the operations did harm. That traumatism such as the patient experienced in the paracentesis, and in the very free subsequent division of the membrana tympani, and the free incisions in the auditory canal, and the cut down to the mastoid bone, might induce adenitis, myositis, cellulitis, and that facial paralysis might result from pressure upon the nerve as it makes its way out of the stylo-mastoid foramen, I think does not admit of a doubt. Certainly there never was any evidence that the facial suffered any lesion until after it had left the cranium and tympanic cavity. Besides, the swelling and paralysis occurred at a point of time which makes it possible to believe that traumatism may have caused them.

[1] Transactions of the American Otological Society, p. 89. 1875.

But, the crucial test of the correct diagnosis was in the results of the case. There was no escape of retained pus either from the mastoid or from the neck. It certainly was not pus which caused the serious symptoms. When they were at their height the discharge from the ear went on, but gradually diminished. And when the patient was fairly convalescent, and up and about, the old swelling and redness of the neck reappeared for several hours. Besides, it should be noted that no chill occurred during the progress of the case. This fact, together with the clearness of the patient's intellect, gave me great encouragement, when I was struggling against the opinion of a valued colleague, who thought the patient was dying for want of an operation. Dr. S—— was relieved after large doses of quinine at a time when the pain was intense, and when these seemed to fail, he was permanently cured after the full doses of alcohol advised by Dr. Loomis.

From the nature of things, the general practitioner will see a great deal of acute disease of the middle ear—if he be on the lookout 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. I think more than seventy-five per cent. of these cases are cured, that is, the membrana tympani is restored and the hearing power becomes normal. As has been said in another place, the old writers on diseases of the ear were not in the habit of applying accurate tests as to the restoration of hearing; so that their standard of cure is not so high as that which obtains among writers of the present day. Many of 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.

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 "méddle" 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.

Occasionally I receive a note from a general practitioner, which conveys the impression to me, that it is supposed by some, that peculiar means of treatment are at the service of specialists which are not in the hands of the average physician, and which can only be used when a disease has become well advanced. To those who hold such views, I would say, the time to treat aural disease is in the beginning of the attack. Aurists or surgeons have no means to combat inflammation other than those at the hands of every practitioner. To wait for so-called special treatment is to lose important time. Besides this, there is no special, mysterious treatment that can be of avail at any time, no matter in what hands. It is true that we must wait for a cataract to ripen, before it can be removed, and then only an expert is competent to operate upon it. But no such condition of things exists in the progress of aural disease. Delay in its management will be as fatal to a cure, as is delay in the treatment of glaucoma.

The course of acute suppuration occurring in the midst of a severe attack of scarlatina, is apt to be violent. The symptoms follow one another with the rapidity of those of purulent ophthalmia. He who wishes to preserve the integrity of the organ, must be prompt and energetic in his treatment, or the drum-head and the ossicula auditus will be swept away, and a profuse and fetid discharge of pus be set up within forty-eight or fifty-six hours.

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 for them, than in those occurring in persons with

drum membranes of normal density and tension. I may also remark, that I have seen erysipelas of the face of a severe type, occur in the course of acute suppuration of the middle ear. This is, of course, a serious complication, but as yet I have seen no fatal results from it. More will be said of this, in the chapter upon "Diseases of the Mastoid."

The following cases may be said to be fairly typical, and to show the ordinary course of the different forms of acute suppuration of the middle ear.

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 ——, aged nine. 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 $\frac{0}{12}$ 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 thorough 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 11th, 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., $\frac{6}{18}$; L., $\frac{6}{12}$. 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.

May, 1890.—The patient is now in active business life; one ear suppurates considerably. His hearing is fairly good.

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 subjects have become inmates of deaf and dumb asylums, and are consequently educated in a necessarily imperfect manner. This boy, although under some obstacles, has been educated exactly as are his fellows, who enjoy good hearing power.

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 ——, aged one, 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 15th, 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.*—March 13, 1873.—George S——, aged thirty-four. He 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., $\frac{2}{48}$. 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 22d, or nine days from the date of the first visit. I afterward learned that he considered himself entirely well.

Case IV.—*Inflammation of Auditory Canal extending to the Membrana Tympani—Paracentesis—Cure.*—Mrs. G——, aged about thirty-five. 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 11th 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.*—February 16, 1873.—C. C——, aged one year. 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. Indeed, an acute diffuse suppuration of the external ear is an extremely rare disease. 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.

### SEROUS INFLAMMATION OF THE MIDDLE EAR.

An increased secretion of the middle ear, is not always either of a catarrhal or a purulent character. As has been observed in the account of the anatomy of this part, its lining membrane sometimes assumes the character of a serous membrane. In like manner an excessive secretion in the middle ear may be, in exceptional cases, predominantly or entirely of a serous character. This may occur when the membrana tympani is sound, and also during the course of a suppurative process. The membrana tympani, if entire, has an unmistakable appearance, when serum is collected behind it in great quantity. It is somewhat bulging, and through its transparent layers may be detected a yellowish fluid, which may be caused to change its position by movements of the head, just as *hypopyon* may be made to change its position in the anterior chamber of the eye. The subjective symptoms of this accumulation, like those from the accumulations of mucus, are sometimes very annoying and trying, without being absolutely painful. The movement of the serum is felt by the patient at each considerable change in position, especially on rising from lying down, and sometimes the sound of his voice becomes very distressing, and even "echo" hearing and double hearing may be present, just as it may be when mucus has accumulated in the ear in sub-acute catarrh. The hearing power is very much affected in these cases, but it may be variable, according as the serous fluid has changed its position. Great pain is sometimes spoken of by patients, but this is usually in neurotic or hysterical subjects, for, from all I can learn, while the presence of serum in the middle ear causes very annoying and disturbing sensations, they are not to be compared in severity with those from the accumulation of mucus, blood, or pus. Dr. Tansley[1] reported a case of serous inflammation of the middle ear, occurring in a woman of advanced age, and because his case was not marked by severe pain, he proposes to divide these cases into two classes, inflammatory and non-inflammatory. To the latter he gives the name of *hydro-tympanum*. This, I think, is a needless and unnecessary refinement in nomenclature, which may possibly lead to a confusion of ideas. Some cases of serous inflammation of the middle ear are attended by pain, and others are not, just as

[1] Archives of Clinical Surgery, July 25, 1878.

we may have a painless suppuration of the middle ear. But as I have already observed, annoying as is a serous inflammation of the tympanum, it is not usually painful in the same sense that acute catarrh or suppuration are found to be. As has been already said, an accumulation of serous fluid in the tympanum may occur in the course of a suppurative process, and it may be added, that it is very difficult to manage from the rapid reaccumulation of the serum. Serous accumulations are apt to occur, in my experience, in debilitated subjects. The inflammation may be considered, I think, as of a bastard type.

Dr. C. H. Burnett [1] reports a case of repeated accumulations of serous-like fluid, in the tympanum of a man fifty-five years of age. The membrana tympani was opened *thirty-seven times* by Dr. Burnett in nine years, and always with relief to the patient. In an obstinate case of this kind, I once made as many as five openings in the drum-head in a few weeks. The patient was a very nervous woman of some fifty years of age, and although she got relief at every operation, it was temporary, and she sought other advice. Burnett entitles his case *dropsy of the middle ear.*

*Treatment.*—Paracentesis of the drum-head is often indicated in cases of serous accumulation, although at times the fluid may disappear under the treatment of the middle ear by inflation. At the same time, the general health will need careful looking after. Generally, paracentesis must be repeatedly performed in the same case before a cure results. Delstanche's masseur will be found very useful in drawing the serous-like fluid, or serum, or tenacious mucus, from the tympanum. Of the accumulation of serum and mucus in chronic cases, more will be said in an appropriate chapter. Leeches and the warm douche are of little or no avail in serous inflammation, but the use of gargles is strongly indicated. By them, the action of the Eustachian tube and the consequent passage of the fluid from the tympanum to the pharynx, are promoted.

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[1] American Journal of the Medical Sciences, January, 1884, p. 122.

# CHAPTER XIII.

## CHRONIC NON-SUPPURATIVE INFLAMMATION OF THE MIDDLE EAR.

Frequency of this Disease.—Nomenclature.—Catarrh.—Proliferous Inflammation.—Subjective Symptoms. — Vertigo. — Tinnitus Aurium. — Insanity. — Subjective Symptoms of Proliferous Inflammation.—Objective Symptoms.—Impairment of Hearing.—Changes in the Membrana Tympani.—Eustachian Tube.—Naso-Pharyngeal Inflammation.—Adenoid Growths.—Pathology.—Causes.

It has been a common reproach both from the profession and the laity, that the treatment of aural disease is unsuccessful. In 1870 one of the Boylston prize questions was as follows : "Criticisms on the recent opinion of a medical writer that the less serious diseases of the ear may be successfully treated by a well-qualified general practitioner, and the more serious affections by none." When Von Tröltsch, announced his intention to devote himself to the study and treatment of aural disease, one of his professional friends warned him that he might put his good name in jeopardy. These incorrect ideas have arisen chiefly from ignorance as to the nature and causes of diseases of the ear. There is a large class of cases in this department of medicine, that at the very best can only be alleviated, and can never be cured. But many of these, have reached such a classification from a point where treatment would have been of the greatest avail. The prevention of a chronic aural affection is often within the power of every practitioner, while it once having become established, its cure is impossible. After many years of careful study of diseases of the ear, I think it may be said that there are but two classes of cases of aural disease in which we may not expect very good results from treatment and care. Nearly all the others are singularly tractable, 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.

Of every thousand cases of aural disease about three hun-

dred belong to the former class, while but a small percentage of disease of the internal ear occurs.

Chronic non-suppurative inflammation of the middle ear, is so insidious in its origin and progress, that it may have existed for months and years before its subject is aware of it, and brings himself under professional care. It may impair or nearly destroy the hearing, with but few of the subjective evidences of what is called inflammation—there may be no heat, redness, or pain—but we find many of the other marks of diseased action, in swelling, thickening, 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 non-suppurative inflammations 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. It is compiled from the first cases of this disease that were observed by me in private practice:

*Cases of Chronic Non-suppurative Inflammation.*

| | | | |
|---|---|---|---|
| Number 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's standing | | 42 |
| " " | less than one year's standing | | 13 |
| | Total | | 525 |

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.

I add a second table made from the last five hundred and ten cases:

| | | |
|---|---|---|
| Cases of | 50 years' duration | 1 |
| " | 40 " " | 5 |
| " | 30 to 40 years' duration | 6 |
| " | 20 to 30 " " | 30 |
| " | 15 to 20 " " | 27 |
| " | 10 to 15 " " | 77 |
| " | 5 to 10 " " | 112 |
| " | 4 years' duration | 43 |
| " | 3 " " | 53 |
| " | 2 " " | 76 |
| " | 1 year's " | 41 |
| " | 6 months' " | 18 |
| " | 3 " " | 21 |
| | Total | 510 |

It will be seen that even in the second table the proportion of cases of from five to twenty years' standing is very large, nearly

one half of the whole number, but there is a gratifying increase in the number of those that have existed less than one year.

Every person has, so to speak, a superfluous amount of hearing, which he may lose before his hearing is sufficiently impaired to annoy him in the common affairs of life. People who spend many hours of the day in noisy places, such as boiler-shops, on board steamships, in the stock-board of Wall Street, 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.

Besides all this, people in general, who have no scruples about confessing to impaired eyesight, very reluctantly admit a loss of hearing. It thus becomes very difficult in many cases to say when an impairment of hearing was first observed.

These causes have conspired, with the general ignorance of the pathology and treatment of non-suppurative aural disease, to render the results of treatment unsatisfactory, as well as to cause patients to consult a physician at a very late stage of their trouble.

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 an ear with a sunken drum-head, immovable chain of bones, dry pharynx, easily permeable Eustachian tubes, is repugnant to all our notions of scientific nomenclature. Whatever may have been the origin or exciting cause of such cases, they cannot be called catarrhal, when their examination shows such a state of things as this.

Gruber 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. This criticism has also been made by Politzer.

My classification is founded upon 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 term 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.

Since the publication of the first edition of this work, the term chronic non-suppurative inflammation, has been widely adopted in Great Britain as well as in this country, and some authorities have also accepted the term proliferous, in the sub-classification.

Some authors and practitioners would admit another classification, based upon the parts involved, and speak of chronic myringitis, or chronic inflammation of the membrana tympani, of the tympanum, 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, as for their effect upon the cavities into which it opens. When air-bubbles are crackling in the cavity of the tympanum, as in catarrhal inflammation, or when the tube is greatly narrowed by the hypertrophy of its lining membranes, but at the same time we have, as we always do, in the latter case, a sunken drum-head, an altered light spot, signs of proliferous inflammation of many of the structures making up the middle ear, 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 then used as a complete substitute for the catheter, when in my opinion, indispensable as it is, its chief value 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. Those who suffer from hay fever, are very apt in time to be affected with chronic catarrh of the middle ears. The disease is, therefore, unlike its companion, proliferous inflammation, not at all insidious in its approach. The patient suffering from this disease, who consults us about his hearing, is usually aware that there is an excess of secretion in his pharynx, and that for years he has been annoyed and troubled by being obliged to use a handkerchief very freely, and by feelings of fulness referred to the frontal sinus and tympanic cavities. There is often, also, at times, a sound in the ear like the crackling of air-bubbles. The voices of friends appear muffled; and it is hard for the victims of chronic aural catarrh, when the disease is advancing, not to believe that every one is speaking in a much lower tone than is usual for them. Such patients often complain bitterly on this subject, and will scarcely admit that their hearing is at all impaired, or, if so, they stoutly assert that it is one ear only, when the fact is, that, with one perfect ear, it is only under peculiar circumstances, certainly not in ordinary conversation, in front of the patient, that a person will be observed to be at all hard of hearing.

There is a feeling about this that is different from that expressed about diseases of the eye at least, 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 sometimes 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 affections of the labyrinth and in cerebral disease. When vertigo occurs in aural disease, it is a consequence of increased pressure upon the labyrinth through the fenestra ovalis or of an affection of the labyrinth or brain. It is by no means a serious symptom, when the cause is to be found in the middle ear, for it is usually relieved by a mechanical treatment through the Eustachian catheter. There are many cases in my note-book which illustrate this, but none more striking than the following :

A physician once consulted me 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, ten years or more since he consulted me.

The subject of aural vertigo has been very much confused by the disposition, especially found among neurologists, to attach the name of "Ménière's disease" to every case of aural disease in which vertigo is a symptom. This will be more fully discussed in a subsequent chapter, but it may be well to say here that vertigo occurs at times in such a large variety of aural cases, that it would be well to abolish the name of Ménière's disease, except with reference to those cases where the origin of the vertigo is undoubtedly in the labyrinth, and where it is not plainly secondary to an affection of the auditory canal or middle ear. As now used it describes nothing, and leads to

want of exactness in the diagnosis. I have just dismissed from my care a young woman, who became very ill from acute catarrh of the middle ears, accompanied by vertigo, the tendency being to pitch forward. By the use of leeches, blisters, and inflation of the middle ears the symptom of vertigo was relieved in twenty-four hours, and disappeared wholly in two days. The leeching and the inflation both afforded immediate relief.

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.

Tröltsch [1] relates a case from Meyer, of Hamburg, where a melancholic person was relieved of a sound in the ear, seeming to him to be the cry of a child, by the removal of a plug of cerumen, which caused deafness on one side. The patient made a rapid and complete recovery from the mental affection, after the cerumen was removed. It is the opinion of Schwartze,[2] 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 [3] 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

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[1] Text-book, second American edition, p. 531.

[2] Loc. cit., p. 532.

[3] New York Medical Journal, August, 1869.

few months after, by blowing out his brains. A few years since a gentleman, a public-school teacher, consulted Dr. Charles S. Bull, while he was in charge of my patients, in regard to a suppuration of the ear, which caused considerable impairment of hearing and great tinnitus. He was exceedingly depressed 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,[1] 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 not in so large a proportion as stated by Schwartze and Koppe.

Dr. C. E. Wright[2] published a case of a patient in the Indiana State Asylum for the Insane, who attempted to destroy herself by putting a steel button in her ear. The patient was discharged from the hospital, as having recovered her reason, but became nervous and despondent, until she was relieved by the removal of the button; and a dread of insanity and of sudden death, from which she suffered, then also disappeared.

Tröltsch speaks of confusion of the intellect, an inability to keep up a connected line of thought, as a subjective symptom of chronic aural disease, 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 celebrated writers, have suffered from boyhood with chronic inflammation of the middle ear and tinnitus aurium.[3]

The sounds in the ears, of which patients speak, are variously described; some speak of a ringing of bells, which is per-

[1] Transactions of the American Otological Society, Fourth Year, p. 46.

[2] Indiana Journal of Medicine, November, 1871.

[3] The late Dr. George M. Beard, has often told me of the tinnitus aurium with which he was affected. He had chronic non-suppurative inflammation and described the noises in his head, in graphic style. They never, however, dampened his cheerful and humorous temperament.

haps the most aggravating form; others have likened them to the murmur of trees, the hum of a tea-kettle, etc. 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.

Tinnitus aurium is usually, although not always, a subjectively disagreeable symptom. Sometimes, however, it is not unpleasant to the patient, but it may accompany its subject as a pleasing musical concert. One of my patients, a young woman having *tinnitus aurium* as one of the symptoms of disease of the middle ear, kept a record for me of what she heard "in her head."

February 13th.—Morning, C sharp, B flat, F sharp in right; B in left. Night, E flat, C flat.

February 14th.—Morning, E flat, C flat. Night, C sharp, B flat, F sharp.

February 15th.—Morning, C sharp, B flat, F sharp. Night, C sharp, B flat, F sharp.

February 16th.—Morning, C sharp, B flat, F sharp. Night, F sharp, E flat.

February 17th.—Morning, E, C sharp, A. Night, D, B, G, and so forth.[1]

Mr. Hinton[2] regarded tinnitus of a distinctly musical character as a sign of nervous affection. One man spoken of by him was subject to sudden attacks of loss of hearing with singing noise, and also complained of dimness of vision. "Dark specks" were found upon the yellow spot.

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[1] American Journal of the Medical Sciences, Vol. LXVIII., p. 378.

[2] The Questions of Aural Surgery, p. 286.

Thus far I have been speaking of subjective tinnitus, of sounds of which the patients give graphic descriptions, as being in their head, but of which the physician can know nothing except from these narrations. There is also an objective tinnitus aurium, usually intermittent in character and of a crackling nature. It is a rare symptom, and is always, as far as my experience goes, very distressing to the patient. In one case, where a crackling and intermittent sound could be heard in the ear both by myself and the patient, the victim was driven into insanity and suicide by failure to get relief from it. This kind of noise in the ear is, I believe, dependent upon abnormal action of the tensor tympani, stapedius, or of the muscles of the Eustachian tube. I have known the symptom to disappear when the disease in which it arose—sub-acute catarrh—was relieved, but I have never known it to be benefited by any treatment when it occurred in conjunction with chronic naso-pharyngeal catarrh.

Ordinary tinnitus should also be distinguished from a venous murmur transmitted from the jugular vein, which runs just beneath the floor of the cavity of the tympanum, and from the pulsating sound of the internal carotid as it winds through the apex of the petrous bone. This variety of tinnitus, is not necessarily connected with impairment of hearing, but is usually dependent upon anæmia or aneurism.

The cause of the common form of subjective tinnitus aurium has been much discussed, but we are yet without any exact knowledge as to how it is produced. We do know, however, in what diseases it is usually found as a constant symptom. It is a very common, almost universal, attendant of chronic non-suppurative disease, and is most distressing in the proliferous form, when it forms the chief complaint of the unfortunate subjects. It also occurs in inspissated cerumen, in acute and sub-acute catarrh of the middle ear. It is not a prominent symptom in chronic disease of the labyrinth, or at least patients do not speak of it as being very hard to bear.

Reasoning from the standpoint of the diseases in which the ordinary subjective tinnitus aurium is generally present, I have always considered it to be a symptom indicating pressure upon the vessels of the tympanum and labyrinth. Dr. Theobald[1] seeks to explain the nature of tinnitus aurium by stating that it is due to "the existence of vibrations exerted in the walls of the blood-vessels of the labyrinth by the friction attending the circulation of the blood." I have found the reasoning of Field, of

[1] Transactions of the Medical and Chirurgical Faculty of Maryland, April, 1875.

London, as to the cause of tinnitus very clear. He believes, as I do, that any impairment of the "pressure equilibrium" of the ear will be a cause of tinnitus. He has illustrated this thesis in a very satisfactory way. He remarks, abnormal pressure of the air in the external auditory canal producing increased pressure upon the endolymph of the cochlea will cause it, just as a sudden striking of the key-board of a piano will set in "discordant vibration every note that it is capable of producing." Thus anæmia and hyperæmia, Mr. Field observes, are powerful agents in modifying *pressure equilibrium.* Overfilled arteries and arterioles cause undue pressure on the peri- and endo-lymph and excite tinnitus.

The tinnitus from quinine, salicylic acid, wintergreen, and so forth, may thus be explained.

The decrease in the pressure of the blood-vessels in anæmia is also called in by Mr. Field, to explain tinnitus, and he gives the familiar illustrations of chlorotic young women, and patients who have suffered from great hemorrhages, as examples, to which may be added the singing in the ears experienced in syncope. I have long taught this theory of increased pressure, as the chief cause of subjective tinnitus aurium, and I am very glad to give a new circulation to Field's more amplified and better view of the disturbance of pressure equilibrium, as that which causes an abnormal vascular tension or lack of tension, and thus becomes the essential cause of tinnitus.[1]

Patients suffering from chronic catarrhal inflammation of the middle ear usually speak of the throat as troubling them quite as much as their ears. In many cases, however, they say nothing whatever about the throat, and even if asked about it, they will insist that it is quite well, although they will often admit that they raise a great deal of mucus in the morning, and that they have sore-throat very often. The greater number of patients with aural catarrh complain greatly of the condition of their pharynx and nostrils, and, under the stimulus of the advertisements and books of charlatans, have generally very much to say of *the catarrh*, although they do not always trace a connection between the throat disease and that of the ear.

There are very many other symptoms than these which have just been enumerated—feelings of fulness, confusion of intellect, vertigo, tinnitus, and neuralgic pains—of which patients with chronic catarrh of the middle ear often complain; but they are not always dependent upon the aural disease, and the examiner

[1] London Medical Times and Gazette, June 8, 1878. Also, Diseases of the Ear, p. 208 et seq.

may often throw many of them out of consideration, and bring the patient back from the long story of headaches, dyspepsia, and so forth, by asking whether, after all, if the ear and throat were well, they would not consider themselves in good health, when an affirmative answer is often given.

### SUBJECTIVE SYMPTOMS OF PROLIFEROUS INFLAMMATION.

If we now turn to the picture of the subjective symptoms of what 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 earaches, frequent coryzas, or to naso-pharyngeal catarrh. It is a peculiarly insidious affection, one which is usually under full headway, and which essentially impairs the function of hearing long before the patient is aware that he has any affection of the ears. The pathology of the disease, 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.

Chronic catarrh of the middle ear, as well as proliferous inflammation may also exist in connection with chronic disease of the labyrinth. The practitioner should not be too ready to conclude that the predominant or chief affection in a given case of impairment of hearing, is to be found only in the middle ear, simply because the patient has a naso-pharyngeal catarrh, and is hard of hearing. There are means to distinguish these affections, of which I shall speak fully before finishing this subject.

### OBJECTIVE SYMPTOMS OF CATARRHAL INFLAMMATION.

The objective evidences of chronic catarrhal inflammation of the middle ear, may be classified as follows :

1. Impairment of hearing.
2. Changes in the membrana tympani.
3. Imperfect action and changes in the structure of the Eustachian tube.
4. Capability of hearing better in a noise than in a quiet place.
5. Better conduction of sounds through the bone than through the air.
6. Naso-pharyngeal inflammation.

If we exclude the latter, we have also the objective symptoms of chronic proliferous inflammation.

### *The Differential Diagnosis of Chronic Non-suppurative Inflammation of the Middle Ear from a Disease of the Labyrinth.*

The tuning-fork is 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 are sometimes in doubt as to whether we are dealing with a peripheric or central disease.

Starting from the well-established fact, that, if the auditory canal of a person having healthy ears be closed by the finger, or in any other way, the sound made by a vibrating body is heard more distinctly on the side of the head where the ear is closed, it has been shown that, in most diseases of the auditory canal and middle ear, such vibrations are more distinctly felt on the affected side, or, if one be diseased, that they are heard more distinctly on the side of the ear affected, and on which the ticking of a watch or the sound of conversation is not as well heard.

The differential diagnosis between a chronic proliferous inflammation of the middle ear, and an affection of the acoustic nerve is important and often difficult. It is important, for while local treatment of a proliferous inflammation of the middle ear is often beneficial, such a treatment applied to an affection of the nerve is always useless and generally harmful. Certainly it adds

to the annoyances of the patient. The differential diagnosis is sometimes difficult, because a secondary affection of the nerve often exists in connection with chronic non-suppurative inflammation of the middle ear. But, as I hope to show in this chapter, and in those upon "Diseases of the Internal Ear," some of these difficulties have been removed, so that we may now more readily make a diagnosis than was formerly possible. The tests which were formerly exclusively used to differentiate between diseases of the middle ear and of the nerve, and which have just been described, I have of late, as was said in chapter second, practically abandoned, not because they were not valuable, but because the *test of the aërial and bone conduction* is much more easy to carry out, and is more certain. When both ears are diseased, it is often difficult for a patient to say whether or not he hears a vibrating tuning-fork better in one ear than the other, but the most stupid person can easily determine whether a vibrating tuning-fork is heard better through the air, when held in front of the meatus, or through the bone when placed on the mastoid process. Now I believe it is a rule without exception, that when the tuning-fork C is heard louder and longer through the bones than through the air, the predominant disease is one of the external or middle ear. Of course, the external ear may be readily excluded or included, by ocular examination. There may, however, be predominant disease of the middle ear, when through any cause,—wax in the canal, mucus, blood, serum, or pus in the tympanum,—abnormal pressure is made upon the peri- and endo-lymph, *and yet the tuning-fork be heard better through the air.* When the pressure is removed, if there be remaining disease of the middle ear, the tuning-fork C will be heard better through the bones. This is beautifully shown in the examination of boiler-makers, who become hard of hearing from their noisy occupation, and acquire disease of the nerve. They are of course also liable to disease of the canal, such as inspissated cerumen. Before the wax is removed in certain cases, the bone conduction is better, but on removing this, the hearing power remains impaired, but the tuning-fork is heard, as it always is heard in disease of the nerve, better and longer through the air. The table showing the results of examination of boiler-makers in the chapters on "Diseases of the Internal Ear" will show this.

The only difficulty then, in the test with the tuning-fork is that we cannot always tell on the first examination, when the tuning-fork is heard better through the air, whether this be due to pressure upon the labyrinth from temporary causes, or to intrinsic disease of the nerve.

By temporary causes, I mean an accumulation of wax in the canal, or of mucus, pus or blood in the tympanum. These being present, pressure may be made upon the labyrinth, and cause the aërial conduction to be temporarily better than that through the bones. We cannot, therefore, in some cases when we find better aërial conduction, determine at once, that it may not be due to disease of the canal or middle ear. We may be obliged in some such cases, to make more than one examination before we come to a positive conclusion. With better bone conduction, however, we have no such difficulty—and with constant use of the tuning-fork in diagnosis, we become more and more confident and exact in our deductions.

Some years since, I suggested a new test with the tuning-fork, which is stated in the following proposition. Generally true, as I believe it will be found, I have abandoned its use also for the simpler test of the aërial and bone conduction.

If, under the same conditions of a sound ear on one side, while the hearing power of the other is impaired, the tuning-fork be not heard better in the worse ear, even if the meatus be stopped by the finger or the like, there is disease of the labyrinth, the acoustic nerve or brain.

I employed the older tests, until constant examinations have convinced me, that the one as to the *aërial and bone conduction* is the most reliable and easiest to conduct of all those, that have resulted from Müller's first experiments.

I now use the tuning-fork simply to determine which is better, the aërial or the bone conduction. At my clinics, where I have a class of practitioners, I have invariably found that it is considered a simple and adequate test, by those who have seen it employed upon almost all kinds of patients. It is indeed a very simple thing to determine whether the vibrations of a tuning-fork are heard better through the air, or through the bones, and this is the gist of the test. In some cases it is well to also test the time during which the fork is heard. A simple way of doing this is to place it upon the bones, after the patient says it is no longer heard through the air, or *vice versa*. In many instances, however, a stop-watch and a test of the duration in each position, are necessary to an accurate idea as to the relative intensity of aërial and bone conduction.

After having, in the doubtful cases of the proliferous variety, settled the fact as to whether we have an affection of the middle ear or of the labyrinth, the ticking of the watch and ordinary conversation become the natural tests as to the impairment of hearing.

The watch is an inadequate test, for the reason that has

already been mentioned in the introductory chapter, that is, that some persons can hear a watch quite a number of inches from the ear, while they hear conversation very badly. Lucae explains 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 which are usually better heard than low ones. But, there are cases where speech is heard much better than the tick of a watch. Careful observation of the lips of the speaker, by the person whose hearing is defective, may have something to do with explaining this class of cases. Excluding these, however, I have become convinced that there is disease of the acoustic nerve, when conversation is heard relatively better than the tick of a watch. I have come to this conclusion, because I have almost invariably found this symptom in connection with others that indicate an affection of the nerve.

In commenting upon Lucae's explanation of the occasional disproportion, between the power of hearing the watch and conversation, Politzer remarks that he believes it to be due to the fact that in anchylosis of the stapes, the membrane of the fenestra rotunda often remains normal. If this be not thickened, he goes on to say, that simple tones and noises may be transmitted without difficulty through the air of the tympanum to the membrane of the fenestra rotunda, while speech can only be perfectly transmitted through the ossicles. "The greater the impediment to the conduction of sound through the ossicles, the greater is the impairment of hearing for speech."[1] This explanation is perfectly consistent with my experience, for I have found an adhesive process in the tympanum more destructive to the hearing power for speech, that is for ordinary conversation than a disease of the labyrinth. Deaf mutes, who are usually deaf from adhesive inflammation of the middle ear, are striking examples of persons deaf to speech, although they may hear sounds and noises through the bones.

### BETTER HEARING IN A NOISE.

Persons affected with disease of the middle ear, uncomplicated by secondary disease of the labyrinth, hear better in a noise than they do in a quiet place. This is true of acute, sub-acute, and chronic disease. But it has only been especially commented upon when occurring in chronic non-suppurative cases. Consequently it has often been mistakenly assumed, that it is always

[1] Lehrbuch, p. 394.

a very unfavorable symptom. It is not necessarily so, but inasmuch as it is chiefly observed in cases that are actually incurable, it is not at all strange that it has been so considered. I believe that important deductions can already be made as to the situation of the nature of the lesion that causes the impairment of hearing in a given case, from this symptom, and I also hope that from a right interpretation of it, may yet come an invention to improve the hearing power of a large class of persons. For these reasons, I shall be quite full in my account of this symptom.

In the collected works of Doctor of Medicine Thomas Willis, published in Amsterdam, a little more than two hundred years ago. in a chapter upon the sense of hearing, and in a paragraph relating to deafness caused by relaxation of the membrana tympani, there is an account of a somewhat famous woman, who could only hear the voice of her husband when a servant was beating a drum in the same room.[1]

Although this passage is often alluded to, it is seldom quoted. No apology will, I think, be required for a translation of it.

"Although hearing is very little produced by the membrana tympani as compared with the proper organ of the sense, yet it so far depends upon it, that deprivation or diminution of that sense not infrequently proceeds from its injury or impeded action. Indeed, a certain kind of deafness occurs, in which, although the patients seem completely to lack the sense of hearing, yet so long as a great din, such as that of bombardments, or of chimes of bells, or of drums, resounds about their ears, they take in distinctly the conversation of those about them, and answer questions intelligently, but, upon the ceasing of such tremendous uproar, they immediately become deaf again. I once had it from a trustworthy man, that he had been acquainted with a woman,

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[1] Archives of Otology, vol. xii., No. 2, June, 1883. The original reads as follows:

*Quanquam auditus à tympano, velut proprio sensionis organo, minime peragitur, tamen iste in tantum ab hoc dependet, ut non raro à tympani actione læsa, aut impedita sensus illius privatio, aut diminutio procedat. Enimvero surditatis species quædam occurrit, in qua licet affecti au itus sensu penitus carere videantur, quam-diu tamen ingens fragor, uti bombardarum, campanarum, aut tympani bellici, prope aures circumstrepit, adstantium colloquia distincte capiunt, et interrogatis apte respondent, cessante vero immani isto strepitu, denuo statim obsurdescunt. Accepi olim à viro fide digno, se mulierem quæ licet surda fuerat, quousque tamen intra conclave tympanum pulsaretur, verba quaevis clarè audiebat; quare maritus ejus Tympanistam pro ferro domestico conducebat, ut illius ope, colloquia interdum cum uxore sua haberet. Etiam de alio Surdastro mihi narratum est, qui prope campanile degens, quoties una plures campanæ resonarent, vocem quamvis, facile audire, et non alias potuit. Proculdubio horum ratio erat, quod tympanum in se continuo relaxatum, soni vehementioris impulsu ad debitam tensitatem, quo munere suo aliquatenus de fungi potuerit, cogeretur.*

who, although she was deaf, would, nevertheless, distinctly hear whatever was said so long as a drum was beaten within the room, and consequently her husband employed a drummer as a household servant, in order that by his aid he might occasionally hold conversations with his wife. I have also been told of another deaf person, living near a bell-tower, who could easily hear any voice whenever the bells were pealing—but not otherwise. Doubtless the reason of these things is, that the membrana tympani, habitually relaxed when left to itself, was forced by the shock of a sound much more intense than usual, to a state of tension sufficient to enable it to perform its function in some degree."[1]

In the two centuries that have followed the narration of Willis's observations, the symptom of hearing better in a noise, has not only been given the name of the author, and is known in our time as *Paracusis Willisiana*, but the facts as stated by the author, have in turn been denied and affirmed, and while many have admitted the truth of the observations, and have conceded that there are some persons with impaired hearing who hear better in a noise, Willis's explanation of the phenomenon has been rejected by them. The writers on aural medicine who allude to it at all, are by no means agreed upon the facts nor upon their explanation. Wilde[2] admits the credibility of Willis's cases, and argues against the notion of Kramer, that the auditory nerve became so excited by these loud sounds as to be able to do its work better. Wilde explains the phenomenon by reference to the state of the membrana tympani, and says that it is remarkable that it does not occur in cases where that structure has been in whole or in part removed. Later on, I shall show that Wilde was in error in thinking that it could not occur when there was a hole in the drum-head.

Tröltsch[3] says: "These statements (as to hearing better in a noise) are founded, as a rule, upon a want of exact observation, as well as upon self-deception." He then relates one of Willis's cases, and also one reported by an author named Fielitz. The latter was that of a deaf son of a shoemaker, who could only hear conversation in the room, when he stood near his father and the latter pounded sole leather upon a large stone. This same boy, heard well in a mill when it was in action.

I cannot agree with Tröltsch, in his idea that the symptom of hearing better in a noise is not a common one. As I have said on several occasions, my own experience has proven that it is a

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[1] Opera Omnia, Amstelædamia, apud Henricum Wetstenium. Pars physiologica, Cap. xiv, p 69

[2] Aural Surgery, English edition, p. 289.

[3] Tröltsch: Lehrbuch, Sechste Ausgabe, p. 253, *passim*.

very frequent one. Rau,[1] like Kramer, believed that better hearing in a noise depends upon excitement of a torpid acoustic nerve. In somewhat poetic style, he says: "If the auditory nerve be awakened from its slumber by loud talking, the patient will momentarily hear even words spoken in a low tone very well. This sometimes goes to such an extent, that the hearing is temporarily restored to a considerable degree by a loud and regular sound, for example, during the pealing of bells, drumming, a ride in a rattling wagon, or the like." Burnett,[2] of our own country, is positive that the symptom is a real one, but confines it to the later stages of chronic aural catarrh, "when the condition of the tympanum has become dry or sclerotic, or when the thickening of the mucous membrane has become great in the moist form."

Dr. E. E. Holt[3] doubts if, in any case the hearing-power is improved by noise, and he states that, so far as he is aware, no one has "ever made a careful investigation to ascertain whether the claim of such persons was a real one or not."

In the first edition of this book, and in all the subsequent editions, I related from my personal experience the case of a mail agent, on one of our railways, who, although very hard of hearing in a quiet place, could hear very well in his car amid the noise of a train. I have had frequent opportunities to study this case, and there is no question as to the facts. No person who did not know of this gentleman's infirmity, would ever suspect him of impaired hearing while conversing in the din of a rapidly going train of railway carriages. But the instant he reached a quiet place, it was with the greatest difficulty, that he could hear loud conversation specially addressed to him.

Politzer has no doubts as to the existence of these cases, and confirms what was stated by me years ago, "that the patients can understand speech during such noises much easier, and at a much greater distance, than people with normal hearing."[4] Politzer, however, states that he has observed this symptom "almost exclusively in the incurable forms of affections of the middle ear."

I have known of two cases where this symptom occurred, in patients who regained their hearing perfectly. While the symptom frequently accompanies incurable disease of the middle ear, I believe it is a very frequent symptom in sub-acute cases, when both ears are affected. Of course, it would not be observed in disease of one ear only. I also have two cases under observation in which the drum-heads are entirely, or nearly removed, and yet these patients hear well in a noise. One of these, I published in

[1] Lehrbuch, p. 292. [2] Treatise on the Ear, p. 386.
[3] Transactions of American Otological Society, 1882. [4] Lehrbuch, p. 233.

the fourth edition of this book. While the occurrence of the symptom in sub-acute cases disposes of the notion that hearing better in a noise implies an incurable disease, the fact that it also may exist when the membrana tympani is gone, shows that Willis's explanation of the phenomenon is not exclusively, if at all, correct. I have never yet seen the symptom except in disease of the middle ear. I believe it never occurs except in cases where the nerve is sound. I have looked over my cases with great care as to this point, and I have yet to see a patient who had, as I supposed, disease of the acoustic nerve, and who yet heard better in a noise. If this be true, the theory of an extraordinary excitement of the nervous apparatus, as a cause of the phenomenon, must be rejected. Buck and Politzer, explain the symptom by a reference to some effect upon the *ossicula auditus*, made by the great din.[1] This is the only theory, incomplete as it is, which fulfils the conditions made by such cases as those just mentioned, where, although the membranæ tympani were gone, the ossicula were intact. How the ossicles are affected is a problem yet to be solved, but when it is solved, it will be possible to invent an instrument to enable those deaf from disease of the middle ear, to hear conversation not only in a noise, but in the quiet of an ordinary room. This latter will, certainly, not be a task beyond the capabilities of a physicist of the nineteenth century. These cases are not at all rare. They are very common. The proof is overwhelming that a large class of persons with impairment of hearing not only hear *better*, but hear perfectly well, in noisy places.

The statement, that these cases rest upon inexact observations, will soon be disproven by a ride of a few miles in a railway carriage or in a clattering wagon, with a person deaf from disease of the middle ear, to ordinary conversation in a quiet place. Examinations of boiler-makers, or of those who suffer from affections of the acoustic nerve, will, however, be disappointing unless they are carefully analyzed, and will lead, as in Dr. Holt's paper, from which I have already quoted, to a doubt in the mind of the observer as to the reality of the symptom. I now quote one of the cases in which the hearing was better in a noise, and which was one of sub-acute catarrh of the middle ears, from which the subject fully recovered under my observation. The writer of his own case is now a practising physician in this city. At the time of the occurrence of the disease he was a boy in school, and I reported his case, except as to the symptom now under discussion, in the *American Journal of the Medical Sciences*[2] and in the first edition of this book. Dr. B—— writes to me as follows:

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[1] Medical Record, July 5, 1875.

[2] Vol. lii., p. 64.

With regard to the disputed fact of many deaf persons hearing conversation better in noisy places, I wish to give in brief my experience. For several years previous to my sixteenth, I had been much troubled with varying degrees of deafness, due, as I then heard and now understand, to acute catarrh of the middle ear, complicating general pharyngeal catarrh. At school I was at a great disadvantage, suffering at times great embarrassment on account of my limited hearing. Living far up-town, I was in the habit of being driven home or to the doctor's by my mother. When surrounded by the noise of wheels and glass, I invariably had occasion to request a moderation of her voice; and she not infrequently made the remark: "How well you hear in the carriage!" Furthermore, on several occasions, my parents were surprised to find that they could not safely carry on a confidential conversation requiring only sound enough to suffice their own hearing powers, while in a quiet room their talk would have been unintelligible.

This is only an echo of the experience of many deaf people I have questioned on the subject.

The other case was that of a student, of seventeen years of age, and is so similar to the one just given, that I simply allude to it. As I have already intimated, the power of hearing better in a noise is a different subject from that of the effect of certain noisy occupations upon the ear. Patients like my friend, the mail agent, may travel for years in the din of a train, and always find their hearing improved and not decreased, so long as it depends upon disease of the middle ear. Neither do I know of any cases of deafness that have been caused by such occupations. But although there is a class of patients who have been made deaf by noise, often confounded with those whose impairment of hearing has resulted from catarrh, they should be entirely disassociated from them. Boiler-makers, and those who become deaf from an exposure to the continuous shock of loud sounds, suffer a lesion of the acoustic nerve. These patients do not hear better in a noise, but they have a source of relief in quiet places, and, like ordinary people, they hear better away from the din that is such a comfort to a person deaf from many forms of disease of the middle ear.

I must confess to have assisted in the creation of confusion in our ideas as to hearing better in a noise, and the effects of noise upon the ear. In 1874, in one of the editions of this work, I gave the results of my examinations of a certain number of boiler-makers, and I incidentally assumed that they heard better in the noise of their occupations. When the paper by Dr. Holt, to which I have referred, appeared, I found that he denied the correctness of my main conclusions; that is, that the impairment of hearing in boiler-makers is generally a result of a lesion of some part of the labyrinth, and that, besides his doubt that any deaf person, much less boiler-makers, ever heard better in a noise, he was inclined to attribute their impairment of hearing to a disease of the middle ear. I then made a new series of ex-

aminations upon boiler-makers, assisted by Dr. J. B. Emerson. As a result of these recent investigations, which were undertaken with the much better means of a differential diagnosis between diseases of the middle and internal ear, now at our command, I find that I cannot agree with Dr. Holt's conclusions, except in one particular, and that is the one just mentioned, *i.e.*, that boiler-makers do not hear better in a noise. This incidental statement made by me, I now find to be entirely incorrect. But that boiler-makers do suffer from a lesion of the internal ear, and not of the middle ear, in so far as they have a peculiar affection from their occupation, I do not think admits of a doubt. The very fact that they do *not* hear better in a noise is an incidental proof that they suffer from a lesion of the labyrinth. Boiler-makers, like men in other occupations, often have impacted cerumen, and occasionally catarrh of the middle ear, but the disease caused by their occupation, "boiler-makers' deafness," in my opinion, is easily shown to be a disease of the labyrinth. Other occupations of a similar nature, that is, occupations amid continuous concussions, undoubtedly cause the same lesion. A recent visit to an establishment where two engineers were employed for the production of electric light, showed me that they had become somewhat hard of hearing, since they had been engaged in an occupation exposing them to the sound of regular concussions from the striking of metallic plates together.

The confusion which I assisted in producing upon the subject was not, however, as regards the seat or cause of the aural lesion, but as regards the ability of these workmen to hear better in the din in which they labor. It will perhaps be remembered that it has just been stated that those who hear better in a noise always suffered from some form of disease of the middle ear. When some years of observation had convinced me of the uniformity of this rule, I was puzzled to account for my cases of so-called boiler-makers' deafness, which, in my paper upon this subject, I had assumed were also improved by being in a noise. I had said: "It will be observed that the subjects of it (boiler-makers' deafness) hear very well in the tremendous din of a boiler-shop, while they are quite deaf in an ordinarily quiet place."[1] This remark, I am constrained to say, although in the other editions of this book, is strikingly incorrect. Boiler-makers, as we should naturally believe, are no exception to the rule, that those who have disease of the nerve hear worse in a noise. Boiler-makers hear so badly in their shops that they

[1] Treatise on the Ear, third edition, p. 510.

have a language of signs that is quite elaborate, called a "boiler-makers' language." They hear no better in a noise than do people with sound ears; on the contrary, they hear better in a quiet place.

If, however, a person deaf from disease of the middle ear, who hears better in the noise of a railway train, enters a boiler-shop, that person will hear better than the boiler-makers, or than persons with sound ears.

It is only very recently that I have been able to send a patient suffering from chronic disease of the middle ear, who heard well in a railway carriage, to a boiler-shop. I had predicted, that although boiler-makers with disease of the acoustic nerves and persons with sound ears, hear very badly in the dreadful din, such a patient would hear well in such a place.

The patient whom I sent is a lady of about thirty years of age, who has had chronic disease of the middle ears, of the proliferous form, for many years. She cannot hear the watch at all, and conversation only when directed into the ear, and then with difficulty. In the cars she hears very well. She only hears the tuning-fork by bone-conduction. Her account of the experiment is as follows:

"I went with my husband (he has excellent hearing) this afternoon to the boiler-shops of the Dickson Co. (Scranton, Pa.), where the noise is perfectly deafening. I could distinctly hear what my husband said, although he purposely spoke in a low tone, while *he* could not hear a word I said, unless I put my mouth to his ear and screamed. I think, perhaps, cars and boiler-shops are the places for me to live." In a subsequent note she informs me that she could not hear the watch tick, although she hears conversation so easily.

In this case it will be noted that the improvement does not depend upon the loud tone of the speaker.

The fact that most patients suffering from disease of the middle ear hear better in a noise, especially that of a railway car, I find as a result of a series of examinations extending over many years, and embracing several hundreds of cases. Wherever this symptom is not present, I have found that either the disease was primarily or secondarily one of the labyrinth or acoustic nerve.

I have gone with such patients to a train in motion, and I have always found their statements correct. From hearing a voice with difficulty directly in the ear, they have been enabled to hear it twenty feet, that is to say to hear conversation at that distance and with ease. In my experience they do not always hear a watch tick farther, but most of these marked subjects

hear a watch a very short distance, if at all, in a quiet place. There is, I think with Politzer, sometimes an improvement in this respect also.

I have also made many tests in my clinic, in the following manner, for the purpose of demonstrating this phenomenon to my class. I have first tested the perception of sound by aërial and by bone conduction. I have then made the room as quiet as was possible, and tested the capability of the patient for hearing conversation. Then the room has been made as noisy as could readily be done by moving chairs on the tiled floor, rapping on walls and tables, and so forth, and I have again tested the hearing. Invariably have I found, that when the tuning-fork was perceived on both sides better through the bones, that the power of hearing was better in a noise, and also that the reverse was true. The result may be formulated as follows :

*Bone-conduction better.*
*Better hearing in a noise.*
*Disease of middle ear.*

*Aërial conduction better.*
*Worse hearing in a noise.*
*Disease of acoustic nerve, either primary or secondary.*

This symptom would often be found in acute disease of both sides did such diseases last long enough to admit of proper tests. To say that the whole explanation is to be found in the fact that the voice is raised when in a noise, is to forget that even in a quiet place, with just such an elevation of the voice, these patients do not hear as well as they do in the noise. Besides, the elevation in the voice is usually only slight, and sometimes there is none at all.

I have yet to find a case where a mistake was made in a deliberate statement by a patient, that conversation was heard better in a noise. When the symptom does occur, it is so marked that no mistake can be made. When a patient does not know whether he does or does not hear better in a noise, we may assume that he does not, and when he does not, the case will, I think, always be found to be one in which the nerve is somewhat involved.

From all the observations I have been able to make upon this subject, I think I am justified in drawing the following conclusions :

1. There is a large class of people suffering from impairment

of hearing in quiet places, who hear very acutely and with comfort amid a great din or noise.

2. The disease causing the impairment of hearing thus relieved is situated in the middle ear. It is usually observed in the chronic, non-suppurative form of disease of the middle ear, but it may also be found in acute or sub-acute catarrh of this part, as well as in a chronic suppurative process with loss of the whole or a part of the membrana tympani.

3. The proximate cause of this phenomenon is not as yet positively known. It is probably to be found in some change in the action of the articulations of the *ossicula auditus*.

If a physicist can give us an instrument which, being placed in the auditory canal, will produce sound enough to act upon the ossicles, as does a great noise in a room, or the noise of a railway train, we shall have found magnifying lenses for the deaf.

## 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 labyrinthine wall of the cavity of the tympanum. I think, however, that we very rarely find an absolute sinking inward of the membrane, unless attended by some impairment of hearing. A sunken drum-head, that is, one in which the head of the malleus stands out like a miniature button, while the whole membrane seems collapsed and sunken,.is 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 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 Tröltsch and Politzer we are 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 observations 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 is seen through it, and it may be quite dull and hazy in appearance.

The light spot at the end of the malleus is usually triangular in shape, although not always. It is, perhaps, always present in some form if the hearing be normal. The head, handle, and short process of the malleus are plainly visible. There may be opacities at the margin of the membrane, where, as Tröltsch showed, the mucous membrane is thickest. The gray color may be modified by a delicate pinkish injection along the periphery of the membrane and handle of the malleus.

It is not uncommon to find chalky spots or points of calcareous degeneration in the membrana tympani. They are found not only in the ears of persons with impaired hearing, but also in those whose hearing power is acute. Undue weight should, therefore, not be attached to these appearances.

Von Tröltsch[1] 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[2] 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-sup-

[1] Politzer: The Membrana Tympani, p. 58.

[2] Loc. cit.

purative 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 was not very thick, the integument was quite easily separated from the calcified parts. The mucous layer was a little more adherent. In some cases both the external and middle layers were involved in the calcific process. Politzer once found a true osseous deposit, together with the calcareous degeneration, in one of his cases. Black or dark brown pigment was also found by him and fat-globules everywhere.

An acute catarrh of the middle ear in childhood, is sufficient to change the color or curvature of the membrana tympani, and thus render it impossible to say that we are dealing with a normal membrane. The membrana tympani of the child, differs from that of the adult, in being more transparent, while it is rather of a yellowish tinge than gray, and the handle of the malleus is not as distinctly seen.

Politzer 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 in the chapter upon "The Anatomy of the Middle Ear."

Politzer[1] believes that we can form no conclusions as to changes in the cavity of the tympanum and membrana tympani, from alterations in the size and shape of the light spot; but 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 ninety-four ears affected with chronic non-suppurative inflammation of the

[1] The Membrana Tympani, translated by Mathewson and Newton, p. 8.

middle ear, seen at the Manhattan Eye and Ear Hospital, and recorded by Dr. D. Webster—

| | | | |
|---|---|---|---|
| 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). |

In the last hundred cases of chronic catarrhal inflammation of the middle ear, that I have seen in private practice, the following notes as to the light spot were made :

| | |
|---|---|
| Well shaped | 16 |
| Small | 48 |
| None | 17 |
| Two | 1 |
| Interrupted | 8 |
| Fairly shaped | 9 |
| Very broad | 1 |
| | 100 |

The experiments of Magnus in compressed air, which have been alluded to in the chapter on "Injuries of the Membrana Tympani," also prove that the non-existence of the light spot does show, that the membrana tympani is forced or drawn inward.

### CHANGES IN MOBILITY OF MEMBRANA TYMPANI.

If a person, having normal hearing power, forces the air into the cavities of the tympanum by a prolonged inspiration and expiration, with the nostrils closed, he has performed the Valsalvian experiment for testing the permeability of the Eustachian tubes, and, on examination during this act, we find that the membranes moved outward and then inward. This change takes place, in a healthy membrane, chiefly at the apex of the light spot, or extremity of the malleus ; but it may occur in other parts, especially in Shrapnell's membrane. In the catarrhal form of affections of the middle ear, the mobility of the drum-head is not affected to any extent. It may be even preternaturally movable. In the proliferous variety, adhesions are apt to occur between the malleus and the membrane, and between the other ossicula, and these will seriously affect the normal movements of the drum-head and the chain of bones. It is true, however, that mere swelling of the membrane, such

as obtains in the second stage of the catarrhal form, will, to some extent, affect the motions of these parts.

It should not be thought, that the 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 ob-

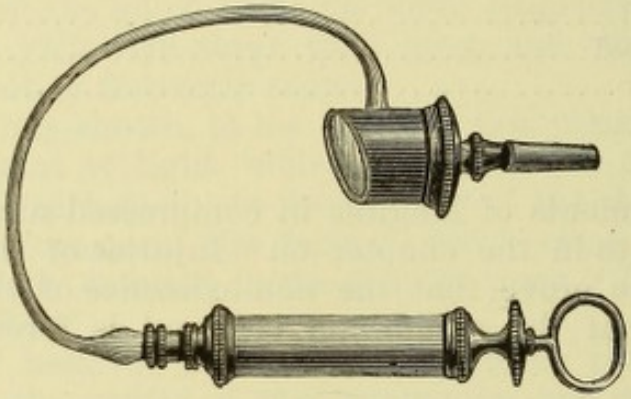

FIG. 83.—Siegle's "Otoscope" with Ely's Attachment of a Syringe.

server. 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.

Siegle's instrument, 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 lips,

while the membrane is carefully watched for its movement, or a syringe may be used, such as Dr. Ely attached to the instrument. Care should be taken that the *speculum*, as it should be called, fit accurately in the auditory canal, so that exhaustion of the air may actually occur. Of course, the otoscope must be used to examine the drum-head through the glass of the speculum.

## CHANGES IN THE EUSTACHIAN TUBE.

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 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.

Dr. Wilhelm Meyer, of Copenhagen, in 1873[1] brought to the

[1] Archiv für Ohrenheilkunde, Bd. I., Neue Folge, p. 254, Bd. II., pp. 129, 241.

particular notice of the profession, a disease of the naso-pharyngeal space, which, although known by reports of isolated cases, seems never to have been adequately studied until Meyer began his investigations. "Adenoid growths in the naso-pharyngeal space" is the title of Meyer's first paper upon the subject. These growths must be known to every practitioner who sees much of naso-pharyngeal disease, but they do not seem to be as common in our country as in Denmark. They are developed in the course of a chronic inflammation of the pharynx. They are of two varieties in shape, follicular or tongue-shaped. The first variety is more common. These cases have been described by Czermak, Türck, Semeleder, Voltolini, and Lowenberg. The latter author

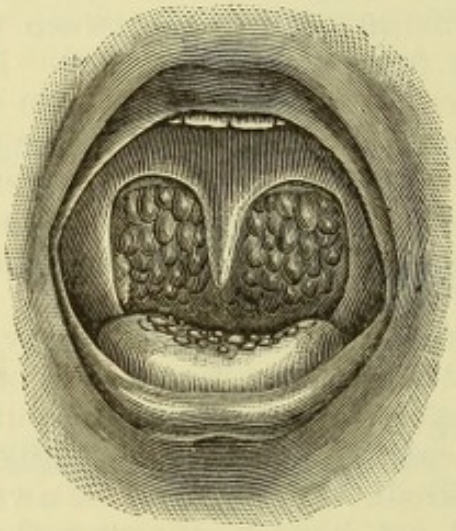

FIG. 84.—Pharyngitis Granulosa. This engraving was made from a drawing, by Mr. G. C. Wright, of the pharynx of a young lady, who had suffered for many years from a chronic suppurative inflammation of the middle ear; but it is a fair type of some of the worst cases of granular pharyngitis, as seen in chronic catarrhal inflammation.

speaks of them under the head of granular pharyngitis, and until Meyer's papers were published they were generally and properly enough comprehended in this title. The microscope, according to Meyer, after the examination of forty different specimens, showed that these growths were of the same structure exactly as the so-called "adenoid tissue" of *His*. When these adenoid growths or vegetations are found in the pharynx, the surrounding parts are intensely injected, swelled, and secrete a delicate, often greenish mucus abundantly. The velum is most swelled, so that it is very much enlarged. The mouths of the Eustachian tube in this disease, according to Meyer, are very often red and swelled, and covered by mucus so tenacious, that it is very difficult to remove it by syringing. In some few cases the mouth of the tube is narrowed to a mere fissure. Most of

my readers can verify this picture of Meyer's from cases they have seen. Of 175 cases observed by Meyer, 130 were associated with disease of the ear. By far the greater number were cases of catarrh of the middle ear, while suppurative inflammation of the middle ear was found in one-fourth of the cases. Of 1083 cases of aural disease observed by Meyer in 1869, 1870, 1871, and 1872, adenoid vegetations in the naso-pharyngeal space were found in about seven and a half cases in a hundred. Meyer cautions us against ascribing too great an importance to these growths as a cause of aural disease, for he recognizes the fact that many of these cases never come under professional observation and treatment, because the subjects of them are sometimes troubled only with a catarrhal throat, for which they do not consider treatment necessary. I have often been surprised at the number of cases of naso-pharyngeal disease of a severe form in which there is no disease of the ear. The intensity of a naso-pharyngeal inflammation seems often to stop at the mouths of the Eustachian tubes. A patient may have chronic naso-pharyngeal catarrh all his life and never suffer from aural disease.[1] There is no doubt since Meyer's investigations, that adenoid vegetations should be distinguished from simple granular pharyngitis, with which it may coexist. These growths affect the physiognomy and the speech, just as do enlarged tonsils. Patients speak "through their nose," say "dose" for "nose," "sogh" for "song," and so forth. The resonance of the voice is very much impaired by enlarged tonsils, and granular pharyngitis, as well as by general hypertrophy of the naso-pharyngeal mucous membrane.

Examination by the finger passed behind the palate is very useful in making a diagnosis of adenoid vegetations. The rhinoscope is of course a valuable aid, but they can usually be detected by simple inspection of that portion of the naso-pharyngeal space to be seen when the mouth is opened.

Meyer's experience, that adenoid vegetations are chiefly seen in youth, is verified by all observers. They are frequently associated with cleft palate, according to Meyer, and Smith and Coles, quoted by him (*Lancet*, 1869, p. 772). Of the prognosis and treatment, something will be said in subsequent pages.[2]

The rhinoscope will be found a valuable assistant in a few cases for an exact diagnosis of affections of the naso-pharyngeal

[1] Beverley Robinson seems also to have noted this. Transactions of American Laryngological Association, 1883.

[2] Meyer's first observations were published in 1868, in Danish, and copied in Schmidt's Jahrbuch for 1869, and as he says with candor, even before this, other observers had published striking cases. They escaped general notice, however.

space. As a matter of fact, however, very few of us who treat a great deal of aural disease, make much use of the rhinoscope. It is only in exceptional cases that we find that its revelations compensate for the time employed.

As I have already intimated in the second chapter, I use much smaller catheters than those usually employed. Large catheters are very difficult of introduction, and their use is generally very painful to the patient. I think one-half the difficulties encountered by the inexperienced practitioner in the use of the Eustachian catheter, will vanish, if he will be content with hard-rubber catheters of small calibre and curve.

Very many of the patients who suffer from pharyngitis 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. There may also be an abnormal position of the septum which renders the canal very narrow and irregular. The manner in which the air passes through the catheter into the tube is deemed by many as of much importance in the diagnosis of chronic catarrhal or plastic inflammation. The passage of a full and strong current almost necessarily precludes the idea of any considerable change in the calibre of the Eustachian tube, unless it be atrophy of its tissue. The mere fact that air can be made to enter the tube, either by the Valsalvian experiment, the Eustachian catheter, Toynbee's or Politzer's 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 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 very much in size. This difference is usually due to a deviation of the septum to one side or the other, in consequence, perhaps, of an injury received when the patient was young, and the bone was soft. In some very rare cases not even the smallest catheter that can be made, can be passed through the nostril of one side. For such cases the catheter has usually been made longer, and introduced through the opposite nostril; but Dr. Noyes,[1] 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 recommends a catheter of double curve for such cases. 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."

Of late years I have scarcely found any cases where a small hard-rubber catheter, after the pattern figured in the second chapter, could not be used, and I have ceased to use the catheter of double curve, or to pass one from the opposite nostril.

In order to test the permeability of the tubes, the subsequent examination of the membrana tympani and the patient's own sensations become important evidences. The membrana tympani may become reddened by the mere application of instruments to the external canal, and to the mouth of the tube, so that we must be careful to exclude such sources of error.

The diagnostic tube of Toynbee, by means of which we listen to the sounds of the air passing through the tube up to the drumhead, is also thought by many to be of assistance in determining the patency of the tube and the size of the cavity of the tympanum.[2] Kramer claimed to determine, by the use of the diagnostic tube, the character of "exudation" and the width of the tube. If there is a piercing (*durchgehendes*), near, rattling, vesicular sound, he then diagnosticated the existence of a free exudation. If, however, a sonorous, near, vesicular sound, it is proof that there is no free exudation; if there is a distant, muffled, vesicular sound, then we are dealing with sub-mucous exu-

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

[2] See engraving on page 73.

dation, 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 was 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 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.

I think the diagnostic tube could well be dispensed with in aural practice. Whether an Eustachian tube is pervious or not, may be learned much more readily than by listening with the diagnostic tube. The old ideas as to the importance of mere permeability of the tube, have been properly lost sight of, in the study of the nature of the inflammatory changes in the calibre of the tube and in the tympanic cavity. I am unable to get much light as to these points from the use of the tube. Yet I must admit, that some of my colleagues, whose opinion I value very highly, still use it.

## PATHOLOGY.

After the clinical investigations of Kramer and Wilde, the first great advance that was made in otology were the dissections of Toynbee. The museum of preparations illustrative of diseases of the ear, in London, is a memorial to Joseph Toynbee, that will be as enduring as scientific 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,[1] and others, we have verified on the dead bodies diseases that have been diagnosticated in the living one, but in many cases, we have only learned, from the inspection of the ears of the cadaver, what is probably the condition of ears in life.

The pathological appearances in chronic catarrhal inflammation are—

1. Collections of mucus or serum distending the cavity of the tympanum.
2. Thickened mucous membrane.
3. Filling up of the cavity by lymph.

[1] 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. Wendt, quoted by Schwartze, Pathology of the Ear, p. 106.

## 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.
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, by adhesions of the membrana tympani to the labyrinth wall.
11. Hyperostosis of the petrous bone, and anchylosis of both stapes.
12. Atrophy and fatty and fibrous degeneration of the tensor tympani.
13. Thickenings and deposits of lime, and of large round cells in the connective-tissue stroma of the fenestra rotunda.
14. Pseudo-membranous growths, sometimes filling the whole cavity with an irregular network, and sometimes covering the fenestra rotunda, and the tympanic orifice of the Eustachian tube.

These are actual appearances of individual cases, taken from Toynbee's catalogue and from the writings of 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[1] 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."

## CAUSES.

I have endeavored, in recording the histories of about forty-eight 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-suppurative inflammation of the middle ear:

*Remote.*—1. A feeble state of the system, due, for example, to inherited or acquired syphilis, phthisis pulmonalis, and so forth.

2. Defective hygienic management, *e.g.*, neglect of bathing, want of exercise in the open air, lack of proper food, care as to dress, and so forth.

*Proximate.*—1. Repeated attacks of acute catarrh of the pharynx and middle ear, a disease popularly known as earache.

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[1] Lehrbuch der Ohrenheilkunde, S. 516. Wien, 1870.

2. Naso-pharyngeal inflammation.
3. Diseases of the lungs and bronchial tubes.

These proximate causes are chiefly to be made out in the catarrhal form of chronic inflammation, while in the proliferous form, the practitioner is often greatly in doubt, as to what may have been the origin or exciting cause of the insidious affection which goes on so steadily to change of structure and loss of function. Indeed, we are often obliged to be content to acknowledge the fact of change of structure without being able to definitely assign a cause for it. Why the changes that make up a true case of proliferous inflammation, or one of a bastard form in which the proliferous element predominates, continue to advance in spite of treatment and of proper hygienic management, is one of the most disheartening problems that a practitioner who treats aural disease attempts to solve. It is not strange, that cases of insidiously advancing impairment of hearing, dependent upon illy defined, but positive causes, have excited the minds of physicians to adopt even what may appear to be fanciful means for their cure.

The history of coryzas and earaches, and of chronic sore-throats, is usually distinct enough in chronic *catarrhal* 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 and the tympanic cavity a thickening is left which forms a good basis for a case of gradual and mysterious middle-ear trouble, and with no known cause. In large towns where the system of drainage or

sewerage is sometimes imperfect, foul air may be forced back through the water-pipes, and becomes a cause, often unsuspected, of catarrhs of the worst type.

With older people a slight and neglected coryza or pharyngitis is followed by a fulness in the ears, that "will wear away," and which does wear away in part; but if it occurs in persons who have no good hygienic habits in such matters as bathing, eating and drinking, and so forth, it leaves behind a degree of hyper-secretion or proliferation, which, as has been said, is the foundation for repeated attacks, and, finally, of permanent thickening and of adhesions.

The syphilitic catarrh of infants and young persons is the frequent cause of an affection of the middle ear, which, unlike its frequent companion, interstitial keratitis, is one of the worst forms of disease in the obstinacy with which it resists all treatment. The eyes may, and generally do, get well; but, if once the tympanic cavities be attacked, intra-auricular adhesions occur, the membrana tympani is drawn inward, the nerve is secondarily involved, and the loss of hearing often becomes almost complete.

There are no peculiar aural symptoms, by which we may positively distinguish a case of chronic disease of the middle ear that was caused by syphilis, from one occurring in a non-syphilitic patient. Yet we may say, in general, that a syphilitic diathesis seems to cause the proliferation of tissue to be more rapid and less amenable to treatment. 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.

Proliferous inflammation of the middle ear is often produced by cerebro-spinal meningitis. In scarlet fever and measles, we are more apt to have suppuration than in the former disease. It has been supposed that disease of the internal ear, is more frequently produced by cerebro-spinal meningitis, than that of the tympanum and Eustachian tube. This, I think, is an error; but for a fuller discussion of this subject, I refer the reader to

the chapter on "Deaf-Muteism." Parotitis also is a cause of disease of the middle ear, but more frequently, perhaps, it affects the labyrinth, if not exclusively, certainly in connection with disease of the middle ear. This subject also will again be alluded to. The excessive use of quinine may also, in rare instances, cause incurable disease of the middle ear.

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 earache;" "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 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 long continuance of such a 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 XIV.

## CHRONIC NON-SUPPURATIVE INFLAMMATION OF THE MIDDLE EAR—(*Continued*).

**Treatment of the Catarrhal and Proliferous Forms.—Constitutional and Hygienic Applications to the Naso-pharyngeal Space.—Nasal Douche.—Cases of Acute Aural Disease caused by its Use.—Gruber's Method of Cleansing Nares.—Politzer's Method.—Anatomy of Nasal Cavities.—Nebulizers.—Faucial Catheters.—Removal of the Tonsils.—Treatment through the Eustachian Tube.—Air.—Steam.—Vapors.—Fluids.—Bougies.—Electricity.—Death from Improper Use of Catheter.—Duration of Treatment.—Prognosis.**

In 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, their ears will rapidly recover, 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 have occurred, that we have found may take place in the tympanum and drum-head.

In one respect the treatment of a catarrhal non-suppurative

inflammation may be fairly distinguished from that of the proliferous form. In the catarrhal form we must give a great deal of attention to the naso-pharyngeal space, while in the other we scarcely need to treat it. Perhaps we may classify the treatment generally advised as follows:

1. Constitutional and hygienic.
2. Local blood-letting and counter-irritation.
3. Applications to, and operations upon, the naso-pharyngeal space (chiefly 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 remedies figure 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.

Of late, Dr. Theobald, of Baltimore, has warmly advocated the constitutional treatment, that is to say, by internal medication, of the form of disease now under discussion, as well as of chronic suppuration, and acute processes, but my opinions as to the general inefficacy of drugs, under the limitations I have given, have not changed since writing the above. Homœopathic practitioners attach great importance to the internal administration of their peculiar medicines, in catarrhal and suppurative inflammations of the ear, but they seem to use all the ordinary local means employed by the profession in general as

well. Dr. Houghton [1] recommends *baryta muriatica, cotyledon umbilicus, iodine lachesis,* and *mercurius dulcis, nux vomica* (in irritations of the mucous membrane of the middle ear, itching in the Eustachian tube, provoking swallowing) for non-suppurative inflammations of the middle ear as well as a host of remedies for the other diseases of the ear. As an example of what a belief in the specific value of internal remedies can produce, I may quote: "As a remedy cinchona proves curative in these two opposite conditions (congestion and anæmia), and acts upon both cochlea and semi-circular canals." . . . *Gelsemium* in conjunction with *silicea,* is said to have restored the hearing in forty-eight hours in a case simulating cerebro spinal meningitis on the one hand, and simple labyrinth vertigo on the other.

In our northern climates, all people should wear flannel next the skin, winter and summer, of course varying the thickness according to the temperature and the strength of the individual. Thick boots in the winter, and overshoes in the wet, are also necessities for those who wish to avoid catarrhs. I also think that the temperature of a sleeping-room should not be allowed to go down at night to a point below 65° to 68° F.; these rules are especially applicable to persons disposed to inflammations of the naso-pharyngeal space and ears. A whole chapter might easily be written upon this subject of personal hygiene. These hints, however, will be sufficient to induce the practitioner to give special attention to the subject in prescribing for chronic and advancing aural disease.

The causes of these forms of disease suggest a kind of constitutional treatment, which should never be lost sight of. Everything that will render a patient more vigorous, and less likely to take cold, will assist materially in curing or alleviating a chronic aural catarrh. We shall thus find much to do, in the way of correcting improper habits of life, in regard to bathing, exercise in the fresh air, ordinary clothing, sleeping apparel, and the like. Hence the Turkish bath,[2] sponge-bathing, walking, riding, boat-rowing, the general application of electricity, the internal administration of iron, and so forth, become prescriptions which the otologist will be called upon to give very frequently, if he properly appreciates cause and effect. It is only against specific drugs, where there is no specific diathesis,

[1] Homœopathic Therapeutics in Aural Surgery.

[2] 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.

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 decided 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. Blisters are also of value in such cases.

## 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.
4. Removal of the tonsils, large granulations, and of adenoid growths.

Injections of the naso-pharyngeal cavity by means of the naso-pharyngeal syringe, and by Davidson's double-bulbed syr-

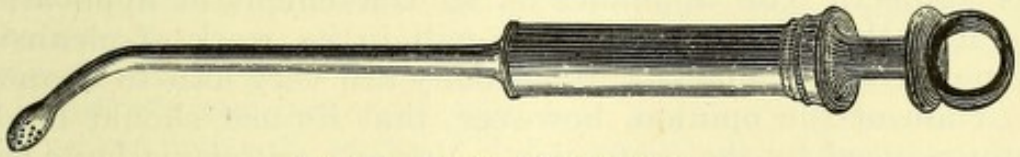

FIG. 85.—Posterior Nares Syringe.

inge usually used for enemata, 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 $\bar{3}$ j., a saturated solution of chlorate of potash, tar-water benzoate of sodium, and so forth. 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 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.

Davidson's syringe is also a safe and useful instrument for

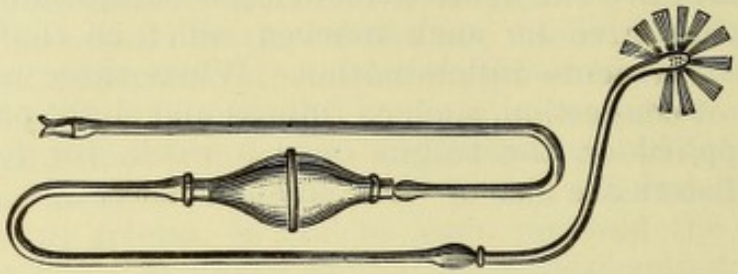

FIG. 86.—Davidson's Syringe, with a Nozzle to go below the Soft Palate.

cleansing the nares. It may be used anteriorly or posteriorly. Of late years, I use it more than I do the posterior nares syringe.

## THE NASAL DOUCHE.

I have published several cases that illustrate the dangerous consequences that may result to the ear from the use of the nasal douche, and I was the first writer to call attention to this subject. The appliance is so convenient of application, and it is thought to be so thorough in its work of cleansing the nostrils and pharynx, that many 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 downward.

The fluid then passes into the opposite nasal cavity, and escapes through the nostril. Professor 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. The fountain syringe is now generally used instead of the cup. Dr. J. L. W. Thudichum brought this apparatus to the notice of the English-speaking profession,[1] and made it more convenient, so that in America it has acquired the name of Thudichum's douche. 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,[2] in order to avoid the reiteration of explanations, that the criticisms upon the case in the *Monatsschrift für Ohrenheilkunde*, and by Professor Elsberg, compelled me to make.

*Case of Otitis Media Purulenta, and Pyæmia, from the Use of the Nasal Douche.*—On December 12, 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 tried this means of treatment, but it had caused such 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

[1] On Polypus in the Nose and Ozœna. London, 1869. Lancet, November 24, 1864.

[2] Archives of Ophthalmology and Otology, Bd. I.

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 endeaving 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 ℥ j. The patient improved under this treatment until January 28th, 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.

January 31st.—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, February 6th, 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, February 7th, at about 11 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 8 o'clock, and noted the following symptoms: The countenance was anxious and flushed, the skin hot, pulse about 96, 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 5 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 96—and he complained of pain and tenderness in the abdominal region. Morph. sulph., gr. ¼, was ordered to be taken *pro re nata*, and a poultice was applied over the abdomen. Tuesday, February 9th.—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. February 10th.—Last night the patient was attacked by a severe pain and swelling of the left foot, and at about 7.30 A.M. he had a severe chill, lasting about fifteen minutes, not followed by sweat-

ing. At 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 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 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*. February 11th.—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. ij., 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 February 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 except two have healed. April 4th.—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 7th.—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.

1884.—I am in the habit of seeing this patient quite often. He is still in excellent health, but a very little lame from the inflammation of the foot.

The late Professor Elsberg, of this city, published a paper[1] 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

[1] Archives of Ophthalmology and Otology, vol. ii., p. 77.

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

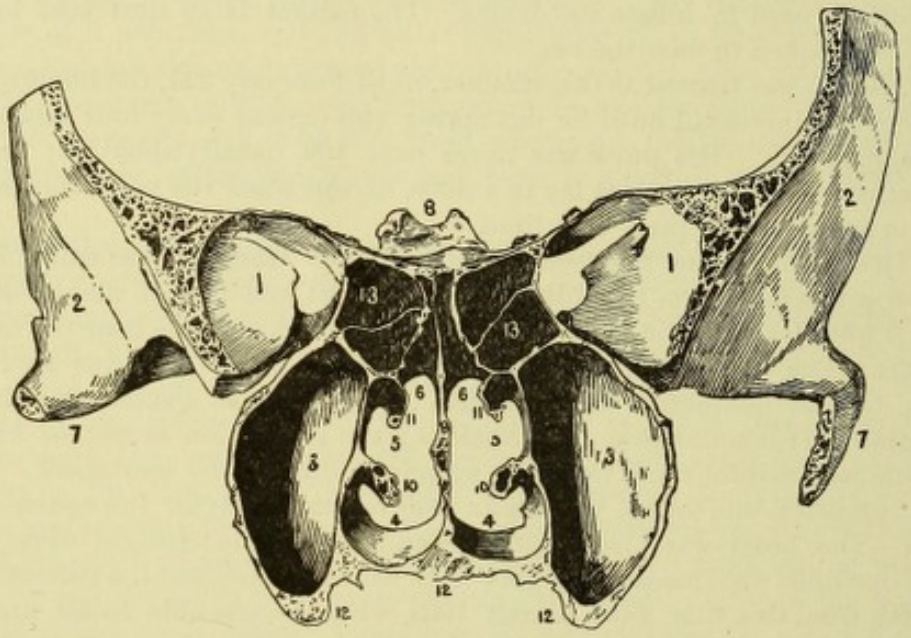


FIG. 87.—Vertical Section of Bones of Face (posterior half, two-thirds size. From Professor Darling's museum). 1, Orbit; 2, temporal fossa; 3, antrum; 4, inferior meatus; 5, middle meatus; 6, superior meatus; 7, zygomatic process; 8, clinoid process of sphenoid bone; 9, septum nasi; 10, inferior turbinated bone; 11, superior turbinated bone; 12, alveolar process; 13, ethmoid cells.

over, and is 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.[1] 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.

[1] Loc. cit., vol. iii., No. 1.

*Injury to the Ear from the Use of the Nasal Douche.*

| Patient. | Instructor [1] 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. |
| II. Dr. Frank.[2] | Dr. Frank. | Cold water, which he advises in all cases. | Acute otitis media. Recovery. |
| III. Mr. D. | Dr. Roosa. | Warm solution of salt and water. | Perforation of both membranæ tympani. Recovery. |
| IV. First of Dr. C. I. Pardee's[3] cases. | A physician. | Warm solution of salt and water. | Otitis media suppurativa. Necrosis of middle ear. Permanent deafness. |
| V. Second of Pardee's [3] cases. Medical student. | A physician. | Salt and water. | Acute otitis media. Recovery. |
| VI. A Physician. | A physician. | Unstated. | Otitis media suppurativa chronica. |
| VII. Patient at Manhattan Eye and Ear Hospital. | Unknown. | Unknown. | Otitis media acuta. Recovered. |
| VIII. Mrs. C. Dr. Mathewson's case. | A physician. | Warm fluids. | Otitis media acuta. Recovered. |
| IX. Dr. Hackley's [4] case. | Unknown. | Warm salt water. | Otitis media suppurativa chronica, supervening on old perforations. |
| X. Dr. Piffard's [5] case. | Unknown. | Warm fluids. | Otitis media acuta. Recovery. |
| XI. Judge ——. | A physician. | Unknown. | "Deafness." Recovery. |
| XII. Dr. Loring's [6] case. | A physician. | Warm fluid. | Otitis media suppurativa chronica. |
| XIII. Physician.[4] Dr. Mathewson's second case. | A physician. | Unstated. | Otitis media acuta. Recovery. |
| XIV. Physician.[4] Dr. Mathewson's third case. | A physician. | Unstated. | Otitis media subacuta. |
| XV. Physician. | A physician. | Warm salt water. | Fainting and otitis media catarrhalis. |
| XVI. Dr. O. D. Pomeroy's case.[4] | Dr. Pomeroy. | Warm salt water. | Otitis media suppurativa. |

[1] The name or profession of 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.

[2] Archiv für Ohrenheilkunde, Bd. V., p. 202.

[3] The Medical Gazette, vol. vi., No. 23. Medical Record, February 1, 1870.

[4] Reported in Archives for Ophthalmology and Otology, vol. iii., No. 2.

[5] Reported by Dr. Pardee, loc. cit. [6] Verbal report to writer.

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.

I am happy to say that since the publication of my warnings against the use of the nasal douche, on account of its danger to the ears, it has been very generally abandoned, and, when recommended, it is with many admonitions as to care in its employment. Since my publications on the subject, many other writers have urged the profession to cease to recommend it. Among them may be mentioned Buck, Pardee, Knapp, Beverley Robinson, Shaw, Rumbold, Cornwall, and others. Buck[1] makes the assertion, in which I fully agree, that "*the introduction of a fluid into the nasal passages in a sufficiently large quantity*

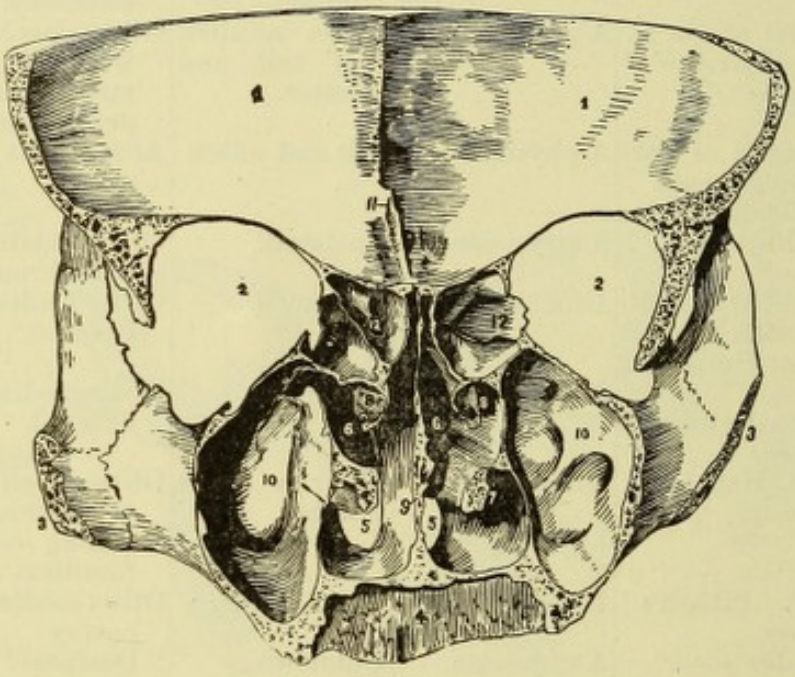

FIG. 88.—Vertical Section of Bones of Face (anterior half, two-thirds size. From Professor Darling's museum). 1, Anterior cranial fossa; 2, orbit; 3, malar process; 4, alveolar process; 5, inferior meatus; 6, middle meatus; 7, inferior turbinated bone; 8, superior turbinated bone; 9, septum nasi; 10, antrum; 11, crista galli; 12, ethmoid cells.

*to bathe the orifice of the Eustachian tube (no matter by what method it is introduced) is not wholly free from the danger of setting up an inflammation of the middle ear.*"

On the other hand, such good authorities as Cassell[2] and Burnett[3] still recommend the douche, if used with care.

Politzer[4] admits that, with all precautions, it sometimes happens, "chiefly in consequence of an involuntary habit of swallowing," that fluid enters into the middle ear and causes evil effects. Politzer, therefore, pours medicated solutions into the

[1] Medical Record, March 24, 1877.

[2] New York Medical Journal, October, 1877, quoted from Dublin Journal Med. Sciences, June, 1877. [3] Text-book, p. 407. [4] Text-book, translation, p. 314.

nose "by means of a boat-shaped glass vessel," while the head is inclined backward. The patient is told to bend his head forward quickly the moment he is conscious that the fluid has entered his pharynx. The fluid, in consequence of the closure of the lower part of the pharynx, has already entered the other nostril, and then it will escape freely. The patient should not blow his nose until a quarter of an hour after the medicated fluid is used. This method is an awkward one. I recommend rather the use of Davidson's syringe as a cleanser, and that the medicated applications be made by a coarse spray, or by cotton on a cotton-holder properly curved.

### *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. He 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."[1]

Gruber believes that it is the root of the tongue, as well as the soft palate, that by instinctive contraction and lifting upward 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.

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[1] Monatsschrift für Ohrenheilkunde, Jahrgang VI., No. 4.

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. I am also convinced, that instruction to patients as to how they should behave while applications are made to the naso-pharyngeal space are useless. I inform my patients that they may act as they please. A fluid should be used which will do no harm if some of it pass into the stomach.

Dr. Gruber fully corrobates 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.

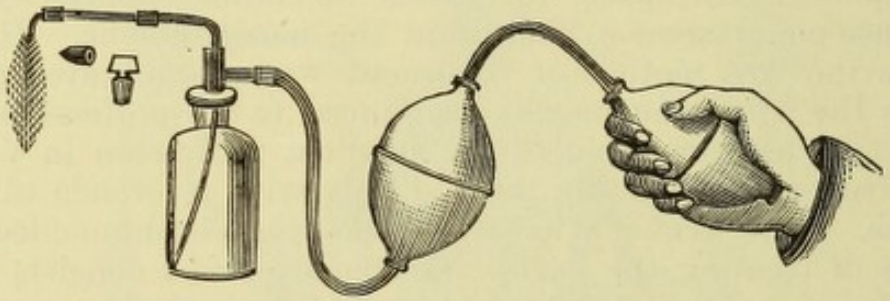

FIG. 89.—Nebulizer for Nostrils and Pharynx.

"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."[1]

I believe the posterior nares syringe, the Davidson's syringe, and the nebulizer have nearly, if not quite, supplanted the nasal douche.

The solutions 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, or benzoate of sodium, ʒ j. to the pint. 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 water, by Von Tröltsch's method, as long as they live. The gymnastic exercise of the muscles of the

[1] Gruber, loc. cit., No. 8.

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.

Treatment 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. I usually use a solution of sulphate of zinc, of five grains to the ounce, in a nebulizer. I also employ nitrate of silver in weak solutions, from one to five grains to the ounce. I seldom use strong solutions by means of a spray, but when I wish to use nitrate of silver in a solution stronger than five grains, I find the application more safely made by means of a properly curved cotton-carrier. I am using strong solutions for simple catarrhal cases less and less, but I rely upon thorough and frequent cleansing by Davidson's syringe and a coarse spray. In the nebulizer I use a solution known as Dobell's solution very much.

℞. Acid. carbol ..... gr. vi.
Soda Bi. Borat ..... } āā gr. xii.
Soda bicarb ..... }
Glycerin ..... ℥ j.
Aquæ .....ad ℥ vi.
M.

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, 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.[1] Although

[1] Transactions of American Otological Society, 1872.

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 toward 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 of the calibre of a No. 1 Bowman's probe, for the injection of air or fluids. This aperture is so placed, 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 faucial instruments have, as yet, reversed this judgment. The faucial catheter of Dr. Cutter,[1] 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.

Sulphate of zinc, of alum, sesquichloride of iron in weak solutions, Dobell's solution, and so on, 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.[2]

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[1] American Journal of the Medical Sciences, April, 1872.

[2] These nebulizers, to which so many different names are given, both here and abroad, are actually modifications of Richardson's local anæsthesia apparatus.

## REMOVAL OF THE TONSILS.

It will often be necessary to remove the tonsils, or at least to greatly diminish their size, during the treatment of chronic catarrh of the middle ear. It is not probable, that the tonsils ever grow to such a size that they press upon the mouth of the Eustachian tube, as is sometimes supposed, but they may be so large as to seriously affect the breathing, the resonance of the voice, and the health of the pharynx and chest. Through the last-named influences, enlarged tonsils may keep up or excite a chronic inflammation of the middle ear. I invariably advise their removal, when they are large enough to have any of these injurious effects, and also, when, although only moderately large, they are frequently the seat of inflammation, and are honeycombed with the fistulæ of former inflammatory processes. For their removal, I usually use the tonsil bistoury here shown, holding the tonsil forward by the forceps. One assistant is generally needed, but in many instances, in the case of those more than thirteen or fourteen years of age, no assistant is required. The patient will often be willing and able, to hold his tongue down by means of the handle of a spoon or a tongue depressor. In some cases, I use Mackenzie's guillotine, especially with very young children. I never saw any alarming hemorrhage, either in my own practice, or in that of my former preceptor, Professor Post, in whose clinic I have often seen this operation performed. The only cases, in which I would hesitate to perform excision of the tonsils, when it is required, would be in that of a person known or supposed to have a hemorrhagic diathesis. I can but think, that with ordinary care, it would be impossible to divide a large artery. I apply tannic acid or tincture of iodine after excision. I am not always able to remove, with the bis-

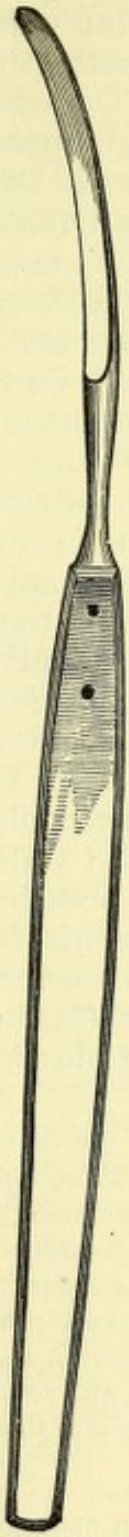

FIG. 90.—Tonsil Knife.

FIG. 91—Tonsil Forceps.

toury, all of the tonsil that I desire to remove at one cut, but it is very unusual for the patient to decline to have a second excision performed.

It has generally been observed, that persons having enlarged tonsils, granular pharyngitis, adenoid vegetations, or nasal obstructions, breathe through the mouth. The reasons for this are evident. Dr. Cassels [1] has made mouth-breathing the subject of an interesting paper entitled "Shut your Mouth and Save your Life." He quotes largely from Catlin, celebrated as an observer of the Indian tribes of this country, who denounced mouth-breathing in no measured terms in his work upon this subject. Catlin says: "If I were to endeavor to bequeath to posterity the most important motto which human knowledge can convey, it should be in three words, Shut your mouth." It is certainly of the highest importance, that the mouth should be kept closed in ordinary breathing, and if the conditions are favorable, that is to say, if the nostrils and pharynx are healthy, this will always be done. I have quoted Cassels' paper at this point, that Catlin's remarkable statements as to the hearing power of the Indians of America may be noticed. Catlin claims to have visited two millions of individuals, living in a savage state in 150 different tribes. Among this number, he found only three or four deaf-mutes, and not another individual who was hard of hearing or deaf. None of the chiefs of the tribes who were questioned upon this point, could remember or find an Indian who was hard of hearing, and Catlin further says, according to Cassels, that not a mouth-breather was known to exist in all these tribes. Dr. Ely wrote his friend, the late Lewis H. Morgan, known to many of my readers as a distinguished ethnologist, as to the correctness of Catlin's observations among the Indians, and he received the following reply:

As a rule, so far as my observation has extended, the Indians are sound in hearing and in vision, both senses being more acute than with us. I have seen cases of sore eyes among the Western Indians and which may have been attended with defects in hearing. At the time, I supposed the cases due to syphilis, which has been a scourge upon some of the tribes.

If you were to select a hundred Indians at random, with a hundred white men the same, you would, as I believe, find a larger number of the former sound-headed, limbed, and sound in the physical senses than of the latter. Moreover, on general principles this ought to be the fact.

Yours truly,

L. H. Morgan.

P. S.—Catlin was a good observer.

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[1] Reprint. Edinburgh: Oliver & Boyd. 1877.

I have no doubt but that Catlin was correct as to mouth-breathers among healthy Indians, but he overlooked the fact that they were nose-breathers, not from habit, but because they had healthy naso-pharyngeal spaces. Secure this for the human race, and they will all breathe with the mouth closed. In the writings of Catlin, and in Morgan's note, there seems to be an overlooking of the fact, that Indians like the Spartans, may have been the *survival of the fittest.* Delicate children, with the snuffles, will probably survive in civilization, when Spartan exposure, or a home in an American wigwam, would soon cut them off.

A curette curved to pass behind the soft palate, is a very useful means of treating granular pharynx or adenoid growths of small size. The practitioner must not attach too much faith to the local treatment of chronic conditions of the fauces, by nebulizers, probangs, curettes, and the like, or he will sometimes be grievously disappointed, and accuse himself of over-medication.

### THE TREATMENT OF THE NOSE.

Of late years the authorities in nasal disease have placed great stress upon operations upon the nasal cavities, for the purpose of overcoming narrowing, or occlusion. It is very common to find a deviated septum, and consequent narrowing of the meatus of one side in persons who do not seem to be aware that they have any trouble in the respiratory tract. Again, as has been before observed, many patients suffer from nasal occlusion from various causes, including even polypi, without being aware of any impairment of hearing. In some cases they have a marked nasal catarrh, hypertrophic or atrophic catarrh, without an aural symptom. It is not reasonable to conclude, therefore, that because a patient has chronic disease of the tympanum, and at the same time nasal obstruction, that the latter is necessarily the cause of the aural disease. Even if it were the primary cause, there are changes occurring in the tympanum, especially in the joints of the ossicles, that will not be removed, after operations upon the nasal cavities have completely restored their normal calibre, or have ameliorated or cured the catarrhal condition. Morbid conditions, especially swelling of the mouths of the Eustachian tubes, as Dr. Clarence C. Rice has shown me, may be removed by treatment, and no change result in the hearing power. Dr. Daly, of Pittsburg, read a paper before a section of the New York Academy of Medicine, in which he affirmed that aural writers had neglected the relations between the nose and ear in their treatment, but our literature as ex-

hibited in these pages, and those of other authors, does not show this. Yearsley, Tröltsch, Meyer, and Pomeroy have dwelt fully upon the subject, long before operations upon the nose became common, but aural surgeons, for reasons that have been already given, have not been enthusiastic about invariable relief to the hearing from the removal of nasal obstruction, however important it may be, to secure patency of the nasal cavities on other grounds. Operations upon the nose, even when performed under pressing indications, are not without danger to the integrity of the ear, from an extension of the inflammation caused by the operations, to the tympanum. I have seen several cases of serious *otitis media* resulting from this cause and also mild cases of septicæmia.

The union of practice in nasal and aural disease is greatly to be desired. Ophthalmology and otology have been united as specialties in Ireland and the United States, ever since the days of Sir William Wilde, but such a union is unnatural; but every aural specialist should be an expert in naso-pharyngeal practice, and *vice versa*. The next generation will probably bring this to pass, and there will be then no complaints that aural surgeons neglect the thorough treatment of the nose, or that rhinologists cannot always discriminate between an affection of the tympanum and one of the labyrinth. When rhinologists have acquired a larger experience in diseases of the ear, they will not be so confident, as some of them now are, of curing chronic aural disease by removal of nasal stenosis. It may be questioned whether the nasal cavities are not of more importance to respiration and speech, than to the hearing.

### THE TREATMENT THROUGH 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 this instrument; but I become more and more convinced after twenty 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,
Fluids,
Bougies,
Vapors,
Electricity.

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

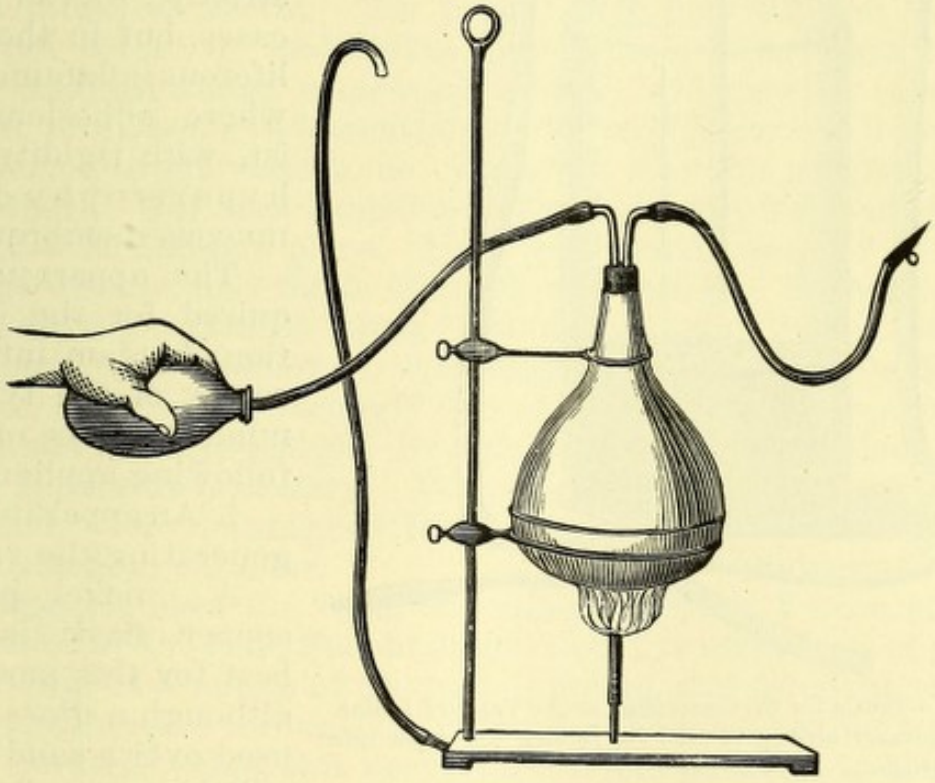

FIG. 92.—Apparatus for Steaming the Middle Ear.

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, the vapor of water—steam—an old remedy, is one of the best.

Dr. C. I. Pardee[1] published a paper, in which he has carefully noted the results of six cases of the most obdurate va-

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

riety 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.

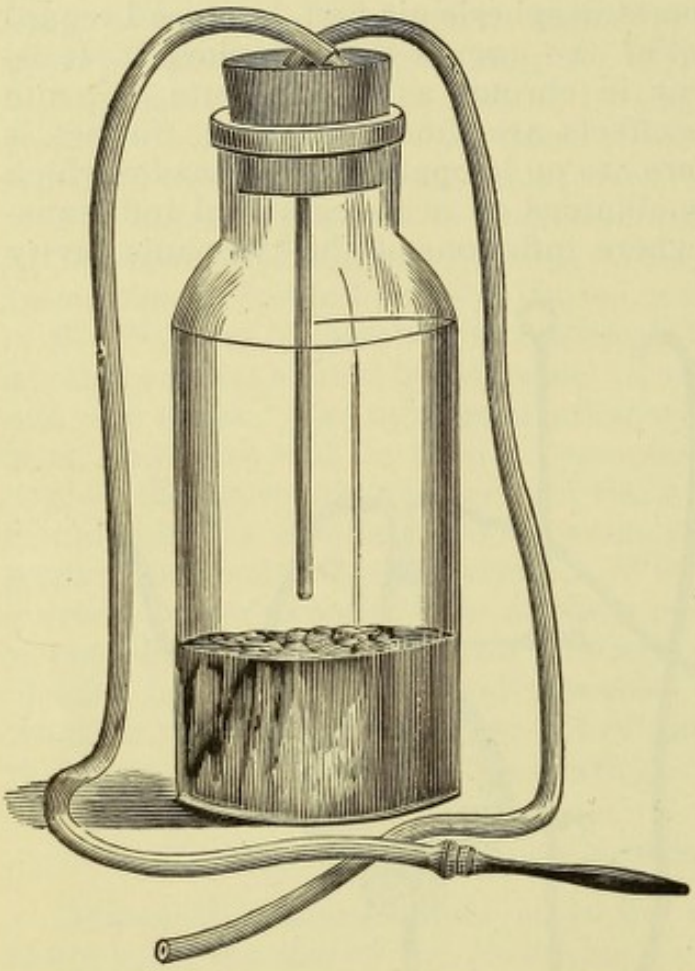

FIG. 93.—Bottle for the Generation of the Vapor of Iodine. An ordinary air-bag is used for forcing the vapor into the catheter.

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. 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 instru-

ment cannot be used, on account of its becoming too hot to be borne. Many practitioners keep the catheter in place by a holder; but I always employ my fingers for that purpose.

The steam may be gotten up by a gas burner, as shown in Fig. 92, or by an alcohol lamp. If gas is to be obtained, its use is more convenient. The steam should be forced in by rather a quick pressure upon the air-bag. A slow movement, since it causes a longer application, is apt to burn the patient's nostrils or pharynx. The nozzle should be removed from the catheter after each puff.

While I still think that steam employed through the catheter is a useful means of treating proliferous inflammation, I have nearly given it up, and substituted the application of the vapor of iodine and gum camphor, chiefly on the ground of convenience. The latter may be more easily used, and its effects are, I think, as useful. The practitioner may as well know, however, before he undertakes these cases, as to learn it by bitter disappointment afterward, that he will *cure no cases of chronic proliferous inflammation of the middle ear.* All he can hope for, is to alleviate some cases, and stay the progress of a few others. But this subject of prognosis will be more fully discussed in another place. I use iodine and camphor in proliferous disease, and fluids through the catheter in those that are markedly catarrhal cases. The use of iodine in the simple way that I now employ it, was suggested to me by Dr. F. H. Rankin, of Newport, formerly one of my assistant surgeons at the Manhattan Eye and Ear Hospital. Fig. 93 gives a clear idea of the apparatus necessary. The patient holds the apparatus in his hand, while the surgeon forces the vapor into the mouth of the Eustachian catheter.

I formerly used the vapor of iodine alone, but I now, at the suggestion of Dr. H. P. Farnham, put about two drachms of gum camphor in two ounces of tincture of iodine, and force the vapor from this mixture through the catheter. Besides having a positively curative value, it is very grateful and pleasant to the patient.

### 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*, some of it enters the tympanum. The usual method of injecting a fluid into the mouth or calibre 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 1¼ mm. 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[1] 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 1.4 mm. 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 six to twelve hours. In about forty-eight hours the beneficial effect should be seen.

Wreden uses the following-named agents through the tym-

[1] Separat-abdruck aus der St. Petersburger medicinischen Zeitschrift, N. F., Bd. I., 1871.

panic 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, using one-eighth to one-quarter of a grain to the ounce of a half per cent. solution of iodide of potassium.
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.
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 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.[1]

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[1] Medical Record, No. 134.

"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 calibre 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 made on the air-bag, while the piston of the syringe is forced

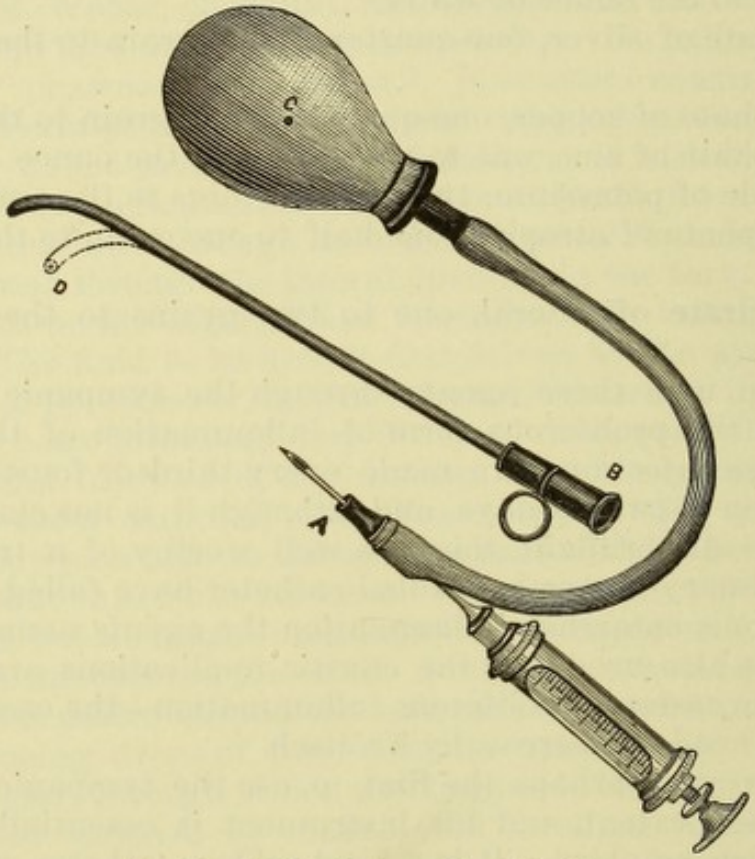


FIG. 94.—Hackley's Eustachian Nebulizer.

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 determine 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 and iodine vapors are 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 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,[1] represented on page 75. The apparatus consists of a hollow bulb of 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

[1] American Journal of the Medical Sciences, vol. liii., p. 62.

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 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 employing 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 its therapeutic value is very limited. The hollow bulb was recommended as an inhaler by Dr. Buttles, of this city, but it was intended to be used in the nostrils only. The attachment to Politzer's air-bag was first made by myself.

## 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,[1] 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 five thousand private patients, I have recorded but very few cases in which, after a fair trial, air could not be driven into the Eustachian tube by means of the catheter or Politzer's

[1] Archiv für Ohrenheilkunde, Bd. II., p. 6.

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 to remove the swelling. Complete stricture of the tube is too rare an occurrence to be really much considered as an indication for the use of the bougies. 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[1] in which a fine whalebone olive-tipped bougie passed into both Eustachian tubes through the catheter, produced suppurative inflammation of the middle ear, but Dr. Noyes, as he very recently told me, still uses bougies and considers them indispensable for certain cases.

In the discussion which ensued on this case, Dr. Weir 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 mm., then the distance from the point to the tympanic cavity, 11 mm., and finally the width of the cavity, 13 mm. 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 quote 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 tym-

[1] Transactions of the American Otological Society, Third Year, p. 55.

panic 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."

Within a short time, bougies have been again recommended by Urbantschitsch, but I have not been able to substantiate the opinions of those who recommend them by my own experience. I fear that years of careful treatment of chronic proliferous inflammation in hospital and private practice, without curing any, have made me a little too chary about the use of troublesome and severe remedies for cases, for which we can expect no more than slight alleviation and temporary improvement.

## 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[1] 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 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,[2] there is a letter from a correspondent accusing this Dr. Turnbull of advertising in the

[1] A Practical Treatise on the Medical and Surgical Uses of Electricity, p. 566.
[2] Vol. ii., 1839.

*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*[1] 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, aged sixty-six, 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 8 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 eighteen, who died while 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 7 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 10 o'clock on Saturday morning at Russell Square. He appeared in good health. There were other patients present at the time. Mr. Lyon, 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 instru-

[1] Vol. ii, p. 558. 1838.

ment 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. Lyon 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 entrust 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[1] show that all traces of an emphysema 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

[1] Monatsschrift für Ohrenheilkunde, Jahrgang VII., No. 1.

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, the patient should receive a course of local treatment until the disease has ceased to progress, for a period of time varying from three to eight weeks, while the general treatment is to be a life-long course. 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 per-

sons 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.

The practitioner, young or old, will do much better in such cases, both for the patient, his own reputation, and that of the profession in general, if he decline to prescribe at all for such persons, for it is only under favorable circumstances, that is to say, with intelligent patients, in easy circumstances of life, who are attentive to advice and punctual in attendance, that anything at all can be accomplished to stay the progress of a well-advanced catarrhal or proliferous process in the middle ear.

Even then it is not always possible. Certainly those who have waited ten or twenty years, and have finally consulted a physician on account of impairment of hearing, depending upon chronic non-suppurative inflammation, with the idea of getting relief in one or two or three visits, have nothing to hope for. It is better to tell them so at once, lest we unwittingly emulate the charlatans, to whom all disease is an object of attack by medication. Otology has suffered much, from innocent attempts to accomplish that which is in the nature of things, not to be accomplished. A little frankness about chronic non-suppurative disease of the middle ear, will soon awaken the laity to the necessity of attention to the causes of the disease, and furnish us all with a larger proportion of curable cases.

I have found chronic catarrhal cases much more amenable to treatment than the proliferous form. Indeed, I think the former cases are frequently curable, but the proliferous variety never. In its results, in spite of good local and general care, it is, to my mind, very like progressive atrophy of the optic nerve or chronic glaucoma.

Since the publication of the works of the modern German school in this country, especially that of Tröltsch, there has been a tendency, in my opinion—I speak for myself at least—to refer too many cases of progressive impairment of hearing to catarrhal or proliferous inflammation of the middle ear, and diseases of the nerve are ignored, or their existence, except as secondary affections, has been even denied.

I advise the practitioner, however, to attempt to make a differential diagnosis between disease of the middle ear and of the nerve, especially in cases of supposed chronic proliferous in-

flammation. The means we have at hand for this purpose, will be fully dwelt upon when we come to the discussion of disease of the nerve. I will only say here, that the treatment of disease of the internal ear, by the local means generally employed in treatment of the middle ear, is harmful, since it aggravates the conditions by inducing congestion of the labyrinth.

# CHAPTER XV.

## THE TREATMENT OF CHRONIC NON-SUPPURATIVE INFLAMMATION—(*Concluded*).

**Operations upon and through the Membrana Tympani.—History from 1650 until our own Day.—Sir Astley Cooper's Cases.—Schwartze's Statistics.—Politzer's Eyelet.—Tenotomy of Tensor-Tympani.—Galvano-cautery.—Division of Posterior Fold.—Prout's Operation.—Hinton's Removal of Accumulations of Mucus.—Abandonment of Operations by American Otologists.—Condensed Air.—Exhaustion of Air.—Weber-Liel and Woakes on Paretic Deafness.—Results of Treatment.**

At the time of the publication of the first editions of this book, operations upon the membrana tympani, the ossicles and muscles of the tympanum were being extensively practised by Politzer, Weber-Liel, Hinton, Orne Green, Pomeroy, and others, for the relief of chronic diseases of the middle ear. Although part of the treatment thus pursued was avowedly experimental, the hope was pretty generally felt in the profession, that operative procedures on and through the drum-head, might perhaps accomplish very much in arresting the progress of a disease, which still remains incurable in a vast proportion of cases. I believe that after a fair trial, we are as yet obliged to say that these hopes have not been realized. After a trial of nearly all the methods of operation of which I have learned, I have abandoned them, and only in exceptional instances do I ever open the drum-head by incisions, except in acute or sub-acute cases. It is not because the operations are dangerous, that I have abandoned them. That I have not found. But it is because they do nothing to stop tinnitus aurium, or arrest progressive impairment of hearing in chronic non-suppurative inflammation. It may be asked, Why, then, consider the subject fully in a practical treatise? To this, I answer, that it is one of great historical interest, for the work that has been done in this direction has been by the ablest of otologists, and has at least taught us much of the prognosis and nature of chronic non-suppurative inflammation. Besides, much useless experimentation on the part of younger observers will be avoided, if they have easy access to what has been already done. 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 the drum-heads of dogs, and ends as yet, with Weber's operation upon the tensor-tympani muscle, and Politzer's section of the posterior fold of the membrana tympani. From the mass of authorities I have collected a history of this subject.

I am indebted to Schwartze's brochure[1] for much of the historical sketch from the time of Riolanus up to 1845, although I have greatly amplified his references to Sir Astley Cooper's writings, as well as to those of other English authorities, and by no means, as one reviewer assumed, have I merely given a translation of Schwartze's interesting paper.

Johannes Riolanus (1650), 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 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.

About a hundred years later (1722), T. Cheselden, surgeon to St. Thomas' 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[2] 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."

[1] Studien und Beobachtungen über die Künstliche Perforation des Trommelfells, Archiv für Ohrenheilkunde, Bd. II., S. 24.

[2] The Anatomy of the Human Body, p. 250. London, 1732.

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[1] says that such an outcry was aroused by the inhumanity of the proposed operation, that Cheselden never again obtained permission to perform it.

Dienert (1748), 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.

The first man who actually performed the operation as a means of benefiting the hearing, was a person named Eli (1760),[2] 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.

Wilde quotes a passage[3] 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 naïvely remarks, "There is no account of the results in this case."

In the beginning of this century, at about the same time

[1] Philosophical Transactions, p. 152. 1800.

[2] 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."

[3] Aural Surgery, English edition, p. 15.

(1800), 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 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[1] of the case of a medical student at St. Thomas' 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, he could hear it but two-thirds of the distance at which the examiner could hear it.

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[1] Philosophical Transactions, loc. cit.

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 no aid from the patient, but with the otoscope, is able to state just what the condition of the part is, and in a very brief space of time.

This observation led the way to the operation of perforation of the membrana tympani[1] 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 is the only one that may be said to be incorrect. The tympanic cavity might be full of blood without causing closure of the Eustachian tube.

Sir Astley reports four cases :

Case I.—A woman, thirty-six years old, who had been affected for eight years. The deafness arose from enlargement 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

[1] Sir Astley's paper descriptive of his operations was read June 21, 1801. See Philosophical Transactions of the Royal Society of London, 1801.

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 Sir Astley, 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 auditory canal. 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.

This case was undoubtedly one of fracture of the temporal bone through the tympanic cavity, such as have been reported by Buck and Rushmore. They have been fully described in the tenth chapter.

In closing his paper, Sir Astley states that little pain is felt in the operation, and that no dangerous consequences follow.[1] 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 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,

[1] 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.

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' 63 cases, in 42 there was no result whatever; while in 21, 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 promised 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 170 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.

Saissy (1822), 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, 81 deaf-mutes were operated upon, of whom 17 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,[1] 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 woman and a man, 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

[1] Text-book, English edition, p. 297.

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 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 the earlier editions of 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.

Sir Astley was incorrect in his ideas as to the closure of the tube being the cause of the conditions for which he opened the drum-head, but his operation was a proper one for those conditions, so far as we can understand his cases. For example, the perforation of the drum-head for the evacuation of blood was a proper procedure. Again, in the case of the woman who had been deaf for six weeks, the operation was undoubtedly of service, even if of only temporary value. Closure of the Eustachian tube no longer exists in the minds of the profession as an independent affection, except in extremely rare cases. When its action is impeded, the congestion or swelling of its lining is always associated with similar conditions in the tympanic cavity.

Since the scientific use of catheters and bougies, it 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 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,[1] 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[2] 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 published a few years since, 100 cases of chronic aural catarrh, 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 100 cases, only 2 were in persons over fifty years of age. Between forty and fifty there were 3 persons. between thirty and forty 8, and only 17 were over twenty. The remaining 81 were under that age, and 46 were between one and ten years, and 35 between ten and twenty. In America, cases of chronic non-suppurative inflammation occurring in young persons are usually quite tractable

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[1] See Introductory Chapter, p. 27.

[2] Archiv für Ohrenheilkunde, Bd. II., p. 36.

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 34 of the cases, the disease, whatever it was, had not existed for a year. There were only 10 cases where the aural affection had lasted between five and ten years, and in 6 cases only, more than ten years.[1]

Schwartze, in a review of this work, seems to think that I have done him injustice in these remarks, as well as in the sentence where I stated that "I have been in the habit of treating many of the cases that he treats by paracentesis, by simpler means." He advises me to study the indications that he has laid down, a little more exactly. I have again gone over this subject from Schwartze's writings, and I am still of the opinion that many of his one hundred cases are not entitled to a place among cases of chronic catarrh, as generally understood, and I also think that very many of them were curable without paracentesis, and that scarcely any American or English surgeon would deem this operation necessary for such cases.

In saying this, I am not aware of making any rude criticism upon Schwartze's procedures. Certainly, I have never intended to be discourteous. But, as a teacher of otology, I am bound to speak freely and frankly of any course of treatment publicly promulgated, even if it come from as high an authority as that of Professor Schwartze.

Schwartze's cases show that valuable as is paracentesis of the membrana tympani, in accumulations of mucus in the tympanum and in cases of catarrh of comparatively recent origin, we have not found in it, a remedy for old and neglected cases of catarrhal and proliferous inflammation. Schwartze's contributions, in other words, principally affect acute and sub-acute disease, or exacerbations in chronic affections. The line should have been a little more distinctly drawn between the cases of sub-acute and chronic inflammation, for which paracentesis was performed. In other words, Schwartze has failed, in my opinion, to prove by his statistics, that paracentesis is of any particular value in chronic cases. That it is an important means of treatment for acute and sub-acute cases, he proved, and thus revived a valuable operation.

It was thought by many (1845) 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

[1] Archiv für Ohrenheilkunde, Bd. VI., p. 195.

opening.[1] 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[2] 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 tympanum than into the canal.

The published experience of those who have performed this operation does not commend it as a successful procedure, and I believe that it is now very seldom performed.

Wreden (1867),[3] 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 opening would close. He says that, when he removed two-thirds of the membrana tympani and the handle of the malleus, he never saw the opening fully heal. 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

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[1] Frank's Practische Anleitung, p. 310. Erlangen, 1845.

[2] Transactions of the American Otological Society, third year, p. 57.

[3] Monatsschrift für Ohrenheilkunde, Bd. I.

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,[1] 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 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.

Gruber's (1863) 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.

F. E. Weber (1868), of Berlin,[2] recommended the division of

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[1] Monatsschrift für Ohrenheilkunde, Bd. I., p. 39.

[2] Ibid., Jahrgang II., p. 51.

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.

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.[1]

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 hindrance 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 tenotomy is divided into four stages:

1. The membrana tympani is perforated with the hook-shaped extremity of the tenotome, about 1 to 1½ mm. in front 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 downward and forward—and thus it is made to grasp the tendon. (Just how the operator is to know when the hook is around

[1] Loc. cit., Jahrgang IV., p. 143.

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 toward 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 *pharmaco-koniantron.*

Weber has reported cases which confirm his view of the benefit from the division of the 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 also advocated 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."[1] 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 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. 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. It is 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, the shaft of the needle stands

[1] Seperat-abdruck aus der Allgemeinen Wiener Medizinischen Zeitung, January, 1872.

parallel to the long axis of the auditory canal. The point of the knife reaches only a little above the inner margin of the handle of the malleus, but does not pass far beyond 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 toward 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 tendon 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.[1]

Hartmann uses a small knife curved on the flat and on the edge, for division of the tensor tympani. The point of the knife reaches about 1 mm. further outward than its upper edge. Hartmann first makes an incision into the posterior segment of the membrane about 1 mm. behind the handle of the malleus, and learns what changes occur in the hearing distance and in the tinnitus aurium. The tenotome is then introduced into the tympanic cavity for a distance of 3 mm., whereby the knife is placed below the tendon of the tensor tympani between the handle of the malleus and the long crus of the incus. By slightly sinking its handle the sharp point of the tenotome is forced so far to-

[1] 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.

ward the upper part of the tympanic cavity, that the tendon is obliquely divided on the withdrawal of the instrument.[1]

Lucae (1871) 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 inward of the handle of the malleus, and great prominence of the short process, and when the Eustachian tube is permeable.[2] Lucae uses a bayonet-shaped needle, and the incision is made from below upward, 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 Professor Politzer, in regard to the performance of this operation, but I 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.[3]

Voltolini (1870) 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 (1872) 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[4] 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 correspond-

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[1] Politzer: Text-book. Translation, p. 383.

[2] Seperat-abdruck aus der Berliner Klinischen Wochenschrift, No. 4. 1872.

[3] Translation of Politzer's Lecture, by Dr. Burnett. Philadelphia Medical Times, vol. ii., No. 56.

[4] Myringodectomy, 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.

ing point of the membrane. In performing the operation, Dr. Prout used a knife such as is here represented.

The patient was thirty-three 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.

FIG. 95. —Prout's Knife.

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 for a time. A permanent suppurative inflammation resulted from the second case.

Mr. Hinton (1869)[1] believed that mucus dried up and became

[1] On Mucous Accumulations within the Cavity of the Tympanum. From the Guy's Hospital Reports, 1869.

dense in the cavity of the tympanum, and thus became a cause of "confirmed deafness." He therefore made an incision into 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 clinic 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 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 performed 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 impairmant 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.

Since the above was published, I have largely added to my experience in operations upon the membrana tympani, and I

have also had the opportunity of studying some of the cases of other surgeons as if they were my own. As a result of this experience, as I have said at the opening of this chapter, I have given up all operations upon the drum membrane or upon the tendon of the tensor tympani, in chronic non-suppurative cases, when there is no suspicion of retained mucus in the tympanic cavity. I believe that any operations yet suggested, are inadequate to relieve tinnitus aurium, improve the hearing, or even to retard the advance of this form of disease. I read a paper[1] expressing this opinion before the American Otological Society in 1881, and my views were confirmed by the members who took part in the discussion, by Blake, Buck, Kipp, Noyes, Burnett, Bartlett, Mathewson, Theobald, as representing "as well as any one statement could reflect the varied opinions of those who were interested in otological questions" (Buck). It may be said then, that a majority of the authorities on the treatment of aural disease in the United States, have up to this time, given up these operations in chronic non-suppurative cases, where there is no suspicion of fluid in the tympanic cavity. If we can yet find a safe means of making a permanent opening in the membrana tympani, I believe we should benefit quite a large class of cases, as yet unalleviated by any means. As Politzer[2] points out, this permanent opening can only be useful, "when the stapes is still movable, when the membrane of the *fenestra rotunda* is not thickened or calcified, and when no labyrinthine complications exist." I believe that we shall yet find some means of securing a permanent opening in the membrana tympani, for we sometimes see cases where we find it impossible to close an opening made by suppuration. The application of collodion (McKeown) and paper disks (Blake) have been advised for relaxation of the drum-head. I have tried the disks, but as yet without good results.

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

[1] Transactions, vol. ii., p. 458.

[2] Text-book, p. 373.

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 from what I have seen of the use of chloroform on the Continent, I think many of the operators are so fearful of the results of the anæsthetic, that they do not put their patients fairly to sleep. If ether be used as we use it in this country, the drum-head may be readily made insensible. I usually perform paracentesis without ether, and often in my consulting-room. I do not regard it as a serious or painful operation. 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.

On page 287 will be found a representation of the paracentesis needle which I generally use.

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 trochar. 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.[1]

Since the above was written, Dr. Sexton and Dr. C. H. Burnett have revived the operations upon the drum-head and ossicles, especially the operation for the removal of the latter for the relief of the tinnitus and impairment of hearing in chronic non-suppurative inflammations. Dr. Sexton has read several papers upon the subject, but the profession as yet remains unconvinced, I think, as to the results of this procedure in such subjects. Further experience, and the details of a fair number of cases in which good results have been obtained, are necessary before the judgment founded upon the failure of our best men, with the same class of cases, and with the same operation, is required, before removal of the ossicles is generally adopted as a therapeutic resource. In Sexton's earlier papers he

[1] 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 Gehörorganes, p. 45. Heidelberg and Leipzig, 1827.

advocates removal of all the ossicles, but to judge from his latest reports, published in the *Archives of Otology* for May, 1891, he removes only the malleus. The incus and stapes he now admits are not always visible. The membrana tympani is also removed. This is very apt to re-form, when the hearing does not continue to be as much improved. I advise a careful consideration of Lucæ's[1] cases, as well as the isolated cases of Prout and Hackley, referred to in this volume, before too high hopes are had as to the efficacy of this operation in any considerable class of cases. But it is a sound surgical procedure in chronic suppurations, as a means of removing necrosed bones and hopelessly morbid tissue. But this is no new discovery, and has no bearing upon the present subject.

### 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[2] 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 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 remain-

[1] Otological Section, Berlin Congress, 1890.

[2] The effects of high atmospheric pressure, before quoted in Chapter X.

ing 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[1] 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 IN THE AUDITORY CANAL.

Politzer recommends the exhaustion of the air in the external auditory canal, by plugging the meatus with cotton-wool, saturated with oil, as a means of drawing out a sunken drumhead, when we have reason to believe that the tensor tympani is retracted. The patient closes the auditory canal in this manner in the evening, and removes the plug in the morning. If the plug be used two or three times a week, for two or three weeks, and no result be obtained, Politzer considers the remedy of no value.

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 tympanic cavity, was much used by the late Dr. H. Pinkney, 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 attached the syringe of a stomach-pump to the apparatus, and exhausted 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 with no satisfactory 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.

[1] Archiv für Ohrenheilkunde, Bd. I., p. 280.

### DELSTANCHE'S MASSEUR.

A great advance in the treatment of adhesions between the ossicles has been made by Delstanche's improvement upon Pinkney's apparatus. Pinkney's instrument was efficacious in his hand, but it is a clumsy instrument, which was displaced by Ely's Siegle, pictured on page 368. This in turn gives way to Delstanche's instrument, which is not only an excellent means of testing the mobility of the ossicles, but also of treating cases of chronic catarrh or chronic proliferous inflammation with the characteristic rigidity of the ossicles. By means of this new instrument I have had better success in the treatment of the rigid ossicula, and I have the agreeable opportunity of modifying my previously expressed opinions as to the negative results of this treatment. I think it an adjuvant of considerable value in the treatment of chronic non-suppurative inflammations, in the relief of tinnitus aurium, and impairment of hearing.

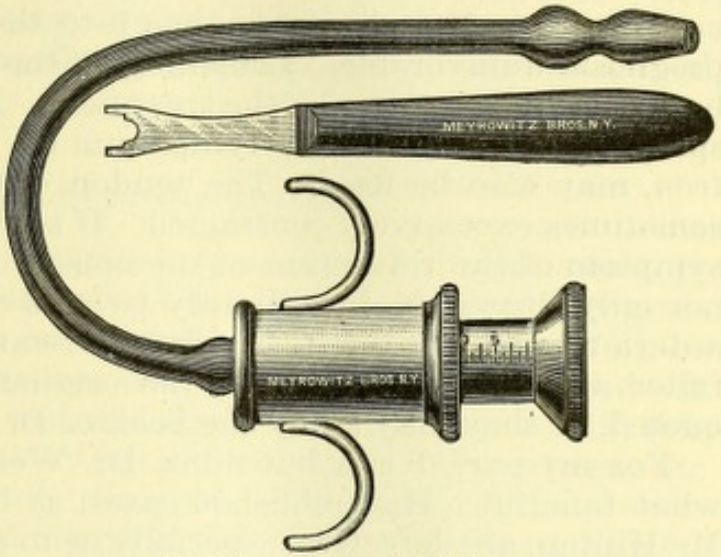


FIG. 95*a*.—Delstanche's Masseur.

### "PARETIC DEAFNESS."

No account of chronic non-suppurative inflammation of the middle ear, would be complete without a mention of the views of Weber-Liel, as first published in his monograph on progressive impairment of hearing, and in an article on affections of the middle ear,[1] published in a German encyclopædia for physicians. The upshot of this view of the chronic affections of the middle ear, belonging to the proliferous form, is that a derangement of the tension of any of the pharyngeal, tubal, or tympanic muscles will bring about secondary vaso-motor changes in all the parts within the tympanum. The most frequent form of such a derangement of tension is seen in a loss of power of the *tensor palati*. This induces a gradually increasing loss of hearing and

[1] Ueber das wesen und die Heilbarkeit der häufigsten Form progressive Schwerhörigkeit. Berlin: Hirschwald, 1873.

tinnitus, sometimes accompanied by catarrh of the tympanum, but more likely to be associated with sclerosis. The restoration of the normal muscular power should be the first object of treatment. Weber-Liel advises local electrization of the pharyngeal and tubal muscles, the continuous current being the most effective. This must be combined with careful attention to the general health. Hereditary tendency to the affection makes the prognosis unfavorable. Lessening of the tinnitus is one of the best signs in the course of the treatment. A very mild astringent spray, introduced into the tympanum by means of the *koniantron*, may also be used. The tendon of the tensor tympani is sometimes excessively contracted. If so it is to be divided. One symptom of the retraction of the muscle is, that the malleus is not only drawn in, but slightly twisted on its axis, so that its anterior surface is directed a little forward. Those who wish a fuller account will find it in the original, from which I have quoted, or they may study the book of Dr. Woakes.[1]

For my part, I can but think Dr. Weber-Liel's views somewhat fanciful. His published cases, as has been suggested by Mr. Hinton, are defective, especially as to their tests of the condition of the acoustic nerve. Dr. Woakes has somewhat amplified the views of Weber-Liel, but his book is essentially a reproduction of Weber-Liel's views. Woakes attaches great importance to inflammation of the gums in children in its reflex influence upon the ear. He seems to think that "the only obvious connecting link between the regions interested (the teeth and the ear) is the continuity of nerve-fibre," and this he finds in the relations of the vaso-motor nerves. This, in my opinion, is begging the whole question, for the direct connection between the buccal cavity and the Eustachian tube is obvious enough to allow of the propagation of inflammation by simple continuity of tissue, without the intervention of the vaso-motor nerves.

Dr. Woakes states that he had embodied his views on the deteriorating effect on the hearing power of certain pathological states of the palato-tubal muscles, in a paper which he read before the British Medical Association, without knowing Weber-Liel's paper, although "Progressive Impairment of Hearing" had been published for some time. Woakes's "Paretic Deafness," however, corresponds with great exactness to Weber-Liel's "Progressive Impairment of Hearing," and what has been said of the views of the one, may be said of the other. The objections to referring cases of chronic proliferous inflammation to catarrh, is one in which I fully sympathize, but I do not think we have

[1] On Deafness, Giddiness, and Noises in the Head. London, 1880.

found the way out in diagnosis, by ascribing their origin to paralysis of the pharyngeal, tubal, or tympanic muscles, nor in treatment by intra-tubal electricity, hydrobromic acid, strychnia, or the sesqui-carbonate of ammonia. I think it possible that some of Weber-Liel's cases, as well as those of Dr. Woakes, belong rather to the labyrinth than to the middle ear. For myself, I think I have been in the habit, in former days, of for getting that the cochlea, like the retina, may become the seat of chronic disease.

## RESULTS OF TREATMENT.

In my opinion, the results of treatment of chronic non-suppurative inflammation of the middle ear, will never be very gratifying. It is essentially an incurable affection. It may often be alleviated and sometimes arrested, but in adults never cured. It is pre-eminently a local disease—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, and sometimes even if they are. And yet a change from a harsh climate with long winters, to a mild one, will sometimes be of avail in lessening the horrors of tinnitus aurium, and arresting the advance of disease of the middle ear. Just how much can be done in this way, it is difficult to estimate, for catarrhal patients seem to grow worse in Colorado, which is so well adapted for many forms of phthisis. The changes of temperature in mild climates, are also felt very much by aural patients who have nasal and pharyngeal disease. One of my patients with chronic proliferous inflammation, has found the tinnitus aurium greatly relieved by a winter in the mountains of North Carolina. Another, with catarrhal inflammation, was happy in Florida, until malaria destroyed her peace. Some patients find the seashore, especially Newport and Narragansett, of benefit to the naso-pharyngeal region, while others cough and sneeze, and their "ears fill up" incessantly there. On the whole, I think the mountains are better for aural patients in summer. But I must confess that I have no exact opinions as to the influence of climate upon non-suppurative disease of the middle ear. The disease of the ear, is the last link in a long chain of improper conditions, and should never be considered as a primary affec-

tion, as an *entity* to be subjugated or driven out by special means adapted to many cases. It exists in this generation, in larger proportion than it will in the next. For acute disease will then be properly considered and treated, the hygienic management of the human body will be better understood. Just as chronic suppuration with its consequences, is markedly lessened in our own time, as the result of a wise appreciation of "earache," and acute catarrh, and suppuration, so will chronic catarrh be lessened as the importance of incipient aural disease is more and more appreciated. If the picture of the prognosis of chronic affections of the ear is a gloomy one to the young and enthusiastic practitioner, he must find his consolation in lessening their number in the next decade, by a proper treatment of acute aural disease in this.

There are yet, however, few medical colleges in this country where the otological course is complete or exact. Worse than this, attendance upon the lectures that are given, is generally not compulsory. It is only in special hospitals, and post-graduate colleges, that any adequate instruction is given, except in very few instances. All this must be changed, before we can expect a knowledge of aural pathology and therapeutics, and with this a decrease in the proportion of neglected and incurable cases.

If I were to sum up my conclusions after twenty years of work in this field, I should say that—

1. Chronic catarrhal inflammation in young subjects, is susceptible of relief and cure in a large proportion of cases.

2. Chronic catarrhal inflammation in adults, is susceptible of relief and alleviation in about twenty per cent. of the cases : of cure in none.

3. Chronic proliferous inflammation remains as yet incurable, and is not susceptible of alleviation or relief, either in the young or old subject, in more than five per cent. of the cases.

# CHAPTER XVI.

## CHRONIC SUPPURATION OF THE MIDDLE EAR.

Consequence of Acute Suppuration.—Otorrhœa an Improper Term.—Often confounded with Chronic Inflammation of the Canal.—Relative Frequency of the two Affections.—Symptoms.—Perforations of Membrana Tympani.—Treatment.—Syringing.—Astringents.—Fluids.—Powders.—Electricity.—Artificial Membrana Tympani.—Cases.—Prognosis.

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 in following chapters, 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.

The name chronic suppuration of the middle ear means a great deal. It comprehends a large variety of disease in one of the important parts of the body. The term chronic suppuration of the middle ear, usually implies a perforation of the drum-head or membrana tympani. In exceedingly rare cases, there may be a suppuration in the tympanic cavity and mastoid cells, especially in the latter, for weeks or even months, without the occurrence of a perforation of the delicate but firm membrane that forms the boundary between the middle and the external ear. In all but exceptional cases, however, when chronic suppuration of the middle ear is stated to be the diagnosis of a given case, it is meant that the ulceration involves the drum-head.

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 usually avail to stop a formation of pus in the cavity of the tympanum or the mastoid cells, unless local treatment is also employed.

We 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 spoken of 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 Inflammatory Affections of the External Ear and Suppuration of the Middle Ear.*

| Hospital. | Year or period. | Inflammation of ext. aud. canal, including eczema. | Suppuration of middle ear. |
|---|---|---|---|
| Manhattan (New York) Eye and Ear Hospital.. | 20 years | 824 | 6,675 |
| New York Eye and Ear Infirmary..... | 1889 | 164 | 1,173 |
| New York Ophthalmic and Aural Institute.... | 1889 | 52 | 296 |
| Brooklyn Eye and Ear Hospital..... | 21 years | 1,245 | 6,843 |
| Massachusetts Eye and Ear Infirmary..... | 1889 | 203 | 679 |
| Salem Hospital..... | 15 years | 123 | 565 |
| St. Michael's Hospital (Newark, N. J.)..... | 1888 | 50 | 178 |
| Newark Eye and Ear Infirmary..... | 1889 | 105 | 374 |
| Illinois Eye and Ear Infirmary..... | 1885–1886 | 32 | 467 |
| Buffalo Eye and Ear Infirmary..... | 1889 | 8 | 48 |
| | | 2,806 | 17,298 |

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 suppuration of the middle ear preponderate over the cases of external otitis of all kinds, 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 inflammation of the canal, simply because at the outset the inflammation was so great as not to allow of a view of the drum-head, which was afterward found to be affected. 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.

Of 4800 cases of my own, observed in private practice, there were 1011 cases of suppuration of the middle ear; of these 201 were cases of acute suppuration, and 810 of chronic. There were 265 cases of inflammation of the canal, including 85 cases of eczema and 13 of aspergillus.

*Symptoms.*—A discharge of pus 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. The term perforation, in its turn, includes a great variety of pathological conditions.

For example, the drum-head may be entirely swept away; one-half of it may be gone; one-third of it may be gone; only a small opening about as large as the head of a pin may exist; two openings may exist; so that in the very appearance of the drum-head we may meet the greatest difference in conditions.

Besides, polypi may be seen through the perforation, springing from the tympanic cavity, or there may be small growths or granulations hardly to be dignified by the term polypi. We may find the opening covered by hardened wax, or even by dried pus. Quite large quantities of muco-pus, pus, or of mucus, or of a fluid, like serum, may conceal the opening and be formed in a quantity sufficient to cause a constant flow into the auditory canal, or the quantity may be very small, and only to be detected on careful examination. In any consideration of the diseases of the middle ear, the practitioner should remember that the mastoid cells, as well as the cavity of the tympanum, are an integral portion of this anatomical region. Hence it is that the lining membrane of the mastoid is usually involved in any inflammation of the middle ear.

As will be seen by reference to a case recorded in a chapter on "The Consequences of Chronic Suppuration," pus may form, exist for weeks in the mastoid process, and 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, although it occurs in adults. 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 earache, 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 earache, 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 chromolithographs exhibit such a perforation, with the blood-vessels that are about to repair it, radiating toward 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.

Besides 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 and uncovered eye of facial paralysis are added to the disgusting detail of the ravages of disease.

After these facts are brought to recollection, I think I am justified in styling the term chronic suppuration of the middle ear, a very comprehensive one. It is an erroneous method of teaching which would describe suppuration of the tympanic cavity and mastoid cells by the term otorrhœa, and I think that a discussion of the treatment of a discharge from the ear, without a comprehensive view of the important pathological conditions which may exist in this part of the body, must be in its very nature misleading. No discussion of the treatment of the formation and discharge of pus from the tympanum, will be profitable unless there precedes it a full understanding of the anatomical and pathological conditions which allow the pus to be formed and collected.

If the middle ear were a simple canal or cavity, the principles at the basis of the treatment would, perhaps, be the same that they are now, but it comprises a *series* of anatomical parts, and the details in carrying out these principles are very different, and are much more varied than they would be were we dealing with a simple and easily bounded space. It is the anatomy of the middle ear, that makes the treatment of its diseases not an entirely simple matter.

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,[1] 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 pathognomonic 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

[1] Guy's Hospital Reports, Third Series, vol. xii.

membrana tympani, in a state of acute catarrhal inflammation, will sometimes exhibit this phenomenon 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."[1] The complete absence of the membrana tympani, especially if the mucus 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 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[2] has found albuminuria in a number of cases of chronic suppuration of the middle ear, where there was no apparent cause for the disease, except the long-continued secretion of pus in the tympanic cavity. 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

[1] Loc. cit , p. 630. [2] Verbal communication at New York Ophthalmological Society.

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, consult his fellow practitioners on the same point, and finally investigate the statistical tables of deaf and dumb asylums. In the answers to these queries 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 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 some cases on record—of which there are, alas! many more than were ever recorded—where disease of the brain has occurred from the extension of a neglected suppuration to the cerebral membranes and substance, and the discharge from the ear has nearly ceased; but these certainly form no argument against the arrest of an ulcerative process before any parts beyond the cavity of the tympanum are involved.

He who believes that we can easily cause a discharge of pus to cease, after caries of the temporal bone has occurred, will find many cases which will cause him to doubt the efficacy of his therapeutics. As well might we refuse to heal an ulcerated hip-joint, as to neglect to check a discharge from a diseased membrana tympani or lining membrane of the tympanic cavity.

It is doubtless true, judging from the histories of cases and the inspection of the membrana tympani, in which cicatrices occur, that many cases of chronic suppuration are cured with very slight treatment, or with none at all. The fact remains,

however, that many of the neglected cases do not so recover, and after a purulent discharge from the ear has once set in, "*we can never tell*," to quote again the words of Wilde, which should be impressed upon the attention of every practitioner of medicine, "*how, when, or where it will end, or what it may lead to.*"[1]

A careful treatment is usually required to check the discharge and treat the ulcerated membrana tympani, and restore the hearing power. Even with the most careful and skilful treatment, we cannot always succeed in all of these things. In some rare cases we do not succeed in any of them; 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 merely 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 the last chapter, Sir Astley Cooper, in a paper published in the "Transactions of the Royal Society," in 1800,[2] 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 has perhaps as many, if not more, important anatomical relations than any one of similar size in the human body. The cavity of the tympanum is covered above by a thin, rarefied bony plate, which is in direct communication with the cerebral

[1] Text-book, p. 407.

[2] Philosophical Transactions, Part I. 1800.

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 constitutional, altogether too much was left to the supposed knowledge and skill of the patient or his attendant.

Perhaps not more than one layman in a hundred can, without 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 133), the proper method of syringing has been carefully described, so that we need not dwell upon the subject again.

Objections have been made to the use of the syringe. One authority, for whom I have a great respect, says, in referring to the cleansing of the ear from pus, and in italics, too, "*The syringe, as a rule, is not to be used.*"[1] When differences of opinion like this as to modes of treatment arise, there is not much to be said except to show that one recognizes his own standpoint, and the difficulties of it, and gives good heed to the contrary one. I think I am not ignorant of the abuse of syringing, or of the fact that much that is called cleansing the ear by syringing has no right to such a name. I am also well aware of the ill effects in isolated cases from syringing. I once reported[2] a case in which a gentleman who consulted me suffered so seriously from syncope, after a very gentle syringing of the ear, that for some moments it was thought by myself and others, that he would certainly die. This patient, however, would probably suffer in the same way from any surgical procedure. After his recovery he told me that he had once fainted in the same alarming way on calling upon a surgeon who proposed to make some kind of an examination. Faintness, vertigo, and nausea are also sometimes produced even by gentle syringing of the ear. Yet, if the proper method is practised, and the proper care as to gentleness be taken, it is not one case in a hundred in which any unpleasant symptoms will occur. Simple a procedure as it is, the proper method must first be learned. The water should be warmed; it should be injected into the concha before it is allowed to pass into the auditory canal—in short, until you know your patient, you should always proceed very slowly and gently with the syringe, especially in the removal of pus.

But, in spite of all these drawbacks, none of which I would underrate, I believe, as an outcome of twenty years' active experience in aural disease, that it remains the best means, on the whole, in by far the largest number of cases of cleansing the ear. I cannot think that the use of warm water to the ear thoroughly and often is any more dangerous, but, on the contrary, of the same amount of good as the use of the same agent in the same way in cleansing fistulous ulcers, open cavities, and other parts of the body which may from time to time become filled with pus. I see no argument in the reasoning that, because warm water may soften the tissue, its use should be avoided for the purpose of cleansing a cavity which requires it. The best syringe which I have ever seen is one to be procured in Paris of Lüer, which has not come into general use, which we are using

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[1] Diseases of the Ear, by A. H. Buck, p. 232.

[2] Archives of Otology, vol. ix., p. 16.

in the Manhattan Eye and Ear Hospital, and which I am using in my private practice with great satisfaction. It is called the reservoir syringe (see page 132), and it is filled without any motion of the piston, so that the one action required is the discharge of its contents into the ear. On the withdrawal of the piston it fills itself perfectly. The India-rubber syringes sold in the shops will do very well for patients to use in cases of short duration; in chronic cases a good metallic syringe is required. The fountain syringe is valuable where prolonged irrigation is required, as is also Fayette Taylor's douche. But for ordinary use the piston syringe, made of metal, is the preferable one for the purpose of removing discharges from the ear.

Unless the practitioner has had a large experience in cleansing ears, he should avoid the use of a syringe whose nozzle is long enough and sufficiently slender to enter the auditory canal as far as the junction of the bony with the cartilaginous portion. The slightest unexpected movement of the patient while the syringe is used, may cause great harm to the lining membrane of the canal.

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, are necessary to the successful treatment of any case of chronic suppuration in the ear. This personal care need not always be daily, although it is better to have it so; but it should, at the very least, be given twice a week, while the attendant of the patient is instructed as well as may be, for the performance of the duty of cleansing the ear in the intervening time. The importance of the cases for which the daily attendance of the physician is required, if properly set forth, will do away with any objections that may be made. No one certainly would object to the daily attendance of a physician upon a case of suppuration of the cornea, and 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: The ear is first carefully cleansed with lukewarm water by means of a good syringe. The bowl to contain the water coming from the ear, should be held by the patient himself—unless a very young child be the subject—and be pressed well into the glenoid fossa, when no water will be spilled. After this the ear is filled with lukewarm water poured from a test-tube, a spoon, or the like, and the meatus carefully stopped by

a bit of 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.

A long slender pipette, or Hartmann's tympanic syringe, are sometimes necessary to clean a tympanic cavity that is not well exposed because the hole in the drum-head is small. The curette will sometimes be necessary also, in order to cleanse the tympanum from inspissated pus.

Sometimes the use of the piston syringe is not well borne by the patient, the shock of the water being too great. In such cases the fountain syringe should be used. 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—

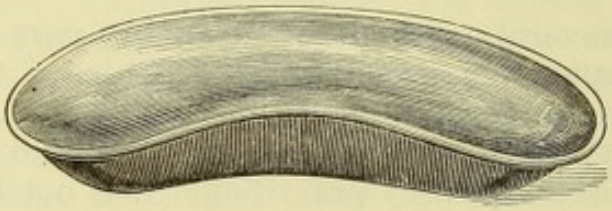

FIG. 96.—Vessel used in Syringing the Ear.

the "Eiterbecher" of the Germans. It 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.

After the syringing, the parts should be dried by the use of absorbent cotton twisted about a bit of wood, or a wire cotton-holder, very carefully applied, with the aural mirror on the forehead, so that both hands are free. For self-evident reasons, it would never be proper to leave fluid in a cavity upon which medication is about to be applied. After you have secured thorough cleansing of the ears, I believe medication is of second-

ary importance. Wilde's snare and Buck's curettes are the best instruments, for removing polypi where instrumental interference becomes necessary. Nothing will keep up a discharge of pus from the ear, so persistently as a small polypus or granulation. My experience is exactly the same as that of Tröltsch, published in his treatise on the ear, in the first edition of 1862, where he states that he has often seen a discharge of very long standing disappear, as in the twinkling of an eye, on the removal of a small growth. I think the curettes should be made with sharp edges — not blunt, as first sold in the shops. The profession is very much indebted to Buck and Politzer, for the suggestion of these very useful instruments for cleaning out the tympanic cavity and auditory canal. I hardly know how I would get on without them, after having enjoyed their use for some years. Pedunculated granulations and polypi, should be removed as one of the first steps in any continued treatment. Granulations with a broad base are very troublesome, it being very difficult to remove them thoroughly, even when the patient is under observation for a long time. It is often necessary to etherize the patient in order to free the tympanic cavity from granulations. The great prerequisite having been accomplished, of securing a free tympanic cavity, the question then is, What agent shall we choose for the cure of the diseased membrane, and, consequently, for stopping the discharge? A very great deal, of late, has been said about the so-called dry treatment of suppuration of the middle ear. There was a famous peripatetic quack who practised a dry treatment which was peculiarly successful. He was in the habit of pouring in plaster-of-Paris, for the cure of long-existing discharge of pus from the ear, and the cure for a time was effectual. Much of the so-called dry treatment of to-day, will in some cases be as disappointing as was its prototype. The treatment by powders is, not particularly new, however. The late Mr. James Hinton was very much in the habit of using French chalk and other powders, and my former assistant, Dr. F. H. Rankin, of Newport, recommended iodoform in diseases of the ear, in an article published in the *New York Medical Journal*, some time after he had

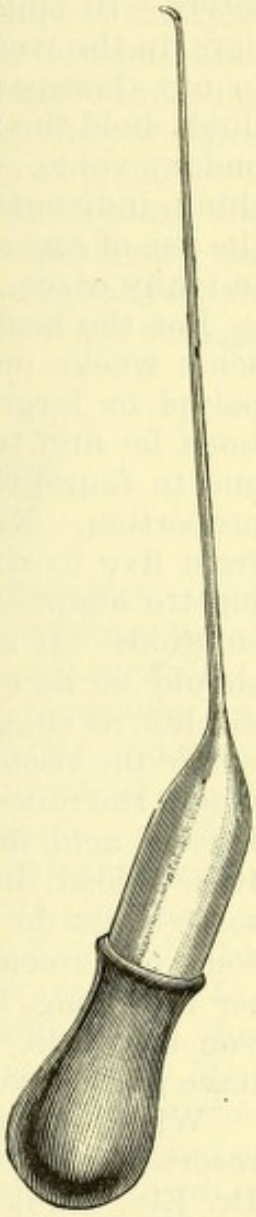

FIG. 97.—Buck's Pipette.

successfully used it in the Manhattan Hospital. Agnew, and Rider, and other authorities have long used powdered alum. Treatment by powders is not, therefore, a new subject, although some agents, boracic acid in particular, have been used only lately. In spite of all the claims for the exclusive use of powders, in the treatment of the ear, and valuable as is their place in our therapeutic resources, I still think that instillations of fluids hold the first rank, and that the use of powders is of secondary value. Whatever may be thought of this view, it is, I think, indisputably sound doctrine that cleansing must precede the use of any agents, and that thorough cleansing is impossible, in many cases, without the use of the syringe.

For the healing of a diseased mucous membrane that has for some weeks or months secreted pus, and which is free from polypi or large granulations, I would advise that fluid applications be first tried. In my practice I use sulphate of zinc, from one to four grains to the ounce; sulphate of alum in the same proportion. Nitrate of silver I use usually upon a cotton-holder, from five to sixty grains to the ounce, or from a long, slender pipette adapted to the middle ear, (see Fig. 97) in the weak solutions. If a strong solution of nitrate of silver be used, it should be at once neutralized with salt and water. I also use alcohol, as suggested by Lowenburg, of Paris, especially in cases where the tissue is granular. A preparation of resorcin in cases where the mucous discharge exceeds the purulent, is also useful. Boracic acid in solution seems to me to accomplish very little. It is, indeed, difficult to say which are the best astringents. But some cases do well with any of the ordinary astringents, and some never cease to be the seat of the formation of pus, no matter how long, how carefully you treat them, and what agents you may use. Carbolic acid and permanganate of potassium have proved worse than useless in my hands.

When solutions do not act well or promptly, powders may be resorted to. Iodoform is valuable in some cases. My associate, Dr. Ely, thinks it especially useful in those cases where the tissues are pallid and have an indolent appearance. Well-triturated boracic acid is also a useful agent, but it is by no means a panacea, no matter how it is applied, or with whatsoever combinations. There are objections to powders which at once suggest themselves when their use is advocated in treating diseased mucous membranes, like those of the nose or middle ear. They are not always absorbed, and they sometimes leave a troublesome, irritating mass behind. Then they occasionally impair the hearing by mechanically obstructing the passage of the sound waves. While a solution is poured into the ear, and in

from five to ten minutes that which is not absorbed may be allowed to run out, the powder must remain until the ear is again cleansed, which is not for hours. A tube made from a quill, or one of the powder-blowers especially invented for the purpose, do equally well for forcing the powder into the canal of the tympanic cavity. I do not employ large masses of the powder—simply enough to give the ulcerated or carious portion a good coating.

Solutions are usually much better tolerated by the ear when they are warm. A lighted gas-burner, the flame of a candle, a bowl of hot water, are all convenient means for heating the solution which is to be used. When powder is employed, the mirror should be used from the forehead, so that one may know just where it has gone, and renew the application if not enough is applied.

FIG. 98.—Knapp's Powder-Blower.

Whatever may be said in favor of certain specifics, used either as powders or solutions, certain cases of suppuration of the middle ear will remain uncured in hands never so skilful. They are, from their nature or their environment, incurable. A case of long-standing ulceration in the tympanic cavity and mastoid is almost certain to involve more or less superficial death of the bone. When there is dead bone that cannot properly be removed by instruments, solutions of dilute mineral acids, nitric acid and sulphuric—one-quarter to one-half per cent.—dropped into the ear twice a day (Dr. Urban Pritchard) will be serviceable. An error in treatment, an injudicious mode of life, an undue exposure to wet and cold, may at any time cause the smoldering disease to blaze into a condition that is fatal to life. Pyæmia, meningitis, and cerebral abscess are by no means the infrequent ending of some of those cases. He who has found a panacea for all of them, is in a state of mind far removed from a scientific consideration, of the conditions which are to be found in chronic suppuration of the middle ear.

When it is said that "a moist treatment of otorrhœa in many instances has a tendency to keep up rather than to check the morbid discharge from the ear,"[1] if by this language, it is meant that careful cleansing of a suppurating middle ear with warm water, and the subsequent instillation of solutions, is in many instances a bad surgical method, I can only answer that this statement, according to my experience, is not borne out by facts.

[1] Burnett: American Journal of the Medical Sciences, January, 1883.

The presence of granulations and polypoid growths does not, in my opinion, contra-indicate the use of warm water. Their presence does indicate, however, a necessity for their removal, either by the snare, the forceps, or caustics, *pari passu* with the constant cleansing process. Over and over again, however, have I seen growths shrivel and disappear, before the operator was ready to remove them by cutting or twisting instruments or by caustics, under the simple plan of cleansing the ear with warm water.

I think it important to inflate the ears very frequently, from two to four times a week, and sometimes daily, by means of Politzer's method, during the treatment of chronic suppuration of the middle ear. The current of air is useful to dislodge inspissated pus or tenacious mucus, and it assists materially in the essential preliminary of all applications; that is, a complete removal of the pus. Sometimes exhaustion of the air from the tympanum by Siegle's otoscope aids in getting the cavity clean. An ordinary air-bag may also be used for this purpose. Those cases in which there is a constant accumulation of long strings of very tenacious mucus, with very little pus, are exceedingly difficult to manage. The cause for this is to be found in the excessive catarrh of the naso-pharyngeal space, and of the Eustachian tube, which usually accompanies this condition of the tympanic cavity. The mucus is so tenacious in these cases that not even the syringe or the cotton-holder will remove it, but the forceps must be resorted to. Of course, fundamental treatment will begin at the *fons et origo*, of the disease of the middle ear, that of the nose and throat. I need hardly say that the general condition is to be most carefully considered in all cases of chronic local disease. The practitioner will often find much to do in this direction, in these cases of chronic suppuration of the ear. The restoration of a perforated drum-head is a most interesting reparative process. The ease and rapidity with which they heal in recent cases is startling, and even in chronic cases, we are sometimes agreeably surprised to see how soon a membrana tympani is restored, after simple cleansing of the middle ear has been maintained for a few weeks.

The caustics which I use for removing granulations, are fuming nitric acid and chromic acid, as well as solutions of nitrate of silver, from twenty to sixty grains to the ounce. Alcohol is also valuable. When alcohol is employed it should be used at least twice a day, and warmed before it is poured in the ear. The application is painful for a few instants only. I usually cause the granulations to bleed freely, by puncturing them with a cataract-needle, before applying the caustics.

Burnett[1] thinks that zinc-drops, may supply something which makes the bottom of the auditory canal favorable to the growth of the aspergillus or aural fungus. As proof of this, is adduced the fact that a fungus is sometimes found in zinc solutions that have been imperfectly stoppered. All the harm that fungi in zinc or other solutions can probably accomplish, is to weaken the solution. I consider this objection to zinc, or other solutions as unsubstantiated as yet by any facts, and doubtful even from a theoretical point of view, for it is improbable that the fungus would be poured into the ear, but that portion of the solution which is clear. Besides, before the growths were established, the next good syringing with warm water would be an efficient parasiticide if any were necessary.

In June, 1878, Dr. Edward T. Ely,[2] my associate in private practice, made use of skin grafting in the treatment of chronic suppuration of the middle ear. Dr. Ely continued this practice in nine cases occurring among our patients, and I have repeated his experiments. This method of treatment is especially indicated for cases where we cannot expect a restoration of the membrane and a cessation of the discharge by the ordinary treatment. The results obtained have not been brilliant, but in two cases a substantial gain in the condition of the tympanic cavity was secured.

This operation is available in cases where the membrana tympani is nearly gone, and where the discharge is at times considerable, but which at other times ceases. The ear is first carefully dried, and after due care has been taken that all the instruments to be used, as well as the hands of the surgeon and his assistant, are scrupulously clean, a small bit of integument is removed from the arm of the patient.

It is carefully soaked in a solution of boracic acid, and applied by means of a cotton-holder, silver probe, or Politzer's eyelet forceps to the exposed surface of the tympanic cavity. As many as three or four grafts may be applied. The canal is then gently packed with absorbent cotton, and the patient is advised to be very careful to avoid active exercise, riding in wagons, stages, or other conveyances, in which there is much motion, for two or three days. The grafts may be examined in three or four days. If union has occurred the packing should be continued for a few days longer. I think, from personal experience, that this method of treatment will be of service in a limited class of cases, where an occasional period of suppuration

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[1] American Journal of the Medical Sciences, January, 1883.

[2] Archives of Otology, vol. ix., p. 343.

occurs in a largely exposed tympanic cavity, over which the drum-head cannot be made to heal by ordinary means, and where the discharge of pus only occurs at intervals, for example, during a coryza. If the grafts do not completely cover the exposed tympanic cavity, they may diminish the secreting surface.

Berthold, in August, 1878, two months after Ely's cases, performed myringoplasty [1] in two cases. The perforations healed, apparently as the result of a new inflammation set up by the manipulations and by the adhesion of a portion of the graft which became a portion of the new tissue. Berthold put a piece of court-plaster upon the drum membrane, which he allowed to remain there three days. The object of this was to remove the epithelium. The drum-head was found to be closed on the twentieth day. In a second case, also, a perforation was healed by this method. C. U. Tangeman, has also published an interesting case of reproduction of the membrana tympani by skin grafting. He denuded the edges of the perforation and put in a piece of skin from the arm of the patient, and retained it in position by collodion. The drum-heads were not entirely closed, but nearly so.[2]

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." [3]

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.

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

[1] Monatsschrift für Ohrenheilkunde, November, 1878. From Vortrag in Naturforscher Sammlung. Cassel, 1878.

[2] Archives of Otology, vol. xii., p. 228.

[3] Archiv für Ohrenheilkunde, Bd. IV., p. 2.

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 syringed the tympanic cavity through the Eustachian tube, and used, both for this external and internal syringing, solutions of carbonate of soda, say of twenty grains to the ounce. 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.

Instead of washing out the canal with a solution of bicarbonate of soda, I think it much better to cause the patient to drop in a solution of say twenty grains to the ounce, once or twice a day. After this has had the effect of softening inspissated pus, the ear may be syringed with warm water.

It is necessary 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.

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 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.

Many cases of chronic suppuration of the middle ear are not cured because the treatment is carried on by the patient himself or by his friends. Very few persons are capable of thoroughly cleansing their own ears. No one is capable of thoroughly cleansing the ear of another unless a special training for this object has been undergone. In fact, a successful treatment of these cases requires the care of a physician. It is easier to learn to clean and dress an ordinary bone fistula, than to learn to remove the secretions from an inflamed tympanic cavity and mastoid cells. He who would bring his cases to a successful ending, must himself bear the brunt of the labor of treatment. It cannot be given over to inexperienced hands. Whenever this personal care of the physician is not to be obtained for these chronic cases, only approximately good results are possible. I have sometimes been able to train a nurse or relative of the patient, so that quite thorough cleansing is effected.

Besides all this, each case should be considered by itself. Some cases will tolerate thorough cleansing by the syringe, cotton-holder, and curette, while others will resent all but the most delicate handling, by fits of vertigo, fainting, and inflammatory reaction, so that a case must be studied for a few days before it can be definitely determined as to how much and what is to be done.

Dr. G. M. Beard[1] thought that the galvanic current was 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, tested this 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.

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[1] Verbal communication.

In cases of chronic suppuration of the tympanic cavity, where the opening in the drum-head is very small, or when from any other reason it is very difficult to thoroughly remove the pus, I have found benefit—in connection with the use of Politzer's method of inflation—from the use of Siegle's otoscope attached to a syringe, for the purpose of sucking out, as it were, the fluids from the drum-cavity. After all the other means of cleansing the part have been thoroughly used, it will still be sometimes found that more pus may be evacuated by the suction method.

Hartmann's tympanic syringe, which has been mentioned on one of the preceding pages, is often useful in cleansing the tympanum. It consists essentially of a silver tube 2½ mm. in circumference and 7 cm. long. Each extremity is curved, the one for the tympanum at a right angle; the curved portion is about one mm. long. The distal end of the tube is curved at an obtuse angle, and has somewhat of a funnel-shaped orifice, to which a bit of rubber tubing is attached. The tubing should be as delicate as possible, so that its weight may not interfere with the position of the tube in the tympanum. The water is injected by means of a Davidson syringe, affixed to the rubber tubing.

Dr. C. I. Pardee[1] 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 surgeon who is in the frequent habit of examining the membrana tympani will find many cases that show how easily an ulcerated drum-head will sometimes heal under very simple or very crude treatment. Cicatricial drum-heads are a very common experience in the aural surgeon's observations. A little study of the history of these cases shows that in very many instances they were healed when they were being treated with what we should term neglect. All this should teach us to be

[1] Transactions of the American Otological Society, Fourth Annual Meeting, 1871.

very careful students of the healing processes of Nature. In our anxiety to see results from treatment, let us remember to put ourselves in the position of Ambroise Paré, whose benediction to his wounded patient was, "I have dressed you, may God cure you."

All cases of chronic suppuration of the middle ear, will not be cured even by good treatment and favorable conditions, while here and there, we are surprised to find that some unpromising cases do very well, even under bad circumstances and with no thorough treatment. To expect too much from treatment, to do too much, is to be meddlesome in intent and action. If we are to make a choice of evils, it is better to be skeptical and inactive, than credulous and meddlesome.

It is an interesting fact that very few patients suffering from phthisis pulmonalis ever recover from a suppuration of the ear. Even so far as the accumulation of pus is concerned, no matter how long they may live, the cough usually prevents any healing of the membrana tympani. I have one case under observation—the only one I have ever seen—where the discharge and formation of pus have ceased, although the perforation of the membrane does not close.

### REMOVAL OF THE OSSICLES IN CHRONIC SUPPURATION.

All aural surgeons have observed the great benefit sometimes resulting from a thorough removal of granulations, and of scraping or curetting the tympanum. When the ossicles are necrotic, and gentler means fail to correct the discharge, much less to stop it, a thorough removal of the ossicles is indicated. Schwartze first suggested and performed this operation, but he is conservative in recommending its performance, while Sexton advocates it very warmly, even on cases where it seems to me that the usually efficient means already described in detail should first be given a fair trial. Whatever may be said to the contrary, removal of the ossicles, and only the ossicles, with however good an illumination, is not a very simple operation, nor one entirely devoid of danger. The inconvenience and danger of a chronic suppurative aural process are, however, so great that we are justified in such a severe procedure, when the continuance of the discharge is due to necrotic bone that may, under anæsthesia be readily removed. No especial directions are needed for such an operation. The patient should be under the influence of ether. The illumination will soon fail on account of the bleeding, but in cases such as those for which the removal of the necrotic bone is performed will suffer no harm if the diseased

membrane be even very thoroughly scraped in removing the bones. To advise the operation, however, when we cannot definitely decide that the ossicles are necrosed, and the tissue granular, before less radical means are given a fair trial, is unwise. Thorough scarification of the bony canal is sometimes of great service in lessening a chronic inflammation of the tympanum.

### 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 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

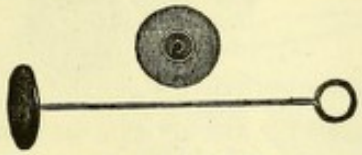

FIG. 99.—Toynbee's Artificial Membrana Tympani.

the canal quite thoroughly. When it is employed for the purpose of improving the hearing, having been slightly moistened, it is inserted under inspection—that is, while the parts are well illuminated by the otoscope—by means of a pair of forceps, that should be very weak in the spring, so that the blades may come together with very little pressure, or by a probe.[1]

The appropriate position for the cotton, where it will improve the hearing, will be found, if it is to do any good, by placing it on different parts of the exposed tympanic cavity, or the remains of the drum-head, until the patient experiences an improvement in the hearing power.

I have taught a number of patients to use this kind of a drum-head, and I have seen many others who have learned to use it from other physicians. In the most cases, however, Toynbee's disk is preferred, as being easier to manage.

There has been quite a good deal written of the cotton pellet of late. This may serve to call it again to the marked attention of the profession. Yet nothing essentially new has been said upon the subject, since Yearsley brought it fully before the pro-

[1] Yearsley on Deafness, p. 245.

fession in his text-book. To Yearsley belongs all the credit of quickly utilizing the strong hint given him by the New York merchant with his spill of paper, and of suggesting a practical use of an artificial membrana tympani. Queerly enough, another New York merchant, who had accidentally learned to improve his hearing by a little roll of paper, without knowing of his immortal predecessor, or of Yearsley or Toynbee, consulted me a few years since.

In 1853, Toynbee suggested another artificial membrana tympani, without knowing of the previous invention. Toynbee's appliance consists of a thin disk of vulcanized rubber, in the centre of which is attached a fine wire about an inch long, which

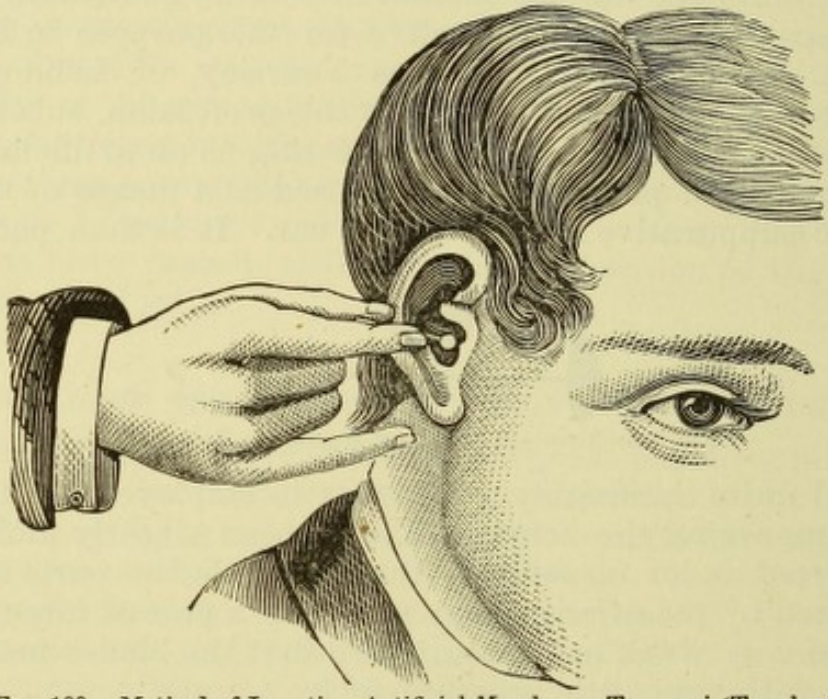

FIG. 100.—Method of Inserting Artificial Membrana Tympani (Toynbee).

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 corkscrew in a cork.

We can never tell without trial, whether the artificial membrana tympani will, or will not improve the hearing. Inasmuch 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 an imperforate membrana tympani. The improve-

ment to the hearing that does sometimes occur when the cotton-wool, or the membrane of Toynbee is used, is probably due to the restoration of the interrupted continuity of the ossicula auditus, or even of the stapes alone, to the fenestra ovalis and the labyrinth. Toynbee explained its benefit by stating that it occurred as a result of the closure of the membrane; but this has been shown to be an erroneous explanation. Cases have been seen where the perforation was not closed by the artificial membrane, and yet great improvement to the hearing resulted from its use. When the patient first begins to wear this membrane, it should be used but for a very short time during the day. It is always a foreign body, and hence it is liable to produce irritation and increase the suppurative process. 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 many 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.

Various modifications of Toynbee's disk attached to a wire have been made. Thus, Lucæ attaches the disk to a small rubber tube. Burkhard-Merian uses a solid piece of india-rubber instead of a wire. Politzer makes one especially to spare the poor the expense of buying Toynbee's disk. A piece ½ ctm. long is cut from the side of an india-rubber tube 2 to 3 mm. in thick-

ness, a hole is then made in one end and a wire handle fastened in it. Politzer also recommends the use of an india-rubber tube, as long as the canal, rounded off at the distal end and pushed down to the remains of the drum-head. In cases in which the sides of the stapes bone have been destroyed, Politzer has also attached a stapes bone taken from a dead body to Toynbee's disk, and introduces it, so that the bone lies in the niche of the fenestra ovalis,[1] with benefit to the hearing.

Michael[2] instills glycerine, in some cases medicated with tannin, and then collodion, and thus forms a membranous covering, of which he speaks highly. Hartmann[3] recommends, in cases where the other varieties of artificial membranæ tympani do not prove serviceable, a noose of the most delicate and elastic whalebone, wound about with cotton.

In introducing this appliance the auditory canal must be straightened, by pulling back the auricle, while the bone is placed in position, somewhat anteriorly in the depth of the canal. Its use requires some care, but this may be said of all artificial membranes; for, as I have said, stupid adults and children cannot use them successfully. Polaki uses paper disks with great success.

*Prognosis.*—The prognosis in chronic suppuration of the middle ear depends upon a variety of local and constitutional symptoms. If the consequences of chronic suppuration have occurred, such as exfoliation and death of bone, the formation of polypi, exostoses, and so on, the treatment is apt to be prolonged, and in some cases may never be entirely or even partially successful. Again, when the membrana tympani is entirely removed, and one or more of the ossicula lost, the prognosis is grave. Yet the membrana tympani has a regenerative power second to that of no other membrane of the body. I have repeatedly seen it entirely restored after all but a narrow rim had been entirely swept away. This has even occurred in cases of long standing. The prompt healing of the drum-head after operative perforation and in acute inflammation, is a matter of common experience.

The state of the general system will also at times influence the prognosis to a marked degree. 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

[1] Politzer: Text-book, p. 492, original p. 563.

[2] Transactions of International Congress, London, vol. iii., p. 434.

[3] Die Krankheiten des Ohres, p 99.

local treatment only is required; while it is essential in all. We may say, on the whole, that the prognosis can never be decidedly given so long as the membrana tympani is open, for this membrane is essential to the safety of the ear from renewed attacks of acute suppuration. All our efforts should be directed, therefore, to closing up this opening. There can be no danger from closing it too soon. Our chief difficulty will be in closing it at all. If the membrane cannot be restored, the tympanic tissue may sometimes be made cicatricial, and thus the suppuration be stopped. If regular and careful treatment by a physician, continued for months, fails to close the opening, 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 inflammation occurs, and they should know that the chief danger to the ear, and the general system, lies in an accumulation and retention of pus.

Patients suffering from an accumulation and discharge of pus from the tympanum cannot be too careful of their general health. A simple cold in the head may be fatal to them by causing an inflammation of the ear, followed by meningitis. Every year of my practice brings to my attention fatal cases of this kind.

### 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——, aged thirty-two. 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., $\frac{24}{25}$; L., $\frac{1}{25}$. 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 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 $\frac{2}{48}$ 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.

I have seen this patient while preparing these pages for the press. Two years ago he had an acute inflammation of the right ear, which subsided, but which left a small opening without ulceration. His hearing distance for the watch varies, but is generally very good and he hears conversation well. He is still actively engaged in business as a merchant, fourteen years since he left my care.

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——, aged twenty-six. November, 1870. Since patient was eleven 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 the left ear is $\frac{30}{48}$. 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——, aged twenty-eight. November, 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, and 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——. November 8, 1872 (sent to me by Dr. H. C. Eno). When the patient was sixteen 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 $\frac{15}{48}$.

On examination, a slight amount of pus is found upon the membrana tympani. On removing this, a small granulation is seen perforating 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. xl. ad ℥ j., was applied in the opening, after a thorough cleansing of the ear by syringing and Politzer's method.

November 10.—The opening of the membrane has closed. The patient remained under observation until November 22d, and suppuration did not again occur. The hearing distance became $\frac{4}{8}$.

1870.—This membrane continues sound, although the patient has had eczema of the canal and perforation in another part of the membrane once, since the one here described healed.

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.

Chronic Suppuration and its Results Inevitably Dangerous to the Health and Life of the Patient.—Refusal of Life Insurance Companies to take Risks of such Cases.—Cicatrices and Adhesions in the Tympanum.—Polypi.—Exostoses.—Mathewson's Operation for their Removal.—Cases.

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 this disease.

It is in view of these consequences, that English life insurance companies are said to decline to insure the lives of persons that are affected with chronic suppuration of the middle ear. 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.

Among the possible and not infrequent consequences of chronic suppuration of the middle ear are—

1. Cicatrices and adhesions in the drum-head and tympanum.
2. Polypi.

3. Exostoses.
4. Mastoid disease.
5. Caries and necrosis of the temporal bone.
6. Cerebral abscess.
7. Pyæmia.
8. Paralysis.

### CICATRICES AND ADHESIONS.

In some fortunate cases of chronic suppuration, as we have seen, an end is finally reached by a closure of the membrana tympani. This may even occur when one or all of the ossicles have been removed. The impairment of hearing may be very great, with a neoplastic membrana tympani, but the danger to life and to the general health, is much lessened by a closure of the tympanum. Healing of the ulcerated membrana tympani, is therefore a result to be desired, even if the hearing be not as great after this has occurred, as it was when it was perforate and ulcerating. The drum-head, however, may not close, and yet its edges cicatrize and adhere to the tympanic wall. The tympanum then will be converted into a dry chamber, its mucous membrane so altered that it scarcely secretes, and only under great provocation takes on inflammatory action. It is sometimes difficult in such cases to determine what is left of the normal furniture of the tympanum, such a mass is it, of displaced and neoplastic tissue. If the stapes bone still remain, or even its foot-plate, it is sometimes possible to use an artificial membrana tympani with great benefit; but generally the adhesions and cicatrices involve so much of the air chamber, with perhaps an extension into the tissues of the labyrinth, that literally nothing can be done for the patient, except to leave his ears to themselves. Bad as this condition is, it is a more favorable one than when the ulcerative process still continues, with perhaps some one or more of the results that are now to be described.

### 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,[1] 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.[2]

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[3] also reports a peculiar growth, which is called a clot of blood in process of organization, but it hardly requires a separate classification.

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,[4] 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[5] quotes him as stating that the chief contents of those polypi were granulation material, although he states that the

[1] Archiv für Ohrenheilkunde, Bd. IV., p. 203.
[2] Transactions of the American Otological Society, 1870.
[3] Archiv für Ohrenheilkunde, Bd. IV., p. 187.
[4] American Medical Times, August 6, 1864.
[5] Archiv für Ohrenheilkunde, loc. cit.

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.

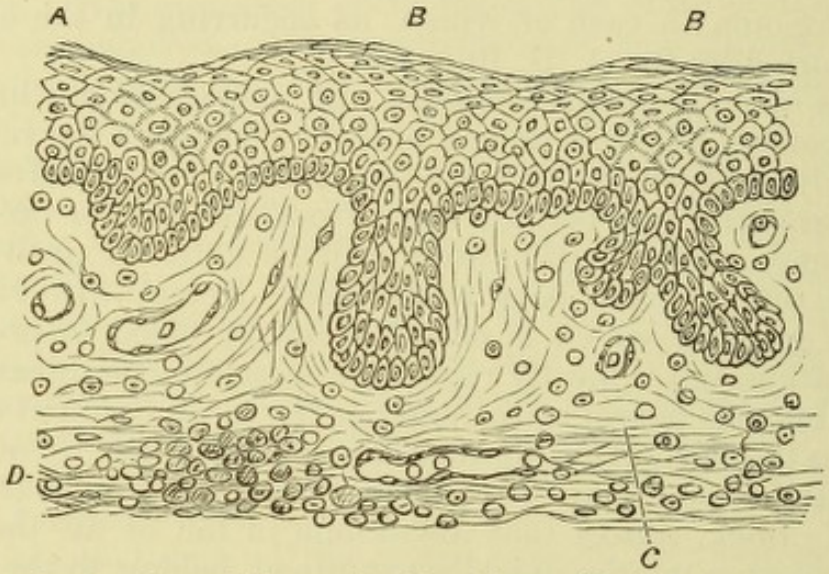


FIG. 101.—Section of Aural Polypus, Case I. *A*, Layer of laminated epithelium, similar to that of skin; *B*, *B*, epithelial cones, the commencement of gland formation; *C*, loose connective tissue, containing round and spindle cells and some fibres; *D*, blood-vessels.

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[1] named the form which Dr. Buck examined, *angioma cavernosum*, because it was characterized by the existence of a network of blood spaces, occupying the place and doing the work of capillary vessels.

It may be said in general terms, however, that aural polypi are growths covered by laminated epithelium, and that they consist of loose connective tissue, containing round and fusiform cells and a proportionately large number of blood-vessels. Their internal structure in some cases gives evidence of the formation of glands.

Dr. H. C. Eno, formerly Pathologist to the Manhattan Eye

[1] Die krankhaften Geschwülste, III. Bd., Hf. I., p. 307.

and Ear Hospital, and 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.

Case I.—Thomas G——, aged twenty-three. 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

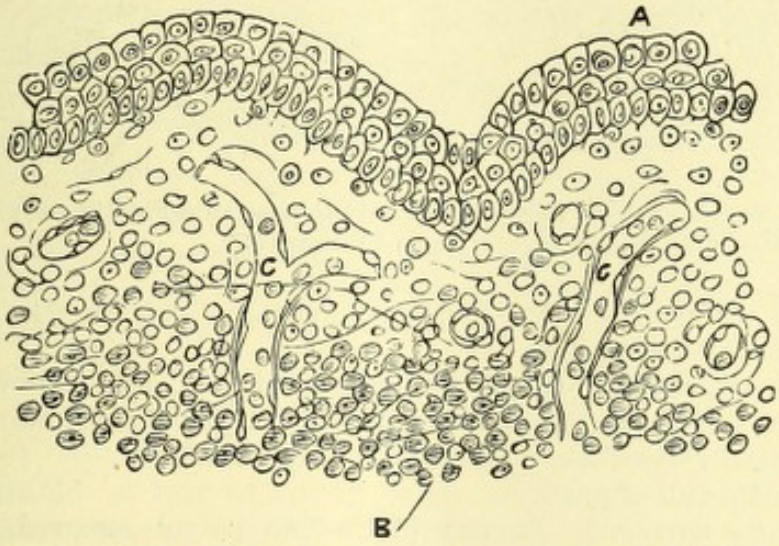


Fig. 102.—Section of Aural Polypus, Case II. *A*, Epithelium; *B*, substance of polypus, made up of a mass of round cells about the size of white blood-corpuscles; *C*, *C*, capillary vessels, containing white blood-corpuscles.

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.

Case II.—Mary Jane N——, aged thirteen. 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.

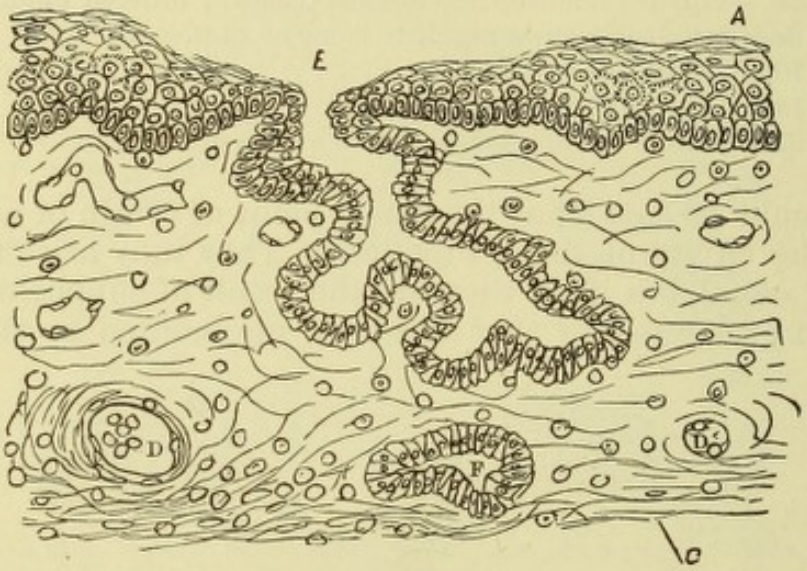


Fig. 103.—Section of Aural Polypi. *A*, *C*, and *D*, same as in Fig. 101; *E*, gland lined with cylindrical epithelium; *F*, transverse section of the same.

Case III.—Mary Ann McC——, aged fourteen. 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 free 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[1] 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,[2] 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,[3] 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.[4] The patient died of meningitis. Wilde[5] 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

[1] Text-book. p. 597. [2] Transactions of the American Otological Society, 1870.
[3] Lehrbuch, p. 597. [4] Gruber, loc. cit. [5] Text-book, p. 280.

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 fungus 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 (Fig. 104), 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.

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.

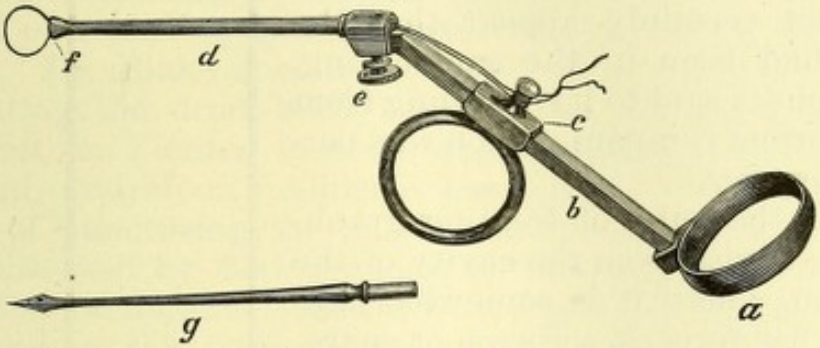


FIG. 104.—Blake's Modification of Wilde's Snare, with Paracentesis Needle.

Forceps may sometimes be employed, although I prefer the snare, scissors, and curette 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 may be often removed by the simple angular-toothed forceps, figured on page 59 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

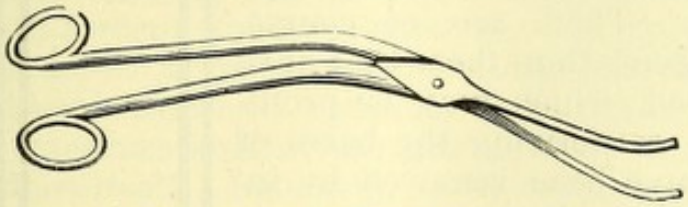

FIG. 105.—Scissors for the Removal of Aural Polypi.

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 forty to four hundred and eighty 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.

Dr. O. D. Pomeroy[1] reports a case of "the removal of a poly-

[1] Medical Record, vol. vi. Reported by D. Webster, M.D.

poid 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.

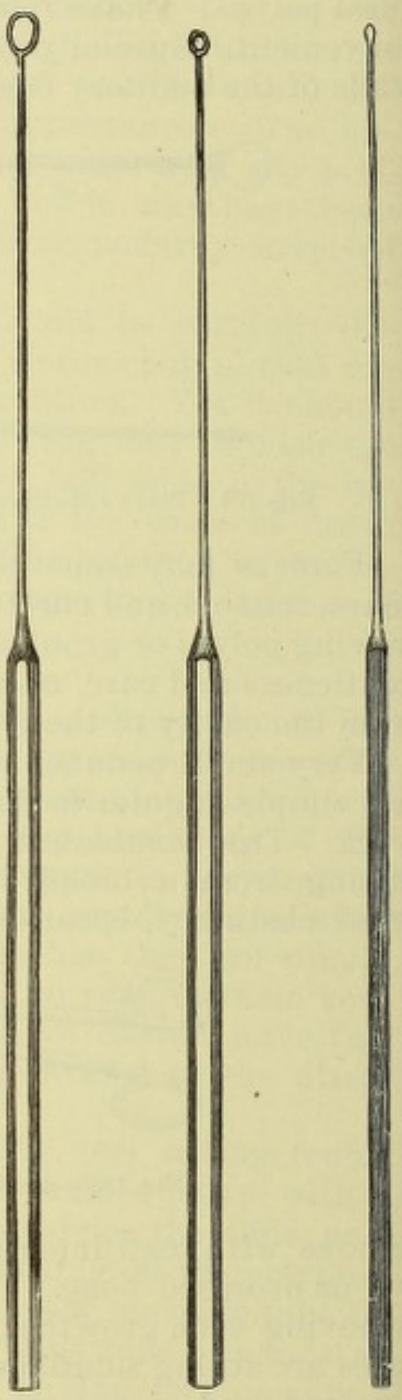

FIG. 106. — Buck's Curettes, for clearing auditory canal and tympanum.

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 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.

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.[1] 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.

[1] On Polypus of the Ear, p. 61.

Dr. Hackley drops a few drops of the persulphate of iron upon small granulations, and he informs me, that after years of experience with this remedy, he is well satisfied with the results of its use. I have lately used it and I think it shrivels the smaller growths very well. But I now chiefly use the curette for small growths.

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 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 abandoned. It is probable, however, that it is not so painful a process when used to remove granulations. Schwartze[1] 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 difficulty will usually be found in the removal of large or pedunculated polypi or granulations. It is only by those that are small and flat, arising from dead bone, and which are very rapidly reproduced, that difficulty will be found. Each surgeon will soon learn how he can best deal with the former variety, whether with forceps, snare, or curettes. The latter form, especially if buried, so to speak, in the tympanic cavity, will often tax the surgeon's skill and ingenuity to the utmost. The use of alum will sometimes shrivel the granulations so as to cause a pedicle to show itself. Iodoform, as has been said, is a good application to pale growths. Alcohol is also valuable. It should be used at least three times a day, and warmed before it is dropped into the ear, when used for polypi. It causes considerable pain, but it is only of short duration. It is well to begin with a fifty per cent. solution.

Free incisions into the granulations, down to the bone, by means of a narrow Graefe's cataract knife, are also effective, especially in recent cases.

No matter which of the methods that have been detailed, be employed in removing an aural polypus, the subsequent treatment will be the same. The case, after the removal of the

[1] Archiv für Ohrenheilkunde, Bd. IV., p. 8.

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. Hot water is also a good styptic.

### *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.[1] 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 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 used in the same handle, and the mirror may be rotated by movement of the stud in the handle."

*Polypus in the Auditory Canal for Forty-one Years—Removal.*—The most remarkable case of polypus in the ear, that I ever saw, was one that came to me

[1] Transactions of the American Otological Society, 1872, p. 83.

in 1875. The subject of the disease was fifty-six years old. He stated that he had had a discharge from his ear ever since he was a small boy, and that he was positive that he had had a polypus in the ear for forty-one years. The right auditory canal was found to be filled with a polypus, and there was a slight amount of pus in the canal. The patient stated that he had taken great care of his ear and his polypus during all these years. He brought with him a peculiar kind of cotton, which he had used to cleanse the canal and to plug the meatus. After I gave him the advice to allow the removal of the growth, he accepted it, but with many misgivings and great reluctance. He seemed to believe that the most serious consequences would follow the removal of the growth. It was effected very easily by a snare. It was attached by a pedicle to the upper and posterior wall of the canal. The membrana tympani was whole, but cicatricial. The hearing power was nil. The growth did not recur, and the patient has suffered no evil consequences from its removal. I have no doubt, after careful investigation, that this gentleman's account of the number of years the polypus had been in his ear, was strictly correct. As Dr. Ely remarked, when we were advising the patient to allow the tumor to be removed: "It was a case of a man attached to a polypus."

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.

II. They are the result of a long-continued, or recent and violent purulent inflammation of the cavity of the tympanum or external auditory canal—usually of the former.

III. Their removal is usually but the beginning, of a treatment of the disease of which they are consequences and symptoms.

IV. The hearing power of the patient will not be restored, although usually improved by the removal of an aural polypus.

V. Malignant growths occur in the ear, which assume the form of, and may be mistaken for, simple polypi.

## BONY GROWTHS.

Exostoses, hyperostoses, or bony growths sometimes occur in the osseous portion of the auditory canal and in the cavity of the tympanum. They may be divided into two great classes—the congenital and acquired forms. With the congenital we have very little to do. Inasmuch as they are not consequences of chronic suppuration, they do not usually, if ever, become a source of trouble, and are generally seen incidentally—that is, when a patient's ear is being examined for some disease independent of the exostosis. In these congenital cases the whole

calibre of the canal is sometimes lessened by a general thickening of the bone, but more frequently the growths extend from one point, with a pretty well defined pedicle.

Professor S. Moos[1] 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 drumhead, 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 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[2] 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 surdité complète de l'oreille gauche dû à l'oblitération du conduit auditif par une tumeur osseuse, siégeant près la membrane du tympan, et guérie par la trépanation 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-tail 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.

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[1] Archives of Ophthalmology and Otology, vol. ii., p. 136.

[2] Monatsschrift für Ohrenheilkunde, Jahrgang II., No. 8, lue à l'Académie Impériale de Médecine, May 26, 1868.

Professor H. Welcker,[1] 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 exostosis." 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 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.

Dr. Victor Bremer,[2] of Copenhagen, also reports a case of removal of an exostosis from the auditory canal. There was a bony growth in each ear. The right canal was entirely closed by an osseous growth situated 22 mm. from the meatus. A fine flexible saw was tried, and its use given up. With a pair of scissors he then succeeded in cutting off a small piece of the tumor. The dental engine, as suggested by Dr. Mathewson, was then tried, but Dr. Bremer feared to continue it, fearing that he would injure the membrana tympani. The scissors were again used, and in a short time he found that he had cut through the tumor and the probe touched an elastic body. The suppuration was then free and the granulations were numerous. The granulations were touched with nitrate of silver. The canal was kept open for fourteen days with laminaria digitata. In five weeks the hearing was restored. When the hearing was complete, it was found that an oblong opening 4 mm. long had been made in the tumor. This case is so superficially reported that it is impossible to say whether the exostosis was congenital or acquired. It is more likely to have been the latter, and to have been the result of long-continued inflammation of the bony canal.

Professor William Turner[3] describes an exostosis of the canal, in an adult male skull obtained near Pisaqua, Peru. Both passages were nearly closed by hard, ivory-like exostoses. These were pedunculated, and on the left side, when the integument existed, they must have blocked up the canal. The exostoses on both sides grew upon that part of the wall of the canal formed by the auditory plate of the expanded tympanic ring. In the adult skull of a flatheaded Chenook Indian, from the district of the Columbia River, Professor Turner found the right external auditory canal partially closed by a broad-based exos-

[1] Archiv für Ohrenheilkunde, Bd. I., p. 171.

[2] American Journal of Otology, vol. i., p. 228. Annales des Malades de l'Oreille. Paris, December 31, 1878.

[3] Journal of Anatomy and Physiology, xii., part 2, p. 200.

tosis, which grew from the posterior wall formed by the tympanic plate. There was also a linear-shaped exostosis deeper in the canal. Professor Turner observed narrowing of the external auditory canal, in several specimens of Peruvian skulls not artificially deformed.

Dr. C. J. Blake, has examined the skulls of the mound-builders of Tennessee, from the collection of the Peabody Museum in Cambridge, Mass. Dr. Blake confirms Professor Turner's opinion that the modification in the shape of the external auditory canal so often found in aborigines of America is not due to the artificial elongation of the skull induced in certain tribes by pressure in infancy. Dr. Blake's attention was drawn to the subject by the late Professor Jeffries Wyman, who found exostoses of the auditory canal in 6 out of 334 Peruvian crania. Dr. Blake examined 195 skulls. In 36, exostoses were found in one or both canals, as well as narrowing of the canals. Fifty Californian skulls, taken from graves in the island near Santa Barbara, were measured for the sake of comparison with those of the mound-builders. The average vertical diameter was found to be more than a millimetre greater in the former, and the antero-posterior diameter more than 3 mm. greater. Of 108 California crania, 5 had exostoses in one or both canals, and in 3 of the 5 a corresponding narrowing of the canal. Dr. Blake does not think there can be any positive opinion, as yet, as to the cause of these exostoses in the aborigines of various countries. There were no evidences of syphilis, in the bones of the Californians examined. He has found that the majority of the cases of exostosis, he has seen in aural practice "occurred in certain families, in the male members of successive generations, the most marked instance being in the three successive generations of one family in which there *is no tendency either to gouty or rheumatic disease.*" Dr. Blake also examined 37 skulls from mounds in Arkansas. Exostoses of the auditory canal were found in 6 of the 37 skulls. Careful search was made for evidence of syphilitic disease, by examination of the long bones, but none was found. The 6, containing exostoses came from one mound.

## 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." In 1866, I published four cases[1] 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 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[2] 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 over-estimated."

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[3] 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 very

[1] New York Medical Journal, vol. ii., p. 424.

[2] Die Krankhaften Geschwülste II. Bd. H lfte I., p. 73 et seq. passim.

[3] Verbal communication, New York Ophthalmological Society.

few exceptions, arose in connection with suppuration in the middle ear. In one exceptional case, the exostosis was so large that the condition of the membrana tympani could not be positively known, and, unfortunately, I saw the case but once.

From all the evidence I can gather, I am inclined to think that all exostoses of the canal may be finally traced to local inflammation. Blake's cases, in the aborigines, as well as his cases occurring in private practice, and my own, pretty thoroughly dispose of syphilis as a prominent cause. I do not think the evidence for a rheumatic diathesis as a factor, has as yet been made tenable. All the cases of which we have full histories, go to sustain the view, first clearly and fully put forward by myself, of local irritation as the determining cause. To this theory I still adhere. Tröltsch, in the first edition of his book, also remarks that he usually considers the growth of exostoses, an incident of catarrh of the tympanum.

*Treatment.*—The treatment of exostoses, unless they are so large as to prevent access to the tympanum, should begin by a treatment of the suppuration that has caused them to appear. If we cannot heal the perforated and ulcerating membrana tympani, as may be the case, we should keep the middle ear scrupulously free from pus, so that no blocking-up may occur. The patient should be taught to cleanse the canal and tympanum. Small growths may be painted with the tincture of iodine. If the exostoses are large enough to close, or nearly close, the canal, Mathewson's operation for removal of these growths by a drill in a dental engine should be performed. Dr. Mathewson first performed this operation upon Case VI., here reported, in 1876.[1]

The machine used was Elliott's suspension dental engine. The patient was under ether. The integument covering the growth was first removed by a dental instrument known as a scaler. The bony growth was then perforated at several points near its centre with small drills about one and a half millimetre in diameter. The larger drills, 2½ to 3 mm. in diameter, were next used to enlarge the openings. The probe, on account of the great bleeding, was the chief guide in the operation. "The excavation was continued cautiously," says Mathewson, "till the largest drill—about three millimetres in diameter—passed freely through with room to spare." The operation consumed about half an hour. The purulent discharge, that ensued was treated by the warm douche and a weak solution of nitrate of silver subsequently. The swollen and granulating soft tissue finally

[1] Report of the First International Otological Society, p. 86. New York: D. Appleton & Co., 1877.

shrivelled and disappeared, and the discharge ceased, with a good opening, through which the posterior and lower part of the drum-head could be seen. The hearing arose nearly to the normal standard. After Mathewson's brilliant result, his operation was generally adopted. Field, of London, seems to have had the most experience in the use of the dental engine for the removal of exostoses.[1] His results, justify all that Mathewson claimed for the operation.

Exostoses seem to be a much more frequent result of aural disease in England than in this country; at any rate, there are many more cases reported by English experts than by those of the United States.

If the membrana tympani be intact, as it is in many cases of bony growths, even in those where there was at one time suppuration in the tympanum, the cases are much easier to manage. There being no pus to rest upon them, they do not usually grow, and if the ear be kept carefully clean and free from wax, they need not be interfered with.

### CASES.

The following cases will give a fair idea of the course of bony growths that are consequences of chronic suppuration and chronic inflammation:

Case I.—Mr. C——, aged thirty-nine, 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. Agnew 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 this 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-fifths of its calibre. 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

[1] Diseases of the Ear, p. 57.

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, aged forty, 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 calibre 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——, aged twenty-five, Connecticut. 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 point 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 had been taken for securing an outlet to the pus, constantly secreted from the cavity of the tympanum, and passing through the perforated membrana tympani, 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 eight and one-half inches from the left auricle and one and one-half 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, aged twenty-seven, 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——, aged twenty-three, 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 the right meatus; not at all on left. A gelatinous polypus was found attached to the hypertrophic 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 calibre 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 ——, aged twenty-five. 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 "earache," 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.

The danger which seemed to exist, when I wrote the foregoing paragraph, was happily averted by Dr. Mathewson's first operation with the dental engine. The case came into his hands in 1876, and he devised and executed a method of removing these bony growths, which as yet remains the best that has ever been suggested or performed.

Case VII.—October 23, 1883. Miss ——, aged twenty-one. When seven years of age she had scarlet fever; both ears discharged excessively during the progress of the disease. Had loss of motion of the right side for thirteen months after. The left ear still discharges. There is no aërial conduction on the right side and the bone conduction is better than the aërial on the left side. Hears the voice about one foot from the left side. There is a bony growth in the left auditory canal, arising from the posterior wall and about half closing the opening into the tympanum. There is no drum-head in either ear.

Case VIII.—March 6, 1884. Mr. A. J——, aged thirty-eight (sent to me by Dr. Jones, of Chicago). When the patient was eighteen years old, the left ear was injured by the explosion of a cannon near his ear. He was thrown into the water, and did not think of his ear for a day or two. He then observed that he could not hear well. His ears have never been quite right since, especially at times. His hearing distance is: R., $\frac{1}{48}$; L., $\frac{\text{laid}}{48}$. The tuning-fork is heard much better in each ear by bone conduction. There are small bony growths arising from the anterior wall of both auditory canals. The membranæ tympani are opaque on each side. The patient was not sure as to whether he had ever had a suppuration in his ears. He had chronic naso-pharyngeal catarrh as well as a decided inflammation of the middle ears. There was no evidence of the existence of either syphilis, gout, or rheumatism.

Dr. Cocks reports [1] an interesting case of a pedunculated bony growth in the auditory canal, which formed the base of a polypus. It was so like a polypus in appearance, that a snare was put about it, and it was fortunately broken off. The growth sprang from the posterior wall of the canal, at the junction of the osseous and cartilaginous portions.

[1] Archives of Otology, vol. xii., p. 59.

# CHAPTER XVIII.

## THE CONSEQUENCES OF CHRONIC SUPPURATION OF THE MIDDLE EAR—(*Continued*).

### DISEASES OF THE MASTOID PROCESS.

Periostitis.—Caries and Suppuration.—Trephining or Opening the Mastoid.—Historical Account of the Operation.—Cases.

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 the tympanum. 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 inflammation of the mastoid process, 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 them as independent affections requiring especial notice and treatment. Severe disease of the mastoid 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 process 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, with formation of an abscess in some part of the cavity.

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 pus.

Sclerosis or hyperostosis should also be mentioned as one of the results of chronic inflammation of this part. During the operation for perforation of the mastoid it is often found, as shown by Agnew's case,[1] and subsequently by Buck's[2] and Schwartze's[3] statistics, in a state of sclerosis. Anatomical investigations indicate, that this is oftener a congenital rather than a pathological condition. If the bone is not pneumatic, it is certainly in a worse condition for the reception of a chronic inflammatory process, than if it were full of air-cells.

Disease of the mastoid is usually seen in plain connection with an affection of the tympanum. In the nature of things this must necessarily be so, for the mastoid process and the tympanum are merely parts of one anatomical space, and no complete separation of their inflammations is possible. But this is not always so. A few weeks ago, I evacuated a drachm or more of pus from the mastoid cells of a young child, through the auditory canal, while the membrana tympani remained intact and apparently uninjured. The patient made a good recovery, and although I could not determine on account of the patient's age —she was about three years old—whether or not there was a catarrh of the tympanum, there was certainly no serious inflammation except in the mastoid. It was markedly red, swelled, and tender. From the history, given by the child's mother, I do not doubt, that the case was one of suppuration of the middle ear, especially affecting the mastoid portion of this part. Other cases of so-called primary periostitis have been published,[4]

[1] Transactions of the American Otological Society, July 20, 1870.

[2] Treatise on the Ear.

[3] Archiv für Ohrenheilkunde, Bd. IV.–XX., *passim*.

[4] Knapp: Report of International Otological Congress, New York, 1876, p. 80. Gruening: Medical Record, June 4, 1881. Cornelius Williams: Archives of Otology, vol. xiii., p. 22. W. Cheatham: Louisville Medical Journal, October 26, 1878.

but a careful reading of the histories shows that while the periosteum of the mastoid, was undoubtedly more severely affected than the lining membrane of the other parts of the middle ear, it is by no means certain that the mastoid inflammation was not actually secondary to that of the tympanum, although the latter may have run its course, by the time the former was under full headway. Buck[1] also doubts if we may correctly speak of a primary periostitis of the mastoid process. He says that he has never seen a case, to which he would feel justified in giving the title of primary idiopathic mastoid periostitis. Buck explains the cause of the apparently primary cases of mastoid disease, occurring in young children, as I do, in supposing that the pus from the tympanum found an easier escape through the mastoid than through the membrana tympani. Mastoid periostitis, as well as caries and abscess, are usually results of disease of the Eustachian tube and the tympanum.

*Symptoms.*—The symptoms of mastoid periostitis are usually so distinct as to arrest the attention of the medical adviser as 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 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.

One of my cases, reported on a subsequent page, as well as others, shows that an inflammatory process may extend to the periosteum of the mastoid, without *pain or tenderness* of this part, but there are then symptoms in other parts of the skull, especially in the occiput, which considered in connection with the inflammation of the middle ear, will keep the surgeon on his guard. Besides, these cases are entirely exceptional.

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.

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[1] Diseases of the Ear, p. 355.

Dr. Orne Green [1] has shown, by the report of three cases, that phlebitis of the emissory veins of the mastoid may occur in the course of inflammation of the middle ear and lateral sinus oftener than has yet been observed. Dr. Green quotes cases from Kolb, Taylor, Moos, and Burchardt-Merian, which indicate this.

In Green's cases, the phlebitis was due to an extension of an inflammation of the lateral sinuses. In all of the cases the "prominent and characteristic symptom was the peculiar induration of the tissues of the neck, such as characterizes a cellulitis dependent upon phlebitis, and one of the best examples of which is seen in *phlegmasia alba dolens.*" Death occurred in all of Dr. Green's cases. In one of them, so far as could be determined by the history, there was no external periostitis, but no autopsy could be obtained in any of the cases. It is probable that phlebitis of the emissory veins is more frequently a consequence of disease of the mastoid process than has hitherto been supposed.

Professor Alfred C. Post, of this city, who was one of the first surgeons 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, as I learned from his lectures during the sessions of 1856–59.

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 clinics. 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. If the symptoms, although positive, be of a mild type, from two to six leeches should be placed upon the mastoid. After the bleeding has subsided, a poultice should be applied. The patient should be kept in-doors and in bed. If the pain and tenderness are not relieved in twenty-four hours, 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

[1] American Journal of Otology, p. 187. 1879.

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 is only when the symptoms are not severe, although positively existing, that a little delay, that is of a few hours, may be admissible for the use of leeches, and the careful continuous application of poultices. If the symptoms are decidedly ameliorated in a few hours, still further delay is justifiable. This, it should be said, however, is only true of cases of a mild type.

In view of the dangerous character of mastoid periostitis, it will be better to err on the side of a free and thorough incision, the so-called *Wilde's incision*, from Sir William Wilde, who first advised it,—than to be too late in other cases. The cases that have been reported as recovering without the knife and from internal medication, by the use of such drugs as the sulphide of calcium, are, in my opinion, cases such as have recovered in my hands, as well as in those of my colleagues at the Manhattan Eye and Ear Hospital, without any drugs whatever. To keep a patient in bed, and in a quiet room, with proper ventilation and warmth, and besides to nourish him well, and to use poultices and the warm douche, is to institute a very thorough treatment for many diseases of the ear. Beyond these means, in many cases nothing is required—and without them nothing whatever can be accomplished.

Although I have classified periostitis and caries of the mastoid, among the consequences of chronic suppuration, it goes without saying, that it sometimes arises in the course of acute and primary disease. It should also be understood that when it occurs in chronic suppuration the acute symptoms also affect the tympanum.

There is a phlegmonous inflammation of the skin and connective tissue over the mastoid, especially in young subjects, generally arising from disease of the auditory canal, which is never serious, although painful. A little experience in the differential diagnosis of diseases of the middle and external ear, will soon

enable the practitioner to distinguish these harmless cases of swelling and tenderness of the skin and connective tissue of the mastoid from periostitis. Furuncles, and other inflammations in the auditory canal may cause an œdema and inflammation 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 from 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.

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 he is actvely 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.

The treatment of the greater number of cases of periostitis is not usually so tedious as the case just reported. With the incision and a few hours of poulticing, if the bone be not diseased, the acute symptoms subside very rapidly, and the patient is soon

about his usual affairs. Although patients are generally to be confined to their room, or house at least, during the time of the acute symptoms, some of them go about enough to visit the surgeon at his consulting-room, especially in the spring weather, and with no bad results.

### CASES.

Case I.—*Periostitis of the Mastoid from Acute Suppuration—Recovery without Incision.*—R. S——, aged nineteen. July 25, 1884. One week ago, after bathing he had pain in his right ear, which has continued at intervals. He now has severe pain referred to the forehead and the neck. The patient is thin and haggard. H. D., R., $\frac{0}{40}$; L., $\frac{10}{40}$. The bone conduction is better than the aërial in the right ear, and the reverse is true of the sound ear. Right auditory canal swelled. Right membrana tympani swelled and red. There is tenderness over the whole surface of the mastoid and down into the neck. On inflation the hearing distance of the ear increased to $\frac{P}{40}$. The patient was seen by my associate, Dr. J. B. Emerson, in consultation with Dr. Fisher, of Hoboken. It was agreed that the patient be put to bed. Two leeches were applied to the mastoid. The hot douche was ordered to be used every two hours, and poultices were applied in front and behind the auricle. The patient began to be more comfortable at once. The drum-head perforated spontaneously on the third day. On the fourth day he was up, with no pain except at long intervals. In eleven days the drum-head had healed, and in twenty days the patient was practically well (H. D., $\frac{20}{40}$), and he left town for the country.

Case II.—*Periostitis of Mastoid occurring during an Exacerbation in a Case of Chronic Suppuration of both Middle Ears—Recovery without Incision.*—J. L. S——, aged twenty-six. Farmer. February 21, 1883. Ten years ago he had the small-pox, which left him somewhat hard of hearing. Five years ago he had a severe cold, which very much increased the trouble. During January of this year, he had the measles, with severe pain in both ears, and a purulent discharge from the left. There was also a slight swelling of each mastoid, but it disappeared in about four days. One week ago this swelling returned. Each mastoid process is swelled and tender. Both drum-heads are perforated, but neither discharges freely. No aërial conduction in either ear. The patient was seen at my office, but he was advised to go to the hospital, which he did. He was then put to bed, two leeches were applied to each mastoid, and the hot douche was used often. The next day the tenderness of the mastoid was markedly diminished. The poultices and hot douche were continued, and in eleven days he was free from all pain and tenderness about the ears.

These cases illustrate very well, how with circumspection, we may sometimes substitute leeches and poultices, for Wilde's incision and poultices.

The two first of the following cases are from the notes of Dr. David Webster, when he was 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 III.—*Chronic Suppurative Otitis Media—Cessation of Discharge—Mastoid Periostitis—Incision—Recovery.*—Eliza N——, aged eighteen, 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 11th.—Patient has had no pain and has slept well. The tent was reapplied and the poultice continued.

May 16th.—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 IV.—*Chronic Suppurative Otitis Media—Mastoid Periostitis—Incision—Recovery.*—William G——, aged thirty, 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 had been 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 14th.—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 28th.—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 a disease of the lining membrane, with some periostitis, while in a case hereafter 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 tympanum*, which is not at once, that is to say, in a few hours, relieved by leeching, poultices, 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 V.—*Chronic Suppurative Otitis Media of Years' Standing—Exacerbation—Mastoid Abscess—Incision—Recovery.*—Gracie B——, aged thirteen. April 25, 1872, I was summoned to Newburgh, by Dr. S. Ely, to see a case in consultation, which Dr. Ely 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 19th.—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.

## CARIES AND ABSCESS OF THE MASTOID.

Caries and abscess of the mastoid result from an extension of the inflammatory process that has been described under the head of periostitis. The inflammatory process advances to suppuration. Sometimes, and perhaps in the greater number of cases, the suppuration is not extensive and finds an outlet in a narrow fistula. This form is, of course, more dangerous than mere periostitis ; and yet cases of caries and necrosis are sometimes relieved at the cost of much unnecessary suffering to the patient, by Nature's slow process of casting out diseased bone.

An argument for temporizing with an undoubted case of suppuration within the mastoid cells, has sometimes been deduced from this tedious manner in which Nature sometimes relieves a case without inducing a fatal result. But every surgeon should certainly endeavor to spare his patient the discomfort and danger of protracted suppuration, by carrying out the rules of his art, which demand an early, free, and deep incision whenever pus is to be found.

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 abscess. 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 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 granulations in the canal should lead us to examine the part very carefully to see if a fistula may not be found. In certain cases it may be easier to remove dead bone through the external meatus. 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.

*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. This enlargement is best made by a drill worked cautiously in the track of the fistula. A good funnel-shaped external opening should be left, so that the pus may freely escape when it reaches the surface, and not burrow beneath the tissues, but chiselling is unnecessary and meddlesome surgery. If there be no fistula, an opening should be made into the cells, into the mastoid antrum preferably, by a drill or a small trephine. Here those who prefer the chisel may use it, but I like the other instruments much better, because the scar they leave is insignificant. Before opening the bone, the periosteum should be stripped off, so as to leave a good field for the operation. The instruments should be usually entered on the boss of the mastoid, which is usually just on a line with the meatus, and worked cautiously downward and inward. It is impossible to say in advance to what distance one must go, for this varies.

Schwartze says, "Never go deeper than 25 mm." Buck says, "It is better, I believe, to place the extreme limit of depth at 20 mm., or about three-fourths of an inch." [1]

By reference to the anatomy of the mastoid process 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

[1] Treatise on the Ear, p. 369.

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. The lateral sinus will always be avoided by keeping the instrument as directed above. In extremely rare cases the position of the sinus is abnormal and it will be impossible to avoid it. In case it is opened or great bleeding occurs from the mastoid veins, the opening should be plugged with oakum and a compress applied. Cases have done well where the sinus has been opened, and septicæmia has resulted.[1]

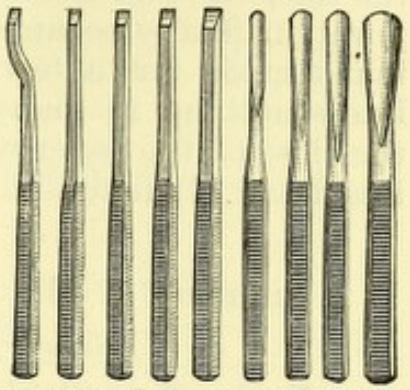

FIG. 107.—Schwartze's Chisels for Opening the Mastoid.

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 oakum or iodoform gauze, and not allowed to heal too rapidly. The patient should be kept free from all noise and excitement, and very carefully watched until the fistula has healed, which may be for months. I think a long tent made of old and thin cotton-cloth, much better than the silver or rubber drainage-tubes. The fistulous opening should be dressed at least once a day. Of late, instead of a cotton or linen tent, on the suggestion of one of my staff, Dr. Frank N. Lewis, I have used a drainage-tube made of a quill with more satisfaction than any other. Dr. Wilson's trephine for use on the mastoid is ingenious and safe. By it the distance to which we go may be easily and exactly regulated.

In some cases—I have one such under observation, which was operated upon by Dr. E. T. Ely—the fistula cicatrizes throughout its course, but never closes. I have also seen a case, kindly sent me by Professor Sayre, where an opening made by a bullet also left a permanent opening without suppuration or other inflammation. The patient, who received the wound in the late civil war, wore a cover to the opening.

I have seen 59 cases of affections of the mastoid process, in 5,797 cases of aural disease occurring in private practice. Occasionally I have omitted to record one which I have seen

[1] In other cases opening the sinus has been followed by no evil consequences.

in consultation, but there are not many such, so that the record is tolerably exact.

Thirty-three cases occurred in my practice at the Manhattan Eye and Ear Hospital in eighteen years. The total number of cases that have been diagnosticated as affections of the mastoid, in all the aural departments of this institution for eighteen years is 110.

Here there is a source of error, for some cases that entered the hospital, and were diagnosticated as simple catarrh or suppuration finally became cases of mastoid disease. Besides this, many made but a few visits and never returned, so that we knew nothing in many instances of the ultimate results. At the close of the paper will be found statistical tables in more or less detail of the total number of cases.

CASES.

A summary of all the cases here reported shows as follows:

*Summary of Cases in Private Practice.*

| | |
|---|---|
| Number of cases treated, males | 33 |
| Number of cases treated, females | 26 |
| | 59 |

*Result.*

| | |
|---|---|
| Died | 9 |
| Cured | 36 |
| Relieved | 10 |
| Unknown | 4 |
| | 59 |

The disease of the mastoid occurred in the following-named affections:

| | |
|---|---|
| Acute catarrhal inflammation of the middle ear | 11 |
| Acute suppuration of the middle ear | 25 |
| Chronic suppuration of the middle ear | 18 |
| Primary mastoid periostitis | 1 |
| Inflammation of the external auditory canal | 2 |
| Exostosis of the mastoid | 1 |
| Neuralgia of the middle ear | 1 |
| | 59 |

*Operations.*

| | |
|---|---|
| Wilde's incision made with evacuation of pus | 9 |
| Wilde's incision without pus | 11 |
| Mastoid opened by enlarging fistula | 16 |
| Opened without finding fistula | 4 |
| Opened through external auditory canal | 2 |
| | 42 |

*Summary of Cases Treated in the Author's Clinique at the Manhattan Eye and Ear Hospital.*

| | |
|---|---|
| Number of cases treated | 33 |

*Result.*

| | |
|---|---|
| Cured | 14 |
| Relieved | 5 |
| Died | 1 |
| Unknown | 14 |
| | 33 |

*Disease.*

| | |
|---|---|
| Acute catarrh of the middle ear | 2 |
| Sub-acute catarrh of the middle ear | 1 |
| Acute suppuration, middle ear | 8 |
| Acute suppuration of the middle ear, with mastoid fistula | 1 |
| Sub-acute suppuration of the middle ear | 1 |
| Chronic suppuration, middle ear | 11 |
| Chronic suppuration of the middle ear, with mastoid fistula | 4 |
| Chronic suppuration, middle ear, with polypus | 1 |
| Chronic catarrh of the middle ear | 1 |
| Primary inflammation of the mastoid | 2 |
| Impacted cerumen with mastoid periostitis | 1 |
| | 33 |

*Operations.*

| | |
|---|---|
| Wilde's incision | 7 |
| Wilde's incision, pus evacuated | 5 |
| Opening mastoid with a drill | 14 |
| Treated without operation | 7 |
| | 33 |

Cases in which death occurred. There were ten of such cases in private practice and one in the hospital cases. One of the deaths was probably not induced by the aural disease; but the others are undoubtedly to be classified in this way:

Case I.—*Suppurative Inflammation of the Middle Ear soon after Birth—Mastoid Periostitis—Incisions—Death.*—Boy, aged three months, seen in consultation with Dr. M. W. Williams. There was an abundant discharge of pus from the tympanum. Considerable œdema of the mastoid, and evidences of meningitis. Dr. Williams had incised the tissues down to the bone before I saw the patient. I repeated this incision a few days after. No pus was found. Inasmuch as there was free drainage from the tympanum, no further operation was performed. The patient died in a few days afterward.

Case II.—*Suppuration of the Middle Ear for Six Years—Death.*—Female, aged fifty. Four years ago she had an attack of severe pain and swelling in the right ear from which she recovered, but a discharge remained. One year ago she had acute inflammation of the mastoid process. The integument and periosteum were incised, pus discharged for two months and then ceased. Two weeks ago the inflammation recurred in the same part. There was intense pain

in the ear, and an offensive discharge from it; the latter continued. H. D., R., $\frac{6}{30}$; L., $\frac{c}{30}$.

The patient has been living in a malarial district, and has taken largely of quinine.

The left auditory canal is narrowed and crooked, and filled with pus. The drum-head is nearly gone, and there is caries of the tympanum, the mastoid cells, and posterior wall of the auditory canal. Dr. E. T. Ely saw the patient for me at first, and advised the application of six leeches and the hot douche every three hours. In a few days the patient was much better, the mastoid was not tender, but there was intense pain in the head and constant vertigo. The bones of the tympanum were gone, and the foramen ovale probably opened. I learned afterward this patient died very soon after Dr. Ely and I saw her, which we did but a few times, when we were dismissed.

Case III.—*Acute Suppuration of the Middle Ear—Mastoid Periostitis—Meningitis—Death.*—This case has already been published in full (*Medical Record*, July 6, 1877). It is simply necessary to say here the patient died of meningitis, from acute suppuration of the middle ear, in twenty-eight days from the first attack of aural inflammation. Wilde's incision was made, but no disease of the bone was found, and the post-mortem examination showed that such an opening would have been in vain.

Case IV.—*Chronic Suppuration of Right Middle Ear—Mastoid Swelling—Abscess—Opened with Drill—Died about Three Months after from Meningitis.*—Male, aged twenty. Under the writer's observation for about fourteen days.

The patient has had a discharge from his right eye ever since infancy. The drum-head of that side is gone, and there is a very free discharge of pus from it. The whole surface of the mastoid is swelled and excessively tender. A free incision was made down to the bone and a fistula was found leading into the tympanum. This was enlarged and a tent introduced and poultices applied. The patient remained under daily observation in New York for eight days, when he returned to his home to be under the care of his family physician. I saw him once or twice afterward. He did well until July or August, when he died suddenly at a watering-place, as I was informed, from meningitis.

Case V.—*Bronchitis—Acute Suppuration of the Right Middle Ear—Chills Simulating Ague and Fever—Mastoid Abscess Opened with a Drill—Death Four Days after.*—D. I——, aged sixty-nine, on April 6, 1886, was sent to my office by Dr. M. H. Williams with the following history: He had acute bronchitis three and a half months before, which in about two weeks was followed by earache. This ceased when the ear began to discharge, but the suppuration has continued ever since. The ear was carefully cleansed with warm water, and an astringent instilled, and the ear was inflated by Politzer's method. There was occasionally some bleeding from the tympanum on cleansing.

The patient has excellent care under good hygienic conditions. To-day the patient has no pain, slight tinnitus occurred, but no other aural symptom.

H. D., $\frac{r}{40}$; L., $\frac{11}{40}$. Bone-conduction better than aëriai on that side. When the tuning-fork is placed on the sound mastoid it appears to be heard on the diseased side. This is a symptom which, as is well known, is quite often seen, and when it is, always, in my opinion, indicates advanced disease of the tympanum and cells, not necessarily suppuration however, with greatly increased resonance of

these parts. The nares are in a catarrhal condition. The posterior half of the drum-head is swept away, the remainder is red; a rather thick discharge from the tympanum. No tenderness, pain, swelling, or redness of the mastoid. Simple cleansing was advised. Nearly a month after, on May 4, 1886, I again saw the patient at his house and got the following history from Dr. Williams. The patient was doing fairly well until April 31st, when he had a chill followed by fever. He has had a chill nearly every day since. The mastoid is slightly tender at the apex, there is no œdema and no pain, but that side of his head feels uncomfortable. The next day the uncomfortable sensation had increased, and the usual incision was made through the integument and the bone opened with a drill. The depth reached was about half an inch, when pus flowed out in considerable quantity. A tent was inserted and a poultice applied. In the evening the patient was very comfortable. Temperature, 98½°. Pulse, 78.

May 6th.—The patient had a chill lasting half an hour, and his temperature went up to 104½°. Two days after, he died, hemiplegia having occurred.

CASE VI.—*Chronic Suppuration of Long Standing—Great Pain in the Head—Delirium—Opening of the Mastoid—Death.*—Male, aged twenty-five. This patient was seen twice in consultation. The history was that he had had a suppurating ear on the right side for many years, and occasionally he has been laid up with earache. He has been sick now for two weeks. Pulse, 90. Temperature, 104°. The tympanum is suppurating moderately. The apex of the mastoid process is tender upon firm pressure, but there is no pain except in the head, and that is not severe. The previous treatment has been the use of quinine and the application of leeches.

The diagnosis was meningeal hyperæmia, from acute suppuration supervening upon chronic suppuration. Four leeches were advised, and poultices around the ear. I heard nothing more of the patient until fifteen days later. I was again sent for. The physician in attendance concluded that the high temperature was due to malarial poisoning, and has given large doses of quinine. He also made an incision through the periosteum of the mastoid process, which has nearly healed. The patient is now delirious, flinches when pressure is made upon the mastoid. The mastoid was opened with a small drill into the cells. No pus was found. The blood was exceedingly dark, but there was no serious hemorrhage. The patient died three hours later. At my first visit to this patient I thought, and expressed my opinion, that the pus that formed on this case was probably inaccessible, for I supposed that the apex of the petrous bone or the roof of the tympanum rather than the mastoid was the principal seat of the disease. I did not concur in the use of the quinine, and never supposed that there was any determining malarial element in the case. When I got consent to opening the mastoid I did not hesitate, however, for I think many lives have been lost because concealed pus has not been evacuated in such cases. With my present convictions, in dangerous suppuration of the tympanum I shall always lean toward opening the mastoid, believing as I do that such an opening secures the best drainage possible for the tympanum. Much as I deplore unsuccessful cases, I shall never hesitate to perform what I believe to be an operation almost without danger—in a doubtful and dangerous case. In a case to be described hereafter, occurring in the Manhattan Eye and Ear Hospital, in my service, and operated upon by Dr. Emerson with my assistance, a case almost desperate, life was, I think, saved by a timely trephining, although no pus was found.

Case VII.—*Chronic Suppuration of the Middle Ear since Infancy—Acute Otitis—Spontaneous Opening of the Mastoid Process—Enlargement of the Opening—Phthisis Pulmonalis—Death.*—C. P——, aged twenty-one. It is doubtful if death in the following case was due to the aural disease. Certainly it was not a result of any operative interference or other treatment. About three months after he was seen by Dr. Ely and myself, in consultation with Dr. F. A. Utter, he died of phthisis pulmonalis. The history stated that the patient had had a discharge from the left ear for a long time from early youth. Four weeks ago he had violent pain in the ear, extending to the side of the head and neck, a swelling in the mastoid opened spontaneously a few days since. The patient is very pale and weak. Temperature, 98⅘°. Pulse, 120. The entrance to the auditory canal is obstructed by granulations from the posterior wall. There is a small sinus below the tip of the mastoid. Rough bone is felt at the bottom. He has no pain now. The opening was enlarged and a tent inserted. The tissues are very boggy.

The patient got better so as to be up and about, a free opening into the mastoid cells was maintained, but the patient died in three months after.

Case VIII.—*Chronic Suppuration of the Middle Ear—Extensive Necrosis of the Mastoid Process—Epithelial Tumor extending into the Cranial Cavity—No External Swelling—Death.*—In consultation with Dr. Mathewson. This case has been fully reported elsewhere ("Transactions of the American Otological Society, 1878"). This patient was a young married woman, in good general health, who had had a purulent discharge from the left ear for ten years. When first seen by Dr. Mathewson, and subsequently by myself, she was suffering pain from the ear. There were fungous granulations springing out of the tympanum. There was no swelling, tenderness, or pain in the mastoid.

Four months after first coming to Dr. Mathewson he opened the mastoid, which was still not swollen or tender, and very extensive necrosis was found. Two months after I again saw the patient. There was considerable pain in the head and ear. The mastoid opening was nearly closed. The canal was obstructed by granulations. The next day Dr. Mathewson removed many pieces of dead bone; a wide opening remained down to the dura mater. The patient died two months later, eight months after she came under Dr. Mathewson's care. A full account of the post-mortem examination of this interesting case appears in the report. From this it appears that the growth had its origin in the tympanum, and that the mastoid was affected only at a late stage.

Case IX.—*Acute Suppuration of the Middle Ear—Redness and Swelling of the Mastoid—Bronchitis—Fistula of Mastoid Enlarged—Death.*—Male, aged three. Seen in consultation with Dr. Emerson. The patient has had a discharge from his left ear for the past six weeks. For two weeks there has been redness of the mastoid process of that side, and slight swelling. There is no fluctuation nor tenderness on pressure. The auditory canal is much swollen. Dr. Emerson advised the hot douche and poultices, and nine days after he was called by Dr. Harrison to see the patient again. He learned that the little patient had had pain for two days. The swelling of the mastoid had nearly disappeared. There was no redness, but there was pain on pressure. The next day I saw the patient with Dr. Emerson. He made a Wilde's incision, found a fistula in the bone, which he enlarged. The patient slept well the night after this, but he died three days after in a convulsion.

DEATHS FROM CASES OCCURRING IN HOSPITAL PRACTICE.

The only death I have seen from aural disease in my service at the Manhattan Eye and Ear Hospital for eighteen years was that of a patient under the care of Dr. Emerson and myself.

CASE X.—*Sub-acute Suppuration of the Middle Ear—Mastoid Tenderness—Opening of Bone—No Fistula or Pus Found—Death in Forty-two Days.*—Male, laborer, aged thirty-seven, was treated as an out-patient for two weeks before he entered the hospital. He said he had a painful ear for three weeks before this. The warm douche and leeches have been used. On admission to the hospital, on June 9, 1877, he complains of dizziness and pain. He was found to have a sub-acute suppurative process in the middle ear. He apparently improved under local treatment for three days, when he had a chill and his temperature went up to 103°.

The mastoid was opened by Dr. Emerson, assisted by myself, on that day. The bone was drilled to the depth of one inch. No pus and no fistula were found, and there was no softening of the external plate. The temperature fell to 100° that evening, but it rose the next day to 103°. The patient was chilly, nauseated. He continued to suffer from nausea for several days; his temperature ranged from 101° to 103°, and on June 21st it arose to 105°. On this day his pulse was increased to 80 for the first time. It had before ranged from 72 to 76. He now has delirium at times. He is given quinine and bromide of potassium. On the 22d he had a chill lasting an hour. The discharge of pus from the ear is scanty. He continued in about this way for three days, when his temperature fell to 98½°, and the next day to 97°. He continued to have chills, and on June 28th his pulse was 120. An examination of the optic nerve and retina showed nothing abnormal. The patient died of septicæmia on July 31st, nearly two months after his admission.

The purulent infection was in the roof of the tympanum or at the apex of the petrous bone. We were not hopeful of the results of opening the bone, but we desired to obtain an outlet for pus, but in this we were not successful.

Cases in which a cure resulted after operation:

CASE XI.—*Caries of the Mastoid from Chronic Suppuration of the Middle Ear—Mastoid Opened Three Times—Recovery.*—Miss X——, aged twenty-six. As this case is reported in my book on the Ear, p. 529, I will simply say that the patient was under observation and treatment for some eight months. Although the bone had been opened twice before I saw the case, once with a chisel, the patient, who is a teacher, was unable to do any mental work on account of pain and dizziness. After a thorough opening up of the old fistula with a drill, and subsequent persistent curetting of granulations, the patient entirely recovered; the drum-head did not heal, however; she resumed her duties, which, ten years later, she still continues to perform without trouble from her ear.

To my mind, a case of mastoid disease arising in the course of a chronic suppuration always, or nearly always, involves a tedious course varying from two to six months if cure results. It is otherwise with the same form of disease arising in the

course of acute catarrh and acute suppuration. In such cases the recovery may be rapid and death also may speedily result. He who succeeds in curing cases where he has opened the mastoid *de novo*, or enlarged a fistula, must expect weeks of rather dreary work of keeping the opening free, by frequently curetting the granulations, picking away the minute fragments of dead bone, pushing in a tent, a drainage-tube, or the like. With such patience, success will generally crown the effort.

I am very unwilling to operate upon a case unless either one of my staff, or myself, or a competent surgeon, alive to the importance of the prevention of retention of pus, have the subsequent charge of the case. The after-treatment, I think, invokes much more skill than the operation.

Case XII.—*Caries of Mastoid of Nasal Bone and of Jaw—Removal of Pieces of Dead Bone from Various Parts—Recovery.*—Female, aged five. This case also illustrates what has just been said on the subject of keeping up the openings in the bone until the last of the unhealthy tissue is removed.

The child was apparently a healthy one of healthy parents. She was sent to me by the late Dr. Lewis Fisher, and she was under the care of Dr. Ely and myself for more than four years. A mastoid fistula existed when I first saw her, when she was three years of age. Dr. Abbot, dentist, of this city, had the care of the caries of the jaw; she was etherized several times, to keep open the original enlargement of the bone fistula and to remove granulations from the tympanum. Finally she recovered, with a neoplastic non-suppurating tympanum, and the mastoid fistula healed.

Several cases have recovered without perforation of the mastoid by getting the patient in bed under the charge of a trained nurse, and the free use of the warm douche, leeches, and poultices. Most of the patients who have been thus relieved have been of decided neurotic tendencies, and although they have had great tenderness and pain in the mastoid, have probably never had more than periostitis. No caries occurred, except in some instances caries of the wall of the auditory canal, when it opens into the mastoid.

But I have written upon this subject at some length in preceding pages.

A case which I have lately seen, in consultation with Dr. F. W. Ring, and which we treated together in the Manhattan Eye and Ear Hospital, re-illustrates the points I have endeavored to make.

Case XIII.—*Acute Suppuration in both Middle Ears—Red, Sensitive, and Tender Mastoid—Increase of Temperature—No Operation—Recovery.*—Mrs. G——, aged twenty-five. November 30, 1886 Five months previously the patient suffered from acute suppuration of both middle ears, while in the West Indies. The suppuration and pain have continued at intervals ever since.

Occasionally she is quite well. She has been under Dr. Ring's care for more than two months. Under his treatment the right drum is now healed; R., H. D., $\frac{48}{48}$; bone conduction better; L., H. D., $\frac{1}{48}$; B. C., better. There is pus in the left tympanum. The mastoid of that side is reddish, painful, and tender. The temperature at about 11 A.M. was 102°, and had been for a few days. She was anæmic and neurotic. She lived in a boarding-house and had insufficient care. On the advice of Dr. Ring and myself she was admitted to the hospital. She was kept in a quiet room, was fed with milk, chiefly stimulants, latterly champagne was given *pro re nata*, massage. Her temperature sank to normal in a few hours after getting under hospital care. The right drum-head again broke down, but finally healed. Locally the hot douche and poultices were used. She was discharged cured. She went to Chicago, had a mild attack of acute suppuration without mastoid trouble, from which she completely recovered in twenty days.

One of my cases at the Manhattan Eye and Ear Hospital, one in which I found a fistula in the bone and enlarged it, developed acute facial erysipelas. The temperature, without the administration of medicine, fell in one day from 104° to 97°. The shock was great, but the patient rallied and made a good recovery. The drum-head healed. Facial erysipelas also occurred in another case where the operation of drilling the bone was performed by Dr. F. Tilden Brown, then one of my assistants. This case may be found in this book, page 524.

The following case, which occurred in private practice in consultation with Dr. E. M. Pulling, and has a peculiar interest from the fact that *descending optic neuritis resulting in atrophy occurred.*

CASE XIV.—Willie X——, aged six. April 10, 1885. Has had pain and discharge from his right ear for some days. He is in bed. Temperature 100½°. The right membrana tympani is perforate. There is inspissated pus in the tympanum. The mastoid process is red and swelled. An incision was made down to the bone, about one ounce of thick pus was evacuated. The periosteum was found to be extensively diseased, but no fistula in the bone was found. The patient slept well that night and recovered. Case went on well as to the ear. Dr. Pulling afterward made counter-openings to prevent burrowing, but no opening in the mastoid bone was ever made, and on March 2d, of this year, I again examined him. I found two linear scars on the mastoid, the membrana tympani is sound and has good light spot, and is of good color. H. D., $\frac{20}{48}$; A. C., better than B. C.

The peculiar interest in the case is found in Dr. Pulling's account of the subsequent progress of the case and in the results of the ophthalmoscopic examinations which I made. Dr. Pulling writes: "After you last saw Willie he had meningitis, lasting four to five weeks. He took bromides in full doses, with aconite and so forth, when the temperature rose. His condition gradu-

ally improved, and at the end of two months or more from the date of your last examination his health seemed quite well established. About this time, however, it was observed that his vision was becoming defective. The impairment of sight I assumed to be due to constriction of the optic nerve from contraction of the tissues about it."

The patient, March 2, 1887, has only perception of light in the right eye and $\frac{6}{200}$ on the left. Both optic papillæ are in a state of white atrophy. The lateral vessels have all disappeared from the right papilla.

It is no new observation to find basilar meningitis in the course of acute inflammation of the tissues of and adjacent to the temporal bone. Our attention has been called by Kipp, Andrews, and others to the usefulness of ophthalmic examinations in the course of diseases of the mastoid, but I think it very unusual for a patient to recover from a suppurative inflammation of the tympanum, with mastoid periostitis, to become blind from optic neuritis and subsequent atrophy.

Case XV.—*Scarlet Fever—Acute Suppuration of the Right Middle Ear—Pain in the Head—Swelling and Redness of the Mastoid—Incision through the Periosteum—Fistula Found and Enlarged—Still under Treatment.*—Miss W——, aged fifteen. The patient was attacked by scarlet fever on November 3, 1886. On the 13th she was seized with a severe pain in the head and with pain in the ear. These pains continued for several days until the membrana tympani broke, when the pain was materially relieved.

The pain in the head continued, however, accompanied by a free purulent discharge from the auditory canal, until February 5th—about three months. I then saw her for the first time, and found the patient anæmic and evidently suffering. The right membrana tympani was nearly gone, and the tympanum velvety. The left drum-head was intact. No tenderness or redness of the mastoid. The hot douche was prescribed, and the ear kept clean. Four days after the patient had severe pains through the temples at the apex of the mastoid. Leeches were applied, and relief given for two or three days, but on February 14th the pain reappeared. There was found to be considerable swelling and redness of the mastoid. At 5 P.M. the temperature was 101¾°.

An incision was made, the periosteum removed, and a fistula found leading from above the middle of the process into the tympanum. Some pus came from this. This was enlarged with a drill. A tent and poultice applied. She began to improve the next day, and her condition at this writing, a little more than four weeks from the operation, is as follows: No headache, anæmia disappearing, scarcely any discharge from the tympanum, and a moderate suppuration passes through a drainage-tube inserted into the mouth of the fistula in the bone. Temperature normal. Patient goes out.

March 31st.—Fistula in bone has healed. Membrana tympani restored. H. D., $\frac{5}{15}$. Subsequently the hearing became normal.

CASE XVI.—*Chronic Suppuration of the Middle Ear—Mastoid Periostitis—Openings down to the Bone—Enlargement of the Fistula—Patient still under Treatment.*—H. B——, aged sixteen, was brought to me March 4, 1887, by Dr. W. H. Cummings, of Honesdale, Pa., on account of pain in the head, dizziness, and occasional swellings of the mastoid process.

The hearing distance on the right side is normal. The drum-head is cicatricial and intact. The left mastoid process is depressed, and has a minute opening, about which the tissues are boggy. A fine probe passed into it can with difficulty be made to enter the bone. The auditory canal was half-filled with sanious pus. It was believed that the tympanum and mastoid were the seat of purulent inflammation, and that they were not well drained.

That day the patient was etherized at the Post-Graduate Hospital, a free incision was made down to the bone, the minute fistula enlarged with a drill and the gouge. The tissue of the mastoid was found to be very soft, and an opening into the tympanum, about one-fourth of an inch in diameter, was easily made. A large quantity of cheesy, inspissated pus, as well as that of a fluid quality, was evacuated. The patient is steadily improving, has no headache or dizziness. Whether or not he will have a permanent fistula remains to be seen. The mastoid tissues have been previously opened several times down to the bone, but not into it, but for the first time thorough drainage has been secured.

May, 1891.--A fistula still exists and is probably permanent. The patient made an excellent recovery.

CASE XVII.—*Acute Suppuration of the Right Tympanum—Mastoid Red, Tender, and Swelled—Fistula Found—Enlarged—Relief—Still under Observation.*—On March 1, 1887, I was asked by Dr. W. A. Dayton to see a female child, aged six, with the following aural history: During the holidays she had the earache several times, generally in the night, with some regularity, at about 1 A.M. These attacks continued at intervals until February 22d, when they became more constant. Her pulse was then 115. Her tongue was coated, the skin dry. The tympanum discharged very moderately; the mastoid process became red, tender, and swelled. Leeches and poultices were applied with only partial relief.

On March 1st I examined the ear. I found the drum-head perforated, caseous pus lying upon its remains, the mastoid as above described. I advised an incision down to the bone, in the usual way. This was made by Dr. Dayton; no pus was found, but a small fistula was discovered about one-fourth of an inch above the apex of the mastoid, with softening of the bone about. This was enlarged and a tent introduced.

March 2d.—The relief has been very great.

March 19th.—There has been no pain since the operation. The wound, previously syringed with weak carbolized water, has been tightly packed every day with a twelve-inch tent.

Granulations have sprung up in the wound rapidly; these have been trimmed away daily with curette and scissors. The use of a four per cent. solution of cocaine has rendered the treatment almost painless.

There has been no pus (from the beginning) save that which comes away on the tent. The child has been kept in bed, in a bright, sunshiny room, and allowed a generous diet, meats only prohibited.

In this case the inflammation has been rather plastic than suppurative, or predominantly of the former character. The case made a complete recovery.

CASE XVIII.—*Acute Suppuration of the Tympanum—Severe Pain—Diplopia—Mastoid Opened—No Pus—No Fistula—Recovery in Four Months—Fistula closed in about a Year.*—A. M——, aged forty-six, colored. June 25, 1885. For five weeks this patient states that he has suffered from a purulent discharge from the left auditory canal. For much of this time he has suffered much pain. He now has a suppuration of the tympanum, and complains of severe pain. Two leeches were applied to the tragus, and morphia was administered hypodermically at bedtime. Warm douche to the canal.

July 5th.—The patient has been very comfortable for a portion of the time, but he has had considerable pain; referred to the left side of the head. Besides the hot douche, poultices have been applied about the ear at times. It has been necessary to give morphia every night. The discharge has been profuse. This evening his temperature is 101°.

July 6th.—The patient has homonymous diplopia, the left external rectus being paralyzed.

July 7th.—Diplopia and pain continued. At about 4 P.M. the mastoid was opened with a drill. Dr. Emerson operated, assisted by Dr. Roosa. No pus, no fistula were found. A tent was placed in the opening and a poultice applied.

July 9th.—The patient has had no pain since the operation. Paralysis of the external rectus continues. The examination with the ophthalmoscope detects no lesion of the fundus oculi.

July 11th.—Yesterday a free discharge of pus occurred from the mastoid cells. He also had pain in the head and back of the neck, lasting three or four hours. This is the first since the operation, and at 5 P.M. his temperature was much higher and his pulse more frequent than at any time since the operation. This morning he is sweating profusely. The discharge from the ear is abundant.

The patient was taken from the hospital for a time, but reappeared in a few days.

August 6th.—He is now up and about his room. His temperature from August 5th to the 12th ranged from normal in the morning to 104° in the afternoon.

The fistula in the bone is free, and the patient has no pain.

On August 20th the patient again left the hospital. He reported daily, and was readmitted in about a month. The granulations were removed from the sinus by a curette, and the opening kept free. On October 14th he was discharged, without pain; the diplopia disappeared. Some thirty days since, the fistula still existed. The patient made a perfect recovery, and is still living. The fistula closed; abscesses occurred in the neck.

In another case, alluded to in this chapter.[1] diplopia also occurred during the course of erysipelas, which supervened upon the operation of opening the mastoid. It is remarkable that no pus was found on opening the mastoid. It soon, however, made its way through, and the fistula thoroughly drained the tympanum, and thus gave relief, and recovery ensued. I can but think that a fatal result might have ensued had not the mastoid been opened.

[1] Archives of Otology, Vol. XII., 1883.

CASE XIX.—*Acute Suppurative Inflammation of the Tympanum—Healing of the Drum-head in Two Weeks—Mastoid Abscess—Removing of Pus—Opening of Mastoid—Subsequently, Deep Abscesses of the Neck—Recovery.*—C. P——, aged twenty-three. Patient was admitted to the hospital on September 3, 1886, and gave the following history:

Three months previously he had an acute suppuration of the left tympanum. The drum-head is said to have healed in two weeks. After this he suffered from severe headaches from the occiput around to the frontal region. A swelling behind the ear occurred a month ago, and since that time he has not suffered much from pain. The mastoid region is found to be swollen, but not red or tender. His hearing distance is $\frac{3}{40}$, and the membrana tympani is intact. The neck is also swollen down to the clavicle. On September 26th, Dr. Emerson opened the mastoid cells with a drill. Pus was found in the cells. A tent and poultice were applied. In four days the great swelling of the neck had subsided, and pus was freely discharging from the opening in the bone. The patient is anæmic and feeble. Whiskey and iron and milk are given. The swelling of the neck reappeared and became greater than before the operation. An incision along the sterno-cleido-mastoid was made by Dr. Roosa on October 17th, and a careful dissection made under the muscle, and a large quantity of pus evacuated. Iodoform dressing was applied and a rubber drainage-tube introduced. An exploratory incision made some days before failed to find pus, but the operation of to-day showed that it has been burrowing for a long time. From this time the patient began to recover, and was discharged from the hospital on December 10th, with one drainage-tube leading down *to* the bone, but not in it. For a long time previously the patient had three drainage-tubes—one into the fistula of the mastoid, one along the side of the sterno-cleido-mastoid, and one over the border of the occipital bone. For some time they communicated with each other. This patient finally made a complete recovery.

The marked feature in this case was the complete healing of the membrana tympani with almost complete restoration of the hearing, while the disease went on in the mastoid bone and extended from there deep into the cervical tissue.

CASE XX.—*Acute Suppuration of the Middle Ear—Mastoid—Abscess—Fistula—Operation—Relief.*—Bertha X——, aged thirteen, was brought to me by her father, a physician, February 28, 1885, suffering intensely at times from pain referred to the left ear. The history states that she had severe pain in the ear on the Christmas-day preceding, and that the ear had soon begun to discharge pus, and that it has continued to do so. The hearing distance is $\frac{c}{40}$. The bone conduction is better than the aërial on that side. The drum-head is gone posteriorly, and there is a free discharge of pus from the tympanum. The mastoid region is red, swollen, and tender. The mastoid is of a delicate anæmic type.

On the same day the mastoid was incised, pus evacuated, a fistula leading into the tympanum was found and enlarged. A tent was applied. Relief to the pain soon followed. The patient was treated in the Manhattan Eye and Ear Hospital for some three months. The bone about the fistula was found exposed. The fistula was enlarged with a drill at the time of the operation, and kept open by the use of the curette; granulations sprang up very readily.

**July, 1890.**—The fistula healed entirely in 1888. Patient is well.

The prominent feature in this case is the fact that the fistula did not heal in a year after the operation. This may have been due to two causes : 1, the delicate health of the patient ; 2, the care of the patient at home—that is, in regard to keeping the fistula and tympanum clear—has not been quite as thorough as when the patient was under daily treatment at the hospital. To keep a fistula free from granulations often causes so much pain that a tender parent, even if a physician, will not always do it.

Case XXI.—*Acute Suppuration of the Middle Ear—Thickening of the Tissues over the Mastoid—No Tenderness or Pain—Recovery without Operation.*—Mrs. H——, aged thirty-three, was brought to my office on June 11, 1886, by Dr. John C. Peters, who desired my opinion as to treatment of her ear. The patient stated that some twelve weeks before she was seized with a pain in the right ear. After using the nasal douche there was soon a discharge of pus from the auditory canal, which has continued ever since. The hearing distance on the right side is $\frac{r}{4\,8}$; on the left, $\frac{4}{4}\frac{8}{8}$. At times she has considerable pain in the ear and the right side of the head. The tissues over the mastoid process were considerably thickened, but there was no redness, swelling, or tenderness. The drum-head was perforate, about half of the membrane being gone, and there was a free but not excessive discharge of muco-pus. The patient, who was a well-developed woman, appeared to be in a high state of nervous excitement. She stated that she had been under the care of several physicians, and that this morning the last one whom she had consulted advised that the mastoid be opened to-day ; another had said she had syphilis, and so forth. Before she had made the statement in regard to an operation, I had advised Dr. Peters that his patient be kept in her room and that the ear be treated by the use of the warm douche and poultices, the latter in case of pain ; after the statement as to the urgent need of an operation I again went over the case, but in view of all the symptoms I concluded that the drainage of the tympanum was sufficient, and that what was now needed was absolute mental and bodily quiet. The patient was treated in the manner indicated, leeches were applied to the tragus the next day, and poultices were used in front and behind the ear. The temperature remained normal, and while she was under my observation (some ten days) she steadily improved, and finally became well as to her general health and had no pain referred to her ear. There remained an opening of the membrana tympani when she was last seen by me, and a slight muco-purulent discharge, but I have been informed by her mother, within a few days of writing this, that the patient, now nine months since, is perfectly well.

In this case the patient's natural disposition and undisciplined mind led her to exaggerate her symptoms, especially as regards pain. Then again, she has kept herself in a state of excitement by running about to various physicians, when the actual objective conditions were really not at all grave. At any rate, I felt that with a tympanum well open, a mastoid scarcely tender on the very firmest pressure upon the apex, with no fever, and a brief history of aural disease, in a person excited by her

frequent change in advisers, that delay was certainly proper. Much as I advise opening the mastoid when the indications are even moderately plain, and the conditions are urgent, I am always very anxious not to perform an unnecessary operation. The case belongs to the same class as Case XIII., and the one narrated on page 514, and before alluded to in this article, where neurotic symptoms predominated over the inflammatory. I ought to add that, after a thorough examination, neither Dr. Peters nor myself thought the patient had syphilis.

If operative procedures are necessary for the drainage of the tympanum, certainly, as a rule, they are best and most safely performed through the mastoid cells. In some instances these may be best reached, however, by an opening in the auditory canal. Such an operation as this, however, is not to be confounded with operations which aim to remove the remains of the drum-head and the contents of the tympanum. Such operations may be indicated in cases where only the tympanum is involved, but if the drainage of the ear is insufficient, and the mastoid cells are at all implicated, opening the mastoid is a much more rational and less difficult operation than removal of the ossicles.

All of us know that even the operations for the removal of granulations deeply seated in the tympanum become very difficult on account of the free bleeding, which soon renders all exact and delicate manipulation almost impossible.

Case XXII.—*Acute Suppuration of the Middle Ear—Vertigo—Mastoid Caries—Trephining—Fistula Closed in Fifty-six Days.*—May 2, 1879. Mr. S——, aged forty-seven. Boiler-maker. Has been hard of hearing and has had tinnitus "*always.*" Seven weeks ago he was attacked by inflammation in the ear, caused by exposure to cold and dampness. He now has suppuration in the left tympanum, the drum-head being perforate. He also complains of vertigo and shooting pains running up over the forehead, down toward the occiput. H. D., R., $\frac{9}{10}$. The warm douche and poultices behind the ear were advised. In a day or two leeches were applied on the tragus and upon the mastoid, and the patient was kept very quiet. The purulent discharge from the tympanum is free. He has slight pain in the tympanum and mastoid at night. Quinine was used, but without benefit. On May 28th he was having rather more pain and vertigo, the latter only when moving about. Slight tenderness over one or two points of the mastoid by very firm pressure. No thickening of the integument. Copious discharge from the ear. The canal is narrowed, and firm granular swelling at the bottom. No marks of drum-head or tympanum visible. Patient can attend to business, that of a superintendent. The pain is intermittent. An incision, the patient *not* being under anæsthesia, about one inch long was made down to the bone. The bone felt softened and rough, but was not carious except at one spot. A probe was worked through this spot until it penetrated into the auditory canal. The opening was enlarged with the drill. No pus was found. The

opening was plugged with lint and a poultice applied around the ear. The external excision was made T-shaped before the drilling was undertaken. The patient had some pain and dizziness until midnight. Absolute rest was advised. There is no fever. The patient did well until July 7th, with only gradual decrease of vertigo and pain. Last night he had an increase of dizziness and a feeling of numbness in the lips on the left side. The fistula in the bone has been closed for a week. The fistula in the soft tissues is still kept open. The canal looks well, and there is only a moderate discharge from the tympanum. The air is felt in the ear on inflation, but there has been no perforative whistle for the last few weeks.

July 21st.—The mastoid fistula has closed. Patient feels very well. H. D., $\frac{r}{40}$; voice, 50′.

August 5th.—The patient has been in the country since last date. Has had dizziness for about ten minutes after tipping back in a barber's chair, and he also suffers from it if he tips his head to the left, or lies on the left side. No vertigo in walking.

August 11th.—Frontal headache for the past two days. More dizziness. Numbness of the left side of the nose and lip. Nothing wrong seen about the ear. Ordered bromide potash, ten grains every two hours, and five grains of blue pill to-night. The patient recovered from this attack, took a voyage to England and back, and on November 29th he was seen and a final note made. There is now a slight purulent discharge from the tympanum. He had a slight bloody discharge from it, after climbing to the ball of St. Paul's Cathedral. The upper and posterior segments of the membrana tympani are now cicatrized. An opening exists below. The surface scar is granular. He complains of soreness of the left nostril and numbness of left side of upper lip (see August 11th). Face seems a little drawn, and uvula seems to tip a little to the right side. The patient has no vertigo or pain.

This patient was hard of hearing from the usual cause in a boiler-maker, but upon this supervened the inflammation of the tympanum and mastoid. The inflammation of the latter was only suppurative in a very narrow track, whatever it may have been in other parts. The tympanum, as shown by the facial paresis, was markedly affected. The first positive relief to his pain and vertigo came from the enlargement of the mastoid fistula by the drill.

Case XXIII.—*Caries of the Mastoid from Chronic Suppuration—Exacerbation of Otitis Media—Mastoid Opened Three Times—Recovery.*—Miss X——, aged twenty-six. January 11, 1877. Six years ago, patient states that she had a discharge from the left ear without apparent cause. It has continued more or less ever since. Last September she took cold, and had severe pain with delirium. Swelling of the mastoid occurred, and in the last week of September it was cut. A free discharge of pus occurred and relief of the pain. The incision healed in a few days and the pain returned. The mastoid cells "were pierced" in October. The patient comes to me on account of continued pain and occasional dizziness. The left auditory canal is red, sensitive, and full of pus. There is a large cicatrix on the mastoid and a sinus running downward and for-

ward toward the auditory canal. The physician who opened the bone afterward, wrote me as follows: "I found a fistulous opening where the mastoid had previously been lanced. I at once made a free opening through the soft tissues into the cells. No pus was found. A fistulous opening existed between the osseous and cartilaginous meatus down quite into the middle ear. The operation afforded very great relief from the urgent symptoms. But as the wound contracted pain recurred."

About a month after, the Doctor again opened the wound, cut away as much of the diseased tissue as possible with a chisel, following the fistulous track. The probe detected diseased bone at the depth of one and one-quarter inch. Relief again occurred. Some time after, a small piece of bone came away. The wound closed, but on January 6th swelling and pain in the mastoid again began. The next day the wound again opened, and at this point she came under my care. After vainly attempting to get permanent relief from the pain, by keeping the fistula open with a tent, and treating the tympanum through the auditory canal, I determined to open the wound freely and enlarge the bone fistula. Accordingly, on April 7th, the patient was etherized. The external opening was enlarged, and the surface of the bone carefully examined. It was found to be smooth. The fistulous opening into the tympanum through the osseous canal was then enlarged with a drill, and the outer opening was made funnel-shaped. The fistula was treated by being dressed to the bottom with a tent, and healed June 23d, a little more than two months after the opening had been enlarged. The patient has been free from pain since a few days after the operation. The tympanum was treated through the auditory canal, by thorough cleansing with a syringe and curette, there being a great disposition to the inspissation of pus and the formation of granulations, but she finally entered upon her duties as a teacher, which she continues (June, 1884) to perform. When last seen, in 1882, a part of a cicatricial membrana tympani existed, there was a free discharge from the tympanum, and a granulation in the upper part. Under the use of iodoform this became better.

The final success in this obstinate case was due, I think, to a persistent care of the tympanic cavity, which was left free from pus and granulations, while the osseous fistula was being healed from the bottom. In opening the mastoid, the surgeon should remember that the operation has become necessary because the pus is not thoroughly evacuated from the tympanum through the canal. There will, therefore, often be found much to be done in treatment of the canal and tympanum.

The following case occurred in my own clinic, and although treated mainly by Dr. Ely and Dr. Brown, I saw the patient frequently, and advised in the later stages of treatment. It was reported by Dr. F. Tilden Brown in a special journal,[1] but it is of sufficient importance to be inserted here, since it illustrates what has been said of the occasional difficulty in diagnosis as to the presence of pus in the mastoid cells.

[1] Archives of Otology, vol. xii., 1883.

Case XXIV.—*A Case of Abscess of the Mastoid, with Entire Absence of Tenderness, Heat, or Swelling over the Suppurating Part, with a constant Distant Pain near the Occipital Protuberance—Trephining—Recovery—Occurrence of Erysipelas during Convalescence.*—John M——, aged forty-eight, came to Dr. Roosa's clinic at the Manhattan Eye and Ear Hospital on September 14, 1882. Examination by Drs. Edward T. Ely and F. T. Brown showed a muco-purulent discharge from the right ear, partial loss of the membrana tympani, diminished calibre of the auditory canal, no swelling or redness behind the auricle, *no tenderness on pressure or percussion over the mastoid*, inability to hear a watch on contact, tuning-fork heard but by aërial conduction. The sole cause of his coming to the hospital was great pain at a point along the right superior curved line, two centimetres from the occipital protuberance; occasionally radiating along the right border of the parietal suture over the frontal bone to its interior angular process; thence above and below the orbit.

*Previous History.*—No direct injury, but had a fall on back of head one month before. Had never had syphilis; was perfectly temperate, and had always been well until the fourth of last June, when he experienced gradually increasing pain in the right ear. Morphine gave temporary relief. Five days after, a discharge appeared. The pain continuing, a blister was applied behind the ear, and on June 16th, he was able to go to work, but returned in a few hours with still greater pain. For the three weeks following morphine (hypodermically) was given twice daily; this failing, chloroform inhalation was resorted to. Late in July, Wilde's incision was made at the New York Eye and Ear Infirmary, but the pain became, almost at once, more intense. A few days later a bone-operation was proposed, but the patient's family objecting, he came with a letter from his physician to the Manhattan Eye and Ear Hospital. Here careful watching for two days and nights verified his story of pain, sleeplessness, and loss of appetite, but no abnormal temperature was detected.

The result of a consultation was to defer operation until thorough anti-neuralgic treatment had been tried. Quinine, alcohol, and galvanism were ordered. Five days later the patient was no better, and perforation of the mastoid was determined upon despite the absence of satisfactory local symptoms. It was performed by myself under the advice of Dr. Ely. The periosteum was healthy, and on its section the bone presented a similar appearance. Brainerd's drill sunk one and a half centimetre, entered a cavity, when about four grammes of pus came away. A warm solution of boracic acid, thrown into the *meatus auditorius*, found exit through the wound, bringing pus. The dressing was antiseptic and directed to favor free drainage and prevent occlusion. Pain was at once and permanently removed. Two weeks later the patient went home, but returned daily for dressing. The discharge now amounted to three grammes in twenty-four hours, and a watch could be heard on contact. On the evening of November 4th, pain was felt about the auricle, followed by a chill with subsequent fever; the pain prompted a vigorous application of camphorated oil. Toward morning the patient vomited. I was sent for the following night, when I found him with a pulse of 90; temperature, 103°; tongue coated; bowels constipated; pupils normal in response to light. Probe passed readily, but the discharge was slight. The tissues about the wound and over the parotid region were œdematous and but slightly sensitive; this pallor suggested serous rather than hæmostatic injection, and might have been either the erysipelatous cause, or the blistering effect, of camphorated oil applied to relieve deeper pain. The

diagnosis of erysipelas was made on the fourth day; this disease, still indifferently marked, had extended to the left malar bone; pulse was 98; temperature, 103⅘°; delirious through the night; sight was indistinct; had convergent squint; pupils responded feebly to light; had moderately rhythmic vibrations of the right forearm. I was again led to doubt the absence of meningitis, and called Dr. Roosa in consultation, who, on examination, found slight cerebral impairment and homonymous double vision existing; the ocular media were clear. Optic disks not seen on account of want of illumination. The mastoid perforation was free, and afforded no evidence of retained pus, although the discharge was greatly diminished. For this reason Dr. Roosa and myself concluded that meningitis due to adjacent suppurative mastoid disease did not exist, and that the diplopia, with other nervous symptoms, was due to a peripheral hyperæmia of the pia mater, by continuity of tissue with the facial erysipelas, resulting in irritation of the sixth nerve at its point of exit.

This belief proved to be correct, for the intensity of the symptoms subsided, and in eight days convalescence began. The discharges from both channels had ceased, and one week later the wound completely closed. This was an agreeable surprise, for in its relationship to disease of the mastoid, I viewed the erysipelas as analogous to epididymitis succeeding a gonorrhœa, and I expected a return of the discharge as the erysipelas subsided.

Dr. Brown gave the following points as being of special interest in this case:

1. The entire absence of tenderness, heat, or swelling over the suppurating mastoid, while there was a constant pain referred to a point near the occipital protuberance.

2. The difficulty in differentiating the symptoms of facial erysipelas from those of meningitis.

3. The direct suggestion made by the case, of the value of active counter-irritation in the treatment of sub-acute or chronic suppuration of the middle ear.

I lately had under treatment at the hospital, a man, aged forty-five, upon whom I performed the operation of trephining the mastoid process for caries and abscess, in whom facial erysipelas developed in three days after the operation. Although he became very ill, having for some time a temperature of 105°, he recovered. The mastoid caries occurred during the course of acute suppuration of the middle ear, which he very much neglected. Although the patient was three weeks in bed from the facial erysipelas, the occurrence of this disease hardly seemed to retard the recovery of the abscess of the mastoid.

Besides the dangers of erysipelas and pyæmia from suppurative inflammation of the mastoid, it is not uncommon to meet with inflammation of the connective tissue of the neck, with the formation of abscesses. In one of my cases the life of the

patient was at one time threatened by the numerous abscesses, and his swallowing was for some days extremely difficult on account of the pressure upon the pharynx.

*Table Showing the Relative Frequency of Affections of the Mastoid in Certain Eye and Ear Hospitals, and in the Writer's Private Practice.*

| Name of Institution. | Total Number of aural cases. | Number of years. | Affections of the mastoid. | Operations. |
|---|---|---|---|---|
| Manhattan Eye and Ear Hospital. | 14,720 | 17 | 110 | Wilde's incisions and opening of mastoid, 105. (Wilde's incision, 94. Enlargement of a fistula, 5. Perforation, 6.) One opening through auditory canal. |
| Brooklyn Eye and Ear Hospital. | 18,366 | 18 | 91 | 126 Wilde's incisions and perforations of the mastoid. |
| New York Ophthalmic and Aural Institute. | 14,634 | 17 | 112 | Wilde's incisions, 108. Perforations of the mastoid, 22. Opening through auditory canal, 1. Total, 131. |
| Massachusetts Charitable Eye and Ear Infirmary. | 9,533 | 3 | 62 | Operations not fully recorded. |
| Newark Charitable Eye and Ear Infirmary. | 3,021 | 3 | 22 | 15 |
| Illinois Eye and Ear Infirmary. | 2,464 | 4 | 8 | 16 |
| New York Charity Hospital. | 20 | 1 | 1 | 1 |
| Author's Private Practice. | 5,797 | 22 | 59 | 42 |

*Percentage of Affections of the Mastoid.*

| Aural cases. | Mastoid cases. | Per cent. |
|---|---|---|
| 14,720 | 109 | 0.74 |
| 18,366 | 91 | 0.49 |
| 14,634 | 112 | 0.76 |
| 9,533 | 62 | 0.65 |
| 3,021 | 22 | 0.72 |
| 2,464 | 8 | 0.32 |
| 20 | 1 | 0.05 |
| 5,797 | 59 | 1.01 |
| 68,555 | 464 | .67 |

*Aural Cases Observed in Private Practice in which the Mastoid Process was Seriously Involved.*[1]

| No. | Age. | Sex. | Form of original disease. | Treatment. | Time under observation. | Result. | Remarks. |
|---|---|---|---|---|---|---|---|
| 1 | 56 | Male. | Acute suppuration of the middle ear. | Wilde's incision. Poultices. | 45 days. | Cure, membrana tympani healed. | Patient had an acute catarrh of the tympanum two weeks later; recovered under use of leeches in a few days. |
| 2 | 55 about | Male. | Nasal polypus; removal; use of nasal douche; acute catarrh of the middle ear. | Leeches. Poultices. | 60 days. | Cure. | Pyæmia occurred; case reported, *Archives of Ophthalmology and Otology*, vol. i., p. 359. |
| 3 | 50 | Male. | Chronic suppuration, middle ear, of four months' standing. | Wilde's incision. Pus evacuated. | 4 days. | Was relieved when last seen. | Polypus also removed from canal. |
| 4 | 30 | Female. | Acute inflammation of the middle ear. | Warm douche. Poultices. | 3 days. | Cure. | |
| 5 | 38 | Female. | Acute inflammation of the middle ear. | Wilde's incision by Dr. Agnew. Pus evacuated. | Unknown. | Cure. | Seen in consultation. |
| 6 | 30 about | Male. | Naso-pharyngeal catarrh; use of nasal douche; acute suppuration of middle ear. | Leeching. Poultices. | Some months. | Died in a few months. Death said to have resulted from disease of the brain. | Seen in consultation with Dr. Loring. Account of final result given to writer by Dr. J. W. Warner. |
| 7 | 13 | Female. | Chronic suppuration of middle ear. | Wilde's incision. Pus evacuated. | 4 weeks | Cure. | Drum-head did not heal. |
| 8 | 70 | Male. | Chronic suppuration of middle ear. | Wilde's incision. Bone fistula found enlarged. | 4 months. | Cure. | Seen with Dr. Loring. Reported in author's text-book, sixth edition, p. 496. |

[1] Cases in which the apex of the petrous bone was the chief seat of lesion, and those of cerebral abscess without serous symptoms in the mastoid, have been excluded from this table.

*Aural Cases Observed in Private Practice in which the Mastoid Process was Seriously Involved* (Continued).

| No. | Age. | Sex. | Form of original disease. | Treatment. | Time under observation. | Result. | Remarks. |
|---|---|---|---|---|---|---|---|
| 9 | 30 | Female. | Acute suppuration of middle ear. | Wilde's incision. No pus. | 16 days. | Relieved. | Final result unknown. |
| 10 | 39 | Male. | Primary mastoid periostitis. | Leeches. | 1 day. | Unknown. | |
| 11 | 3 mos. | Male. | Acute inflammation of middle ear. | Wilde's incision. No pus. | A few days. | Died. | |
| 12 | 45 about | Male. | Sub-acute suppuration of middle ear. | Leeches. | 1 day. | Unknown. | |
| 13 | 26 | Male. | Acute inflammation of middle ear. | Wilde's incision. No pus. | 1 month. | Cure. Drum-head healed. | Mastoid periostitis occurred the sixteenth day after the ear was first affected. |
| 14 | 41 | Male. | Acute suppuration of the middle ear. | Wilde's incision. Fistula found. | Some months. | Cure. Bone fistula healed. | |
| 15 | 1 | Female. | Chronic suppuration of middle ear. | Wilde's incision. Pus evacuated. | 1 day. | Unknown. | Seen with Dr. Jenkins, of Yonkers. |
| 16 | 50 | Female. | Chronic suppuration of middle ear. (Mastoid abscess, caries.) | Leeches. Hot douche. | A few days. | Died. | |
| 17 | 27 | Female. | Inflammation of external auditory canal. | Leeches. Wilde's incision. | 11 years. | Cure. | Still has eczema of the auditory canal. |
| 18 | 60 | Female. | Acute suppuration of the middle ear. | Wilde's incision. No pus. | A few weeks. | Cure. Drum-head healed. | In consultation with Dr. O. J. Ward. |
| 19 | 21 mos. | Female. | Chronic suppuration of the middle ear from measles. | Wilde's incision. Pus evacuated. | Some days. | Relief of acute symptoms. | |
| 20 | 26 | Female. | Chronic suppuration of middle ear. | Wilde's incision and enlargement of fistula with a drill. | 2 years. | Cure. Drum-head did not heal. | |

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| 21 | 28 | Female. | Chronic suppuration of middle ear. | Mastoid trephined by Dr. Mathewson. | 3 months. | Relief to pain for some time. Disease recurred. | Full account in body of article. |
| 22 | 42 | Male. | Acute suppuration of middle ear. | Leeches. Wilde's incision. No pus. | 28 days. | Death from meningitis. | Reported, p. 310. |
| 23 | 15 | Male. | Chronic suppuration of middle ear. | Wilde's incision. No pus. | Several months. | Cure. | Patient now said to be dying of phthisis, some ten years later. |
| 24 | 9 | Male. | Chronic suppuration of middle ear from scarlet fever. | Removal of polypus. | 30 days. | Relief. | Mastoid had been previously perforated and healed. |
| 25 | 47 | Male. | Acute suppuration of middle ear. | Opening of mastoid with drill. | 1 year. | Cure. | |
| 26 | 42 | Male. | Acute catarrh of middle ear. | Paracentesis of membrana tympani. Wilde's incision. No pus. | Some months. | Cure. | Facial paralysis occurred. |
| 27 | 33 | Male. | Naso-pharyngeal catarrh; used nasal douche; acute suppuration of middle ear. | Wilde's incision. Dr. Chas. Phelps. Fistula found. | 18 months. | Cure. Fistula remained open 18 months. | |
| 28 | 5 | Female. | Chronic suppuration of middle ear; spontaneous opening of mastoid. | Enlargement of mastoid fistula. Necrosed bone removed. | 3 years. | Cure. | |
| 29 | 28 | Female, colored | Exostosis, mastoid process; no other disease of the ear. | | | | |
| 30 | 21 | Male. | Chronic suppuration, middle ear; fistula, mastoid. | Fistula enlarged. Granulations removed. | 3 months. | Died of phthisis pulmonalis 3 months after. | |
| 31 | 20 | Male. | Chronic suppuration of middle ear. | Wilde's incision, and enlargement of fistula with drill. | 8 days. | Died some months after of meningitis. | |

*Aural Cases Observed in Private Practice in which the Mastoid Process was Seriously Involved* (Continued).

| No. | Age. | Sex. | Form of original disease. | Treatment. | Time under observation. | Result. | Remarks. |
|---|---|---|---|---|---|---|---|
| 32 | 30 | Female. | Acute suppuration of middle ear. | Hot douche and poultices. | 3 days. | Relieved. | |
| 33 | 26 | Male. | Acute suppuration of middle ear. | Leeches. Poultices. Warm douche. | 1 month. | Cured. | |
| 34 | 5 | Male. | Acute suppuration of middle ear. | Wilde's incision. Fistula found. | 1 month. | Cured. | Dr. Dew performed the operation. |
| 35 | 7 | Male. | Acute suppuration of middle ear. | Hot douche. Poultices. | 23 days. | Cured. | |
| 36 | 19 mos. | Female. | Acute suppuration of middle ear, with facial paralysis. | Opening mastoid through external auditory canal. | 8 weeks. | Cured. | Operation performed by Dr. Blake White. |
| 37 | 38 | Female. | Chronic non-suppurative inflammation of middle ear, with facial paralysis and periostitis of mastoid. | Mercury and iodide of potash. | 33 | Cured. (Facial paralysis remained when last seen.) | |
| 38 | 19 | Male. | Acute catarrhal inflammation of the middle ear. | Leeches. Poultices | 20 days. | Cured. Drumhead healed. | Treated by Dr. J. B. Emerson. |
| 39 | 60 | Female. | Chronic suppuration of middle ears since childhood. | Counter-irritation. | 4 months. | Cured. Drumhead healed. | |
| 40 | 4 | Female | Acute suppuration of middle ears with mastoid; fistula and facial paralysis. | Enlargement of fistula. Removal of nearly the whole of the temporal bone. | 1 year. | Cured. Permanent fistula in bone. | Reported in full in *Archives of Otology*, vol. xv. |
| 41 | 35 | Male. | Acute suppuration of middle ear. | Opening of mastoid cells with chisel. | 2 weeks. | Cured. | In consultation with Dr. Gruening. Operation by Dr. Gruening. |

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| 42 | 36 | Male. | Acute suppuration of middle ear. | Leeches. Poultices. Incisions in auditory canal. | 6 months. | Relieved. | |
| 43 | 7 | Female. | Acute catarrh of middle ears; malarial poisoning. | Quinine internally. Poultices. Hot douche. | 3 months. | Cured. Drum-head healed. | |
| 44 | 13 | Female. | Acute suppuration of middle ear. | Wilde's incision, with enlargement of fistula by drill. | 2 years. | Relieved. Fistula still open. | |
| 45 | 6 | Male. | Acute suppuration of middle ear. | Wilde's incision. Pus evacuated. | 2 years. | Cured. Drum-head healed. | Meningitis. Atrophy of optic nerves. Full report in this chapter. |
| 46 | 69 | Male. | Bronchitis; acute catarrh; acute suppuration of middle ear. | Mastoid opened with drill. | 1 month. | Died. | |
| 47 | 25 | Male. | Chronic suppuration of middle ear. | Opening of mastoid with drill. | 15 days. | Died. | |
| 48 | 21 mos. | Female. | Acute suppuration of middle ears. | Wilde's incision. Enlargement of fistula. | 1 year. | Cured. | |
| 49 | 30 | Female. | Acute suppuration of middle ear from use of nasal douche. | Warm douche. Poultices. | 6 months. | Cured. | |
| 50 | 52 | Male. | Inflammation of external auditory canal. | Warm douche. | 1 month. | Cured. | |
| 51 | 25 | Female. | Acute suppuration of middle ears. | Warm douche. Poultices. | 2 months. | Cured. | |
| 52 | 43 | Male. | Acute suppuration, right middle ear. | Warm douche. Poultices. | 1 day. | Cured.[1] | |
| 53 | 16 | Female. | Neuralgia, middle ear. | Tonics. Change of air. | 1 month. | Cured. | |
| 54 | 15 | Female. | Acute suppuration of middle ear from scarlet fever. | Wilde's incision. Fistula found and enlarged with drill. | 50 days. | Relieved. | Under treatment. Membrana tympani healed. |

[1] Since writing this I have received a note from this patient stating that he is well. This reduces the number of results unknown to three.

*Aural Cases Observed in Private Practice in which the Mastoid Process was Seriously Involved* (Continued).

| No. | Age. | Sex. | Form of original disease. | Treatment. | Time under observation. | Result. | Remarks. |
|---|---|---|---|---|---|---|---|
| 55 | 16 | Male. | Chronic suppuration of middle ear from scarlet fever, with mastoid fistula. | Wilde's incision. Pus evacuated. | 17 days. | Relieved. | Still under treatment. |
| 56 | 38 | Male. | Sub-acute catarrh of middle ear. | Wilde's incision. | 1 month. | Died. | |
| 57 | 6 | Female. | Acute catarrh of the middle ear. | Wilde's incision. Soft bone broken down with a probe. | 20 days. | Relieved. | Operation by Dr. Dayton. |
| 58 | 3 | Male. | Chronic suppuration of middle ear. | Wilde's incision. Fistula found and enlarged with drill. | 13 days. | Died. | |
| 59 | 4 | Male. | Chronic suppuration, middle ears, from scarlet fever; fistula in both mastoids. | Enlargement of fistula with drill. | 1 month. | Relieved. | |

*Statistics of Cases of Disease of the Mastoid in the Writer's Service at the Manhattan Eye and Ear Hospital.*

| No. | Age. | Sex. | Disease exciting present attack. | Treatment. | Time under observation. | Result. | Remarks. |
|---|---|---|---|---|---|---|---|
| 1 | 12 | Female. | Sub-acute catarrh of middle ear. | Wilde's incision. Pus evacuated. | ..... | Unknown. | |
| 2 | 36 | Female. | Chronic suppuration of middle ear. | Wilde's incision. Knife went through with mastoid cell. | 2 weeks. | Relieved. | Deafness, with tinnitus aurium, and occasional stinging pains in the ears, appeared 4 months ago; has had no good sleep, until the operation, for 3 weeks. |
| 3 | 18 | Male. | Chronic suppuration of middle ear. | Wilde's incision. Pus evacuated. | ..... | Relieved. | |
| 4 | 6 | Male. | Fistula of the mastoid. | | | | |
| 5 | 9 mos. | Male. | Chronic suppuration of middle ears; polypus; abscess of mastoid. | Enlargement of opening. | | | |
| 6 | 6 | Female. | Acute suppuration of middle ear; small fistula in mastoid. | Enlarged with a drill. | ..... | Relief. | |
| 7 | 5 | Male. | Chronic suppuration of middle ear. | Enlarged with a drill. | 40 days. | Cured. | |
| 8 | 2 | Male. | Primary inflammation of the mastoid. | Wilde's incision. No pus. | ..... | Unknown. | Drum-head normal. |
| 9 | 6 | Male. | Acute suppuration of middle ear, with mastoid periostitis. | | | | |
| 10 | 2 | Female. | Chronic suppuration of middle ear, with mastoid fistula. | | | | |
| 11 | 48 | Male. | Acute suppuration of middle ear. | Opening of the mastoid with drill. No pus. | 18 months. | Cured. | |

*Statistics of Cases of Disease of the Mastoid in the Writer's Service at the Manhattan Eye and Ear Hospital* (Continued).

| No. | Age. | Sex. | Disease exciting present attack. | Treatment. | Time under observation. | Result. | Remarks. |
|---|---|---|---|---|---|---|---|
| 12 | 20 | Male. | Acute suppuration of middle ear. | Wilde's incision. Enlargement of fistula with drill. | 3 months. | Cured. | |
| 13 | .. | Male. | Acute suppuration of middle ear. | Wilde's incision. Pus evacuated. Small fistula found, which was enlarged with drill. | | | |
| 14 | 17 | Male. | Chronic suppuration of middle ear. | Wilde's incision. Evacuation of pus. | ..... | Relieved. | |
| 15 | 9 | Male. | Chronic suppuration of middle ear. | Wilde's incision. Fistula in mastoid. Enlarged with drill. | 3 months. | Cured. | Operation by Dr. Ramsdell. |
| 16 | 23 | Male. | Acute catarrh of middle ear. | Wilde's incision. Enlargement of fistula with drill. | 7 months. | Cured. | |
| 17 | 39 | Male. | Impacted cerumen, with mastoid periostitis. | Leeches. | | | |
| 18 | 15 | Male. | Acute suppuration of middle ear. | Wilde's incision. Evacuation of pus. | 1 month. | Cured. | |
| 19 | 31 | Male. | Chronic catarrh of middle ears. | Wilde's incision. | 1 week. | Relieved. | |
| 20 | 58 | Male. | Chronic suppuration of middle ears. | Wilde's incision. | | | |
| 21 | 10 | Male. | Chronic suppuration of middle ear, with polypus. | Wilde's incision. No pus. | | | |
| 22 | 39 | Female. | Acute inflammation of middle ear. | Leeches. | | | |
| 23 | 54 | Male. | Chronic suppuration of middle ear. | Mastoid opened with a drill. | | | |
| 24 | 4 | Male. | Mastoid periostitis. | Leeches. | | | |

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| 25 | 35 | Male. | Chronic suppuration of middle ear. | Wilde's incision. Removal of necrosed bone through auditory canal. | Some weeks. | Cured. | Reported in author's text-book, 6th ed., p. 512. |
| 26 | 48 | Male. | Chronic suppuration of middle ear. | Opening of mastoid with drill. | 3 months. | Cured. | Erysipelas occurred. Operation by Dr. Tilden Brown. Reported in *Archives of Otology*, vol. xii., 1883; also in author's text-book, 6th ed., p. 522. |
| 27 | 24 | Male. | Acute suppuration of middle ear. | Incision in auditory canal, and Wilde's incision. Pus removed. | 3 months. | Cured. | Abscesses of neck. Reported in author's text-book, 6th ed., p. 525. |
| 28 | 30 | Male. | Chronic suppuration of middle ear. | Wilde's incision. | 15 days | Cured. | Reported in author's text-book, 6th ed., p. 498. |
| 29 | 22 | Female. | Acute suppuration of both middle ears; mastoid periostitis. | Leeches. Poultices. | 2 months. | Cured. | |
| 30 | 37 | Male. | Subacute suppuration of middle ear. | Perforation of mastoid with drill. No pus. | 51 days. | Died of pyæmia. | |
| 31 | 15 | Male. | Chronic suppuration of both middle ears. | Opening of mastoid with a thick probe. | 3 months. | Cure. | Patient had pyæmia. Fully reported in vol. x., *Archives of Otology*, p. 41; also in author's text-book, 6th ed., p. 544. |
| 32 | 43 | Male. | Acute suppuration of middle ears. | Opening of mastoid with a drill. | 2 months. | Cure. Drum-head healed. | Erysipelas occurred. |
| 33 | 5 | Female. | Chronic suppuration, with mastoid fistula. | Enlargement of fistula. | 6 months. | Cured. Drum-membrane did not heal. | |
| 34 | 2 | Female. | Mastoid periostitis. | Mastoid opened through wall of auditory canal. | 2 weeks. | Cured. | |

## HISTORICAL SKETCH OF OPERATIONS UPON THE MASTOID PROCESS.

It is now about a hundred years, since a Danish surgeon, Berger, of Copenhagen, who evidently suffered from chronic non-suppurative inflammation of the tympanum, or from disease of the labyrinth, misled by the indications laid down by the surgeons of his time, died from meningitis induced by an operation for perforation of the mastoid process. "A martyr to the operation," says one of the writers of his day. Beck[1] states that Berger was old and deaf, and that after the bone was opened injections would not pass through the opening into the nose or mouth. Fever, sleeplessness, vomiting, and delirium followed, and the patient died in eleven days. There was suppurative meningitis. Where the bone was opened it was two lines in thickness, while the perforator entered for five lines.

Like perforation of the membrana tympani, trephining the mastoid, having been successfully performed under proper indications, was widely recommended for cases for which it could do but harm, and poor Berger's life paid the penalty for a want of knowledge on the part of the surgical writers of his day. If the operation had been performed many times, in such cases as those of Dr. Berger's, there would have been many more martyrs.

A regimental surgeon, Jasser, in 1776, performed the operation upon the ear of a soldier who had suffered long from a chronic suppuration with occasional acute attacks attended by great pain. The mastoid was swelled: the patient was half insane with pain. Jasser made an incision on the mastoid about an inch long and found a drop of pus. Encouraged by this, he cut down upon the whole length of the mastoid bone. He found the surface roughened. With a probe he went quite deeply into the mastoid cells. He injected fluid into the opening; it came out of the nose, and, at the same time, a large quantity of pus was discharged from the external meatus. The patient immediately exclaimed that the pain had left his ears. He went quickly to sleep and rested uninterruptedly for ten hours. In three weeks the opening behind the ear had healed, the discharge from the auditory canal had ceased, and the patient heard better than before. Stimulated by this, Jasser performed the same operation upon the same person, upon the other ear, from which there was no discharge, but in which the hearing was

[1] Handbuch, p. 60.

impaired. Here the hearing is said to have also been improved, although there was no caries of the bone. The operation got its name from Jasser, although, as every medical reader knows, it had been proposed by Riolanus more than a hundred years before Jasser's time, and Petit had opened a mastoid with a gouge and hammer in 1750. The first named had proposed the operation for deafness and tinnitus caused by stoppage of the Eustachian tube.

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 Valsalva. I have examined the original passage in order to verify this claim made for Valsalva, and I find that 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 :[1] "*Observatio ulceris ad processum mamillarem, per quod injectâ, statim in oris cavitatem, licet undequaque illæsam transmittebantur.*" The passage itself is as follows : "*Adeoque mitto prolixius confirmare per quondam meam in vivo homine 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.

This passage may be translated 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.

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[1] Tractatus de aure Humana, 1742, p. 89.

Morgagni declaimed against the operation, not on good grounds, however, but because he supposed there was no opening of the mastoid cells into the tympanum. Petit, however, recommended the operation for caries and abscess of the mastoid. Jasser seems to have lost his head after his first properly performed and successful case, and he probably was the cause of the widely spread recommendations of this surgical procedure for all kinds of aural cases. If Jasser had rightly understood the indications for opening the mastoid—indications which were plain in his first case and which were not to be found in the second,—a valuable surgical procedure would not have been practically ignored by the profession for nearly fifty years. It required about this length of time before surgeons would "meddle with the mastoid." The operation was, however, occasionally performed by independent surgeons, when pus was evidently retained in the bone, but very few reports are found of these cases. Tröltsch [1] finds seven cases prior to 1858. In the operative surgery of Sir Charles Bell,[2] as early as 1812, he says: "We learn from this view of the subject how carefully we ought to attend to symptoms when there is disease of the ear, lest it should become irrevocably bad, and end in communicating the disease to the brain. We must bleed and purge and foment to allay the pain and inflammation if it be active, . . . and when we can ascertain that there is caries in the posterior angle of the bone, with danger of the confinement urging the progress of the diseased action of the brain, we have to apply the trephine and penetrate into the cells of the bone." But here, as in all the writings until our own generation, there is a notable absence of any careful account of the early symptoms of mastoid disease. No one would be able from these general descriptions to diagnosticate and successfully treat the early stages of the affection. Dieffenbach,[3] in 1848, utterly condemns the operation, and agrees with Itard in saying that it should be entirely abandoned. He believes that a carious process would be increased by opening the bone. As great a man as Sir William Wilde [4] evidently does not understand that the bone ought to be opened under certain circumstances. He alludes to artificial perforations of the process for the purpose of throwing injections into the middle ear, or to relieve deafness in cases where the Eustachian tube had been closed,—an operation, he continues, which has long since been exploded, not only as ineffectual but positively hazardous.

[1] Virchow's Archiv, 1861.

[2] A System of Operative Surgery, first American edition.

[3] Tröltsch's Lehrbuch Sechste Auplage, p. 499.

[4] Text book, p. 363, English edition.

Although he had given a name to an incision through the periosteum of the mastoid for the relief of periostitis of this part, and although he alludes to fistulas being formed in this bone in the course of chronic suppuration, he gives no sign that there might be cases in which it would be wise to go farther than the periosteum and open the bone. Indeed, in many cases where Wilde's incision was performed, a little search would have found an opening that nature was trying to make. But the improper indications of "closing of the Eustachian tube, tinnitus aurium, deafness," were so confounded with the one proper one of retention of pus, that even Wilde could not separate them.

Toynbee had a very large experience in fatal cases of mastoid disease, and yet all he has to say upon the subject of the operation is: "Perforation of the mastoid process also suggests itself, and this operation may doubtless be performed in those cases, when the matter is pent up in the cavity of the ear, and is causing such urgent and serious symptoms as are likely, if not relieved, to terminate in death. I have never performed this operation, but I should not scruple to do so in a case in which the life of the patient was threatened."[1]

Good surgeons everywhere followed Wilde in his advocacy of a free and deep incision down to the bone. In this city, the late Professor Post regularly lectured upon affections of the mastoid, and often made Wilde's incision, but he also considered the operation of opening the process, as one only or chiefly recommended for affections where it would be useless if not dangerous.

Prompted by a happy experience into which he entered rather timidly, Tröltsch in 1861 published a paper in *Virchow's Archives* upon the subject of perforations of the mastoid, which probably did more than any other one thing, to bring the subject clearly before the profession. He there reports a case in which he had, in 1858, perforated the mastoid with a blunt probe. He collected the scattered cases from the literature of the subject, and seems to have been the first writer after Berger's martyrdom, who was wise enough to show that opening an ulcerated mastoid to remove dead bone, concealed pus, and secure thorough drainage, was a proper and often necessary operation. According to Tröltsch's own words, although the indications would now be considered imperative and clear, he opened the softened mastoid with fear and trembling. He says: "I went to work with uncommon care, even with dread."

Tröltsch's case was one of those that I have found more

[1] Disease of the Ear, London, 1860, p. 341.

frequently than any other—that is to say, one in which a fistula had been made in the bone by the suppurative process.

Tröltsch seems to have hesitated after making a Wilde's incision. He looked up the accessible literature of the subject, and he found some cases where life was apparently saved by the operation. All the authorities, however, were in doubt about the propriety of performing it, and he continues :

"What was more natural than that such an operation appeared to one who had scarcely practised medicine for a year, as an affair to be well weighed, and that I treated the case with great circumspection and almost in an experimental manner." "I think," he says, "if I had not achieved my end with a simple probe, then I would scarcely have desired to act more vigorously with other instruments." But Tröltsch had been a student of the great Irishman. He had often seen him divide a red, tender, painful, and swelled mastoid down to the bone, and he imitated him in this case, and in spite of the authorities, in two days he went farther, when the pus escaped and relieved the sufferings of his patient.

In February, 1862, Lawrence Turnbull [1] published two cases in which he made an incision down to the bone, and a third in which two months after he had opened the external tissues, he perforated the surface of the bone with a sharp hollow probe, and applied nitrate of silver freely. A month later he again broke down a part of the bone, and nineteen days later he removed a large piece of bone, which was found to be movable with the probe. This was an operation very like that of Tröltsch, although the German surgeon only waited a few days before venturing to go into the cells with a probe, while the American delayed for two months. In spite of its exclusion from some tables, Turnbull's case belongs to the same category with that of the reviver of the operation. It was operated upon but three years after Tröltsch's case, and only one year after it was published.

In 1863 Pagenstecher [2] published two cases, with some remarks upon the nature of affections requiring the opening of the mastoid. He declares the technique of the operation to be simple and easily acquired. This is an article written in a truly surgical spirit. In 1868 James Hinton reported [3] a case in which he perforated the mastoid cells with a trocar, the next day after he had made an incision through the periosteum. The

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[1] Philadelphia Medical and Surgical Reporter, vol. vii., p. 463.

[2] Archiv für kliniche Chirurgie. Bd. iv., p. 322.

[3] Times and Gazette, London, vol. ii., p. 378.

case was one of chronic suppuration of the tympanum. Mr. Hinton speaks of fourteen cases of perforation of the mastoid for the evacuating of matter reported by various authors. Twelve he says were successful. In one of the fatal ones pyæmia occurred. He says the operation is suitable to two classes of cases : 1, Those in which the matter collects in the dependent mastoid cells ; 2, those in which caries takes place in the roof of the pyramid. He recommends the centre of the mastoid for perforation in the former case, and in the latter the upper part of it, about on a level with the roof of the meatus. His recommendations are evidently inspired somewhat by Pagenstecher's paper.

In 1864 A. B. Crosby, living in the mountains of New Hampshire, probably not knowing of Tröltsch's writings, but perhaps having Sir Charles Bell's sound advice in mind, opened the mastoid, in three cases where he suspected the presence of pus, with a gimlet. Although this was in 1864, the cases did not get to general professional knowledge until 1873. Relief was given in all the cases. Some years after, in 1872, I was present when Agnew again opened one of these gimlet cases and found a sclerosed condition of the bone, one well known to the early writers.

By this time, 1864, the operation begins to be freely spoken of. Ludwig Mayer, of Worms, Jacoby, of Breslau, Follin, and others reported cases. Jacoby had a considerable experience, and wrote two or more valuable papers in the *Archives of Otology*. He proposed instruments, gave tables, and so forth.

Schwartze first appears in the literature on this subject in 1864 (*Praktische Beitrage*, 1864), as having, some days after he had made a Wilde's incision, opened the roughened exposed bone with a probe, in the case of a child aged one year and a quarter. The bone, he says, was very easily perforated. In August, 1869, he, with Koppe, reported a case of reflex epilepsy, with caries of the temporal bone, cured by an operative perforation of the mastoid process. He used a trephine.

In 1870 Agnew, at a meeting of the American Ophthalmological Society, reported the case to which I have already alluded. At the same meeting, I reported two cases in which I had opened the mastoid cells through a minute fistula, in each case with a stiff probe.

To those cases was added a history of the operation, which I believe was the first complete account that appears in any language since the time of Berger. In this paper I attempted to lay down certain indications for the performance of the operation. After seventeen years of added experience I do not know

that I can materially alter these rules, although I have somewhat amplified them.[1]

In 1873 A. H. Buck began his writings upon the subject of opening the mastoid with a report of thirty-five cases occurring in various parts of the world, six of which are his own.

In the same year Schwartze and Eysell[2] published an historical account of opening the mastoid with a table of sixty-three cases, seventeen of which were from their own practice. This publication of cases has continued until the present day.

Although it seems clear to most writers that all these steps have led to a point where we see that opening the mastoid process in many cases is a perfectly justifiable and a life-saving surgical procedure, the voice of specialists in this country is not quite unanimous upon the subject. The weight of authority seems to me, however, largely in favor of the operation, under the ordinary indications. In a discussion two years since, Strawbridge[3] said that he had seen over four thousand cases of purulent middle-ear disease in the last twelve years, and yet he had not trephined a single mastoid, nor had he seen a death, except in one child, six months old, that died a few hours after he first saw the case. Dr. Theobald (*loc. cit.*) stated that his experience accorded with that of Dr. Strawbridge, although he had not seen so many cases. He had never opened the mastoid in the living subject. He had seen mastoid symptoms disappear under active constitutional treatment. These experiences, however, seem to stand by themselves. Nearly all of those who have seen many cases of aural disease have been obliged, occasionally at least, to open the mastoid. To me it seems as if the field of operation in this direction were likely to be enlarged rather than diminished. I have elsewhere advised a thorough search for pus, and by an opening through the bone in all cases when death seemed to be threatened from cerebral abscess. The only point in the subject that remains open for discussion, seems to me to be the one pertaining to cases in which the only object is to secure better drainage of the tympanum, the mastoid itself being perhaps sound. No one with surgical education will deny that it should be opened when there is pus in it which has no sufficient outlet. No one, on the other hand, would consent to open it to fulfil such indications as those which deceived poor Berger.

I lay comparatively little stress upon methods of operation. Schwartze forsook the trephine at an early day and took up with chisels. In this he has many followers. I have continued to use a stiff probe and a drill or a trephine. Buck continues to

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

[2] Archiv für Ohrenheilkunde, neue Folge, Bd., 1873.

[3] Transactions of the American Otological Society, 1883.

use the drill, occasionally the chisel, while Crosby preferred a gimlet.

For many decades aural surgery was almost exclusively in the hands of men who were endeavoring to cure the incurable, by injecting vapors and fluids through the Eustachian tube in cases of chronic non-suppurative inflammation of the tympanum. Their results were deplorably bad. Otology was in such bad repute that no one would meddle with the ear or investigate its curable affections.

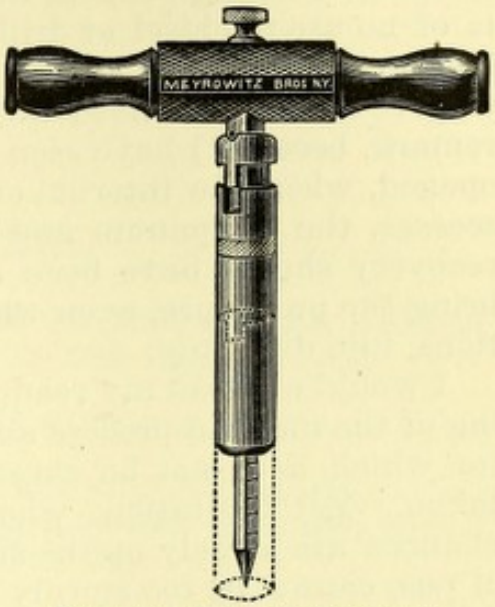


FIG. 107a.—Wilson's Trephine.[1]

Sir Astley Cooper, after benefiting one patient by a paracentesis of the drum-head, although he failed in all subsequent attempts, filled his waiting-room with the incurable deaf, whom he speedily drove out lest they should injure his reputation as a surgeon. Thus, in one way or another, aural surgery became a true *terra incognita*, about which the most absurd tales got full audience, and in which very few capable and honest men labored. In these latter and better days the light of scientific and honest investigation has so cleared the pathways in otology that even if one direction vary here and there, we may walk with a fearless tread.

So far as propositions in regard to operations upon the mastoid can be formulated, I should say :

I. The integument and periosteum of the mastoid process should be freely divided in all cases, when there is great pain, tenderness, and swelling in this part.

II. Such an incision should also be made, whenever severe pain, referred to the middle ear, constantly exists, and which is not even temporarily relieved by the use of leeches, poultices, the warm douche, and so forth.

III. The bone should be thoroughly examined by the aid of such an incision, whenever we have good ground for suspecting that the bone is diseased or pus is retained in this part.

IV. The mastoid process should be perforated after such an incision, whenever the bone is found softened, and if a fistulous opening is discovered, this should be enlarged. It should also be perforated, when the suppuration of the middle ear involves the mastoid cells or antrum to such an extent, that thorough

[1] This new instrument is a very safe one, and easily managed.

drainage cannot be secured through the membrana tympani or external auditory canal.

When general septicæmia or pyæmia has developed, even if it has its starting-point in the mastoid, as it sometimes does, it is of no use to chisel or drill the mastoid process. Purulent infection of the whole system having occurred, it is then too late to give an outlet to hardened pus at one point. I am led to this remark, because I have seen two cases in which the mastoid was opened, when the internal organs were already the seat of abscesses, the tympanum and mastoid were dry, and all hope of recovery should have been abandoned. Such operations only bring the procedure, even when undertaken under proper conditions, into disrepute.

I would not lead my readers to think that I consider the opening of the mastoid process as a trivial procedure, the indications for which, need not be carefully considered before it is undertaken. Yet hesitation, when the way is plain, or when the chances are largely on the side of the necessity of the removal of pus, cannot be too sternly condemned. No drug has yet been discovered, which can be substituted for the scalpel, or trephine, when pus has actually formed in the mastoid cells. I wish, however, to repeat what I have said before on the subject of surgical operations. I am in full accord with the great English surgeon, Sir James Paget, who, in his admirable lectures, expresses many times his hesitation to perform any surgical operation, however trivial, that is not absolutely required. We have no right, I think, to perform operations to clear up doubtful diagnoses ; if in case the operation proves to have been unnecessary, the patient will be decidedly the worse for it. If we put ourselves in the place of our patients, what we may regard as a trifling thing, "a mere cut," will not be so esteemed. A mere cut, when unnecessary, may have the most serious consequences, and all the history and symptoms should be carefully weighed before even that is undertaken. Such care will never prevent prompt, rapid, and thorough surgical interference when demanded.

In teaching medical students, I have always found them, when fully awakened to the dangers of *neglecting* certain diseases, to be more apt to do too much, than too little, especially with the knife and active drugs. It is possible also that the crying ignorance and neglect of the previous decades in regard to the treatment of aural disease, has had a tendency to cause us who see many of the affections of the ear, to lean toward the side of surgical operations upon the drum-head and mastoid. This is a leaning no less dangerous to the cure of some cases, than was the steering toward Scylla or Charybdis to the safe navigation of ancient mariners.

# CHAPTER XIX.

## THE CONSEQUENCES OF CHRONIC SUPPURATION OF THE MIDDLE EAR—(*Concluded*).—NEURALGIA OF THE MIDDLE EAR.

### CARIES AND NECROSIS OF THE TEMPORAL BONE.

Cases.—Treatment by Operation and Internal Medication.—Fatal Hemorrhage.—Cerebral Abscess.—Pyæmia.—Paralysis.—The Ophthalmoscope in detecting Cerebral Disease of Aural Origin.—Neuralgia of the Middle Ear.

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—the walls of the tympanum—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. An exception to this has already been noticed in one of the chapters upon disease of the auditory canal. The anatomical relations of the cavity of the tympanum, than which there are none more important in the whole body, 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, from reports of cases by myself and others, that caries may occur with an intact drum-head. Dr. Orne Green[1] 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 backward and inward into a circular cavity about one-quarter of an inch

[1] Transactions of the American Otological Society, 1871.

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 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[1] 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 facial paralysis. The patient was a boy aged twenty months, and had a discharge from the ear, accompanied by severe 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 afterward 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 it was given up.

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,[2] Agnew,[3] Gruber,[4] and Voltolini[5] have reported cases of the extraction through the external meatus of the whole of

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[1] Transactions of the American Otological Society, 1872.
[2] Text-book, p. 37.
[3] Von Tröltsch on the Ear, American edition.
[4] Lehrbuch, p. 542.
[5] Monatsschrift für Ohrenheilkunde, Jahrgang IV., p. 84.

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 semi-circular 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 upon retention of pus by the exostosis. The case as regards the exostosis will be found on page 486 of this work.

The patient was a gentleman of thirty-eight years of age,[1] 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 April 16, 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, semi-circular 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.

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[1] American Medical Times, vol. vi., p. 183.

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 evidence that the disease dates back to an early period in the life of the child.

Toynbee[1] 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.

I also add to the literature, the following case.[2]

*A Case of Acute Inflammation of the Middle and Internal Ears (Panotitis), Followed by Facial Paralysis and Necrosis and Removal of the Whole Petrous Portion of the Temporal Bone, with the Annulus Tympanicus—Recovery.*—H. G——, four years of age, female, was sent to Dr. Roosa, February 1, 1884, by Dr. S. G. Carpenter, of Chester, N. Y., who furnished the following history:

"On June 25, 1883, the patient was attacked with scarlet fever; eruption was copious; temperature, 105° F.; eruption began to decline on the sixth day. The throat was affected early; the tonsils, uvula, and pharynx were covered with a dense diphtheritic membrane on the second day; the nares were also affected, and discharged an irritating mucus. Soon after the ears began discharging. Her general condition was one of coma, from which she could be partially aroused by the handling necessary to cleanse the throat and nares. At the time that the eruption began declining, sloughing occurred in both tonsils. On the tenth day facial paralysis was first noticed on the left side. A little later a puffy swelling made its appearance over the mastoid, which eventually suppurated. There was complete deafness for a time, but later the hearing of the right ear became partially restored."

Her condition when first seen at the office was as follows: There was complete left facial paralysis; discharge from both ears, that from the left being very fetid and profuse; there was a fistula in the mastoid leading down to rough bone; granulations in both tympanic cavities. The general condition was good.

February 2d.—Dr. Roosa made an incision, under ether, through the skin and periosteum of the left mastoid, enlarged the existing sinus in the mastoid cells with a drill, and removed the granulations from the tympanum with a sharp curette. The mastoid cells and ear were washed out with a weak solution of chlorinated soda, and a tent inserted in the wound.

March 13th.—The opening in the mastoid was enlarged, under ether, and small particles of dead bone scraped off by Dr. Roosa.

March 14th.—There is now an opening down into the mastoid cells about the size of the end of a little finger. In dressing the wound a small fragment of bone about the size of a three-cent piece came away. The patient soon after this was placed in the Manhattan Eye and Ear Hospital, and from this time the notes were made by Drs. Beard and Hale, House Surgeons.

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[1] Archiv für Ohrenheilkunde, Bd. I., p. 113.

[2] Archives of Otology, vol. xiv., No. 1, 1885.

March 29th.—Considerable swelling about mastoid ; the auricle was pushed forward. A great deal of fetid pus was discharged both from the canal and the opening. This condition lasted until April 30th, when loose bone was discovered, and a piece of the size of an infant's little finger was removed by Dr. Roosa.

On May 29th the patient was again placed under ether, and the granulations removed and the carious mastoid cells gently scraped by Dr. Roosa.

From this time until September 23d the wound was dressed twice daily, being cleansed with Labarraque's solution by means of the syringe, and a tent of linen was pushed well to the bottom of the wound. The discharge was very fetid and profuse; granulations were frequently removed, but no tendency to heal was shown, although the patient was in good health ; she had no head symptoms or pain. The wound was dressed with great difficulty on account of the sensitiveness of the ear to all handling.

The ophthalmoscope showed no lesion or change in the fundus of either eye.

On September 23d it was discovered that a piece of bone not only filled the entire opening, but caused tumefaction below. On the next day the patient complained of pain in the ear.

September 25th.—The patient was placed under ether, the wound enlarged vertically, and the bone grasped with dressing-forceps and with slight difficulty removed by Dr. Emerson. There was little hemorrhage.

It was found that the portion of bone removed was the whole of the petrous portion of the temporal bone, photographs of which, taken of the actual size, are herewith exhibited.

For a few days after the operation the discharge and odor were greater than ever, fine particles of broken-down bone continually coming away. On the day following, the malleus bone was washed out in perfect condition.

On October 14th another sequestrum, which proved to be the *annulus tympanicus*, was removed, without ether, by Dr. Roosa. Since then there has been great and constant improvement. All discharge and odor disappeared within a week.

January 20, 1885.—A fistula of one and a quarter inch in depth remains. The discharge from it is usually not sufficient to soil the dressings. The edges are contracting. It is probable that a permanent but small fistula will remain. (See Fig. 4.)

FIG. 1.

FIG. 2.

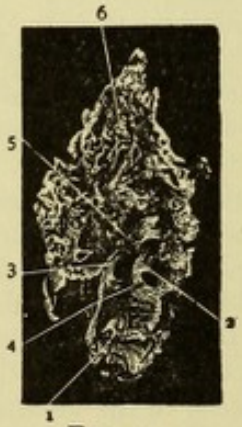


FIG. 3.

The first specimen (Fig. 1) is the entire petrous portion of the left temporal bone. It measures $1\frac{3}{8}$ inch in length, $\frac{3}{4}$ inch

in breadth, and $\frac{5}{8}$ inch in thickness. The posterior surface is considerably eroded, and shows near its centre the first turn of the cochlea (1). Posterior to this is the internal auditory canal (2), $\frac{1}{4}$ of an inch in depth. At the lower edge is the groove for the superior petrous sinus (3).

The anterior surface shows the eminence for the superior semicircular canal in perfect condition; anterior to that the bone is eroded, and the tract of the facial nerve where it leaves the internal auditory canal and enters the tympanum is shown. The outer or tympanic surface (Fig. 3) shows the following objects: Beginning at the apex, the bony groove for the Eustachian tube (1); in front of that, the promontory (2); above this, the ovale (3); and below, the foramen rotundum (4); above and external to this is seen aquæductus Fallopii (5); and posterior, the mastoid cells (6).

The second specimen (Fig. 2) is the annulus tympanicus and part of the bony external auditory canal. The cut is a view of the internal surface, actual size, and shows the groove for the

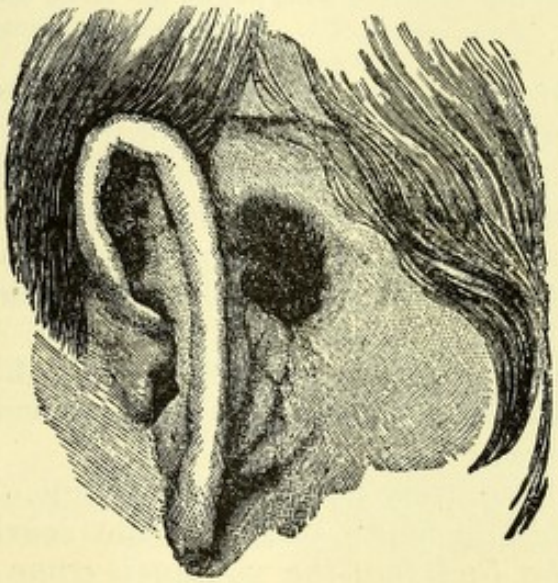

FIG. 4.

membrana tympani (1) and the mastoid cells (2). It measures $1\frac{1}{4}$ inch in length, $\frac{5}{8}$ inch in breadth, and $\frac{1}{4}$ of an inch in its thickest portion.

In Toynbee's cases *the sequestra were not removed until after death.* This fact deprives them of much of their importance. Mr. Shaw, of London, has published a case of exfoliation of the whole of the internal ear and part of the petrous bone.[1] As the case so nearly resembles the one here reported, the main facts are quoted:

[1] Transactions of the Pathological Society, vol. vii., London, 1855.

"Boy, seven years of age, otorrhœa from scarlet fever two and a half years ago. Facial paralysis of left side, and complete deafness. Left external ear projected considerably beyond its proper level; irregular piece of bone, surrounded with granulations, protruded from the meatus into the concha." Mr. S. "first extracted the piece of bone which projected into the concha; this appeared to have been the posterior border of the external meatus of temporal bone. The cartilaginous tube having been ulcerated by the pressure of the bone fragment, the point of the little finger could be passed to some depth, and another piece of bone was felt rolling freely in the cavity; this was removed with dressing-forceps with some difficulty. Patient made good recovery, paralysis remaining. The bone removed was nearly the whole of the petrous portion of the temporal bone; it measured one inch in length and one-half inch in thickness and weighed twenty-two grains. On one side, nearly in its centre, was an opening and cavity, the internal auditory meatus. Depth of canal was three-fifths of an inch, showing that the whole of the internal meatus was included. On the side of the specimen in relation to the brain the surface presented the cancellated appearance peculiar to diploë, when it was concluded that the process of separation had taken place in the diploë, and that the cortical layer had retained its vitality, and that, remaining in contact with the dura mater, served as a barrier to prevent the disease from extending to the cerebrum. The opposite aspect of the bone shows the inner wall of the tympanum, etc."

Dr. Pollak, of St. Louis, has also reported a similar case of loss of the petrous portion of the temporal bone.[1]

There was no diploë in the case here reported, and the bone showed markings, such as the uneroded groove for the superior petrosal sinus and the eminence, which conclusively proves that it was separated from the dura mater throughout the most, if not all, of its extent.

How this could happen without the meninges becoming inflamed, the sinuses obstructed, and the internal carotid artery affected, is not easily seen.

There were absolutely no head symptoms, except the coma occurring during the acute stages of the scarlet fever. *From this fact, and the fact that the paralysis came on soon (within ten days) after the beginning of the scarlet fever, we think we are justifiable in thinking that the internal ear and petrous bone were primarily affected with a purulent inflammation, and that it was not, as is generally the case, the result of secondary inflammation extending from the middle ear.*

From the first we maintained a *perfect* and *free* drainage of the products of inflammation, both from the ear and mastoid opening. To this the child is most probably indebted for her life.

The operative interferences were only made when nature,

[1] Archives of Otology, vol. x., p. 361.

unassisted, proved insufficient for her task of giving a free exit to purulent and dead material. The child took no drugs during the eleven months that she was under our care.

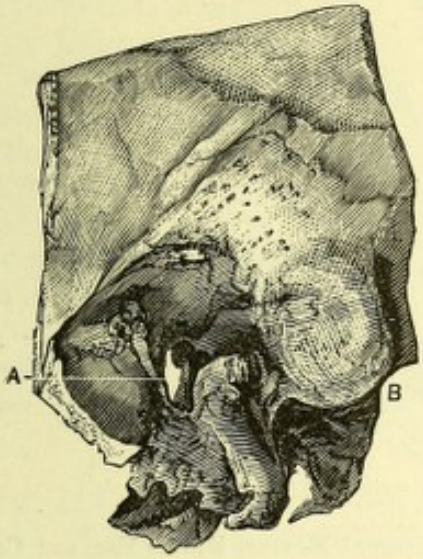


FIG. 108. — Left Temporal Bone, from Case I. Exterior view, showing the external meatus: *a*, From which the anterior wall has been removed, as has also the inner wall of the middle ear; *b*, the mastoid process.

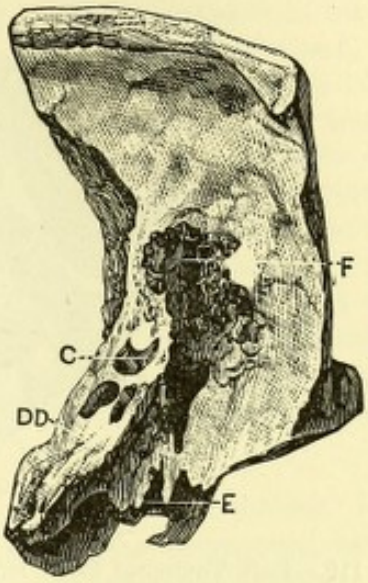


FIG. 109. — Inner Surface of the same Specimen, showing: *c*, The vestibule; *d*, *d*, the windings of the cochlea, which have been exposed by sawing away portion of the bone; *e*, the tympanum, communicating with *f*, the mastoid cells, which have been exposed by chipping away a thin layer of bone.

The above 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.

*History.*—CASE I. (Figs. 108 and 109).—Left temporal bone from a man who had phthisis, and died suddenly of pneumo-thorax, August, 1866. His hearing distance was nothing for the watch, nor could he distinguish words, though he seemed 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 forward into the meatus, and backward into the mastoid cells; membrana tympani gone; stapes only one of ossicles present; membrane of fenestra rotunda gone.

CASE II. (Fig. 110).—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 few 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 upward into a cavity which also had an opening outwardly.

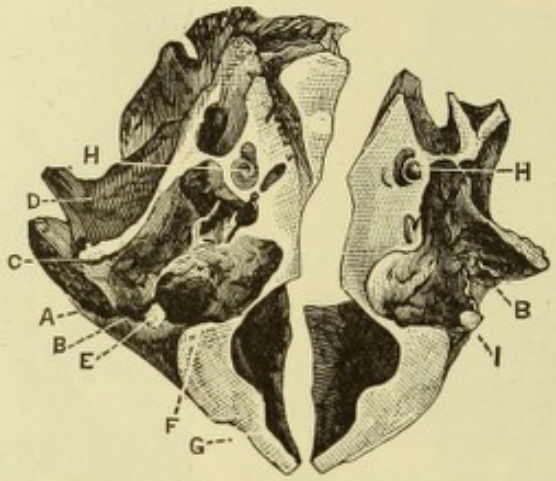


FIG. 110.—Left Temporal Bone, sawed through External Meatus, Middle Ear, and Cochlea. The pieces are turned to one side, showing: *a*, Mastoid process; *b*, *b*, external meatus, ending in *c*, the middle ear; at *d* there was an opening downward through the bony meatus, and at *e* an opening upward, 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. (From Dr. Hackley's collection.)

CASE V. (Fig. 111).—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

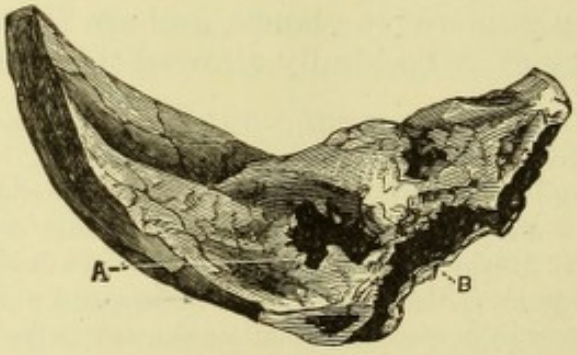


FIG. 111.—Right Temporal Bone, from Case V., showing the Cranial Surface of the Bone. At *a* the bone was very thin, and broke away when the dura mater was removed; the bone was much hollowed out about *b*, the middle ear. (From Dr. Hackley's collection.)

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 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, 1869, treated again with leeches, cold to head, bromide of potash, and tonics. About May 1, 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 atrophied 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.

Fig. 112, from a photograph given me by Dr. Sexton, is a view of the extensive ravages of disease of the temporal bone, perhaps of a traumatic origin. I first saw the case upon Dr.

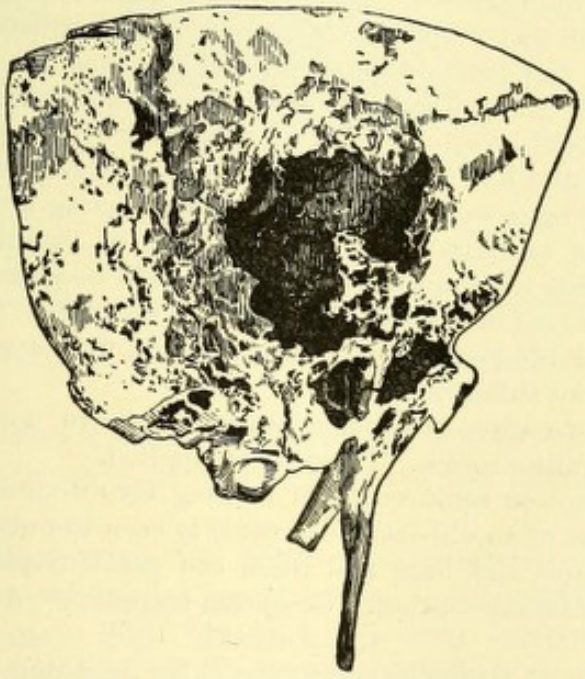

FIG. 112.—Caries of Squamous and Mastoid Portion of Temporal Bone. (From Dr. Sexton's collection.)

Sexton's invitation, and some time afterward, I was present when Dr. George A. Peters, under whose care he then was, performed the operation which is described in the following notes, kindly furnished me by Dr. Peters.

*St. Luke's Hospital—Aural Polypi—Mastoid Disease—Dr. Peters, attending surgeon.*—George R——, aged forty-four, car driver, native of the United States.

Admitted April 13, 1876. He was a sailor for several years, and received a good many blows about the head at that time. He denies any venereal complaint. Up to a year ago he was perfectly healthy; at that time he had frequent attacks of vertigo, losing consciousness for a brief period.

In June, 1875, he had quite a large abscess opened behind the right ear; there was a free discharge of pus, and in due time it closed. Some few months ago he noticed that the right side of his face was paralyzed. About this time his doctor told him, that his right ear contained polypi.

On admission his condition is pretty fair. Has had no marked attacks of vertigo for past few months; but his dizziness has increased and has become almost constant, so that be has been unable to work. Often feels a desire to wheel around and around. There is marked paralysis of face on right side, and the patient imagines there is loss of power on same side, but examination does not seem to confirm his idea. There is a fluctuating tumor behind right ear.

April 25th.—Exploratory puncture made, and ʒ ij. of dark brown-colored serum was withdrawn. Since then the tumor has again become quite tense, and careful examination reveals marked pulsation. This impulse is probably due to pulsations of some branches of posterior auricular artery.

Drs. Loring and Roosa advise the removal of polypi and an incision into tumor.

May 5th.—The patient was etherized, Dr. Peters operating. Polypi could not be snared, so they were evulsed. Incision, three inches long, was made into the tumor; the incision was perpendicular, and just over squamous suture extending down beyond the mastoid process. No pus was evacuated, only serum tinged with blood. No large vessels were severed, not even a small artery, to which a ligature could be applied, and yet there was such a general and profuse oozing, that the wound had to be plugged, and a tight compress applied. Many small flat pieces of bone were taken away, and on passing finger into wound the mastoid portion of temporal bone was found to be extensively diseased and broken down; so that the impulse of the brain could be perceived at the bottom of the wound. The amount of blood lost was considerable.

May 6th.—He rallied very well from operation, but complains of extreme weakness. Does not suffer much pain.

May 7th.—Temperature and pulse not much above normal. Dressing removed, bleeding quite profuse. Compress reapplied.

May 9th.—Compress removed. On looking into wound, the entire bottom of it (about the size of an old-fashioned cent) is seen to pulsate. Finger easily detects the pulsation, and here and there can perceive pieces of dead bone. There is still considerable oozing. Compress reapplied. An occasional dose of opium given.

May 10th.—He is stronger and better. No bleeding on removing compresses. Wound washed out with carbolic water and dressed with lint soaked in carbolic oil.

May 15th.—He sat up to-day. Carbolic lint dressing continued. Pulsations still perceptible. Fragments of bone can be felt and any attempt to remove them causes bleeding.

May 26th.—Wound granulating and filling up rapidly. Can still detect a slight pulsation at bottom of wound. The intense headaches, of which he complained constantly before the operation, have entirely disappeared. Discharged cured.

The patient succumbed to the disease finally, from meningitis.

The history of the following case was given me by Dr. Cooper, of New Jersey, together with the specimen :

Male, aged sixty-five. Gradually increasing bladder-disease for five years. Enlarged prostate. Cystitis.

First part of December, earache. Severe discharge in twenty-four or forty-eight hours. Three years before, trouble in same ear. Discharge was less, but the ear continued to trouble him. Pain behind it.

January 5th.—Sudden and severe pain in head, in front and back. Stupor in twelve hours, and died January 8th, in morning.

Head opened. Dura mater congested, and lymph at base of brain. Abundant pus, extending to the medulla.

FIG. 113.—Caries of Petrous Portion of Right Temporal Bone (two-thirds size).

Fig. 114 is from a specimen furnished from a case reported by me in 1875.[1]

The patient was a man of twenty-five years of age, who suffered from suppuration of the right ear for four years or more before his death.

In consultation with Dr. Cameron and Dr. McKay, I saw the patient once, when he was dying from purulent infection, pleuro-pneumonia. The drum-head was entirely gone, and there was considerable inspissated pus lying in the tympanum. He had been suffering for some weeks from pain in his head and ear, with profuse purulent discharge. There was never any tenderness over the mastoid. For several days his temperature ranged from 102° to 103.5°. On May 8th he had a chill, and on the 9th Dr. Cameron found pleurisy of the left side. On the same day another chill occurred, and on the 11th pleurisy of the right lung was detected, and double pneumonia.

[1] Transactions of the American Otological Society, p. 92.

The discharge from the ear became more abundant, there was copious expectoration, the head symptoms were greatly alleviated, the mind became clear. But five days after, chilly sensations were again experienced and they were followed by intense pain over the region of the lateral sinus. Five days after this I saw the patient when he was unconscious, and, as has been said, there was a free discharge from the ear. There was also exophthalmus. He died the next day.

The post-mortem examination was made by Drs. Cameron, McKay, Ely, and myself.

*Brain.*—General congestion of the substance of the brain and very marked fulness of the vessels on the surface. No softening. No purulent collection; thrombosis of the right internal jugular; pus in the right lateral sinus.

*Thorax.*—Suppurative pleuritis of the right lung. The entire

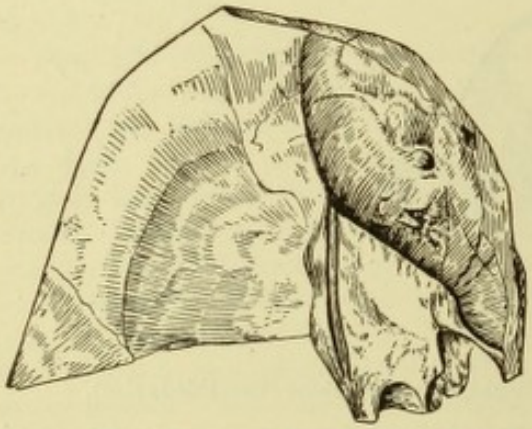

FIG. 114.—Caries of Lateral Sinus of Right Temporal Bone (two-thirds size).

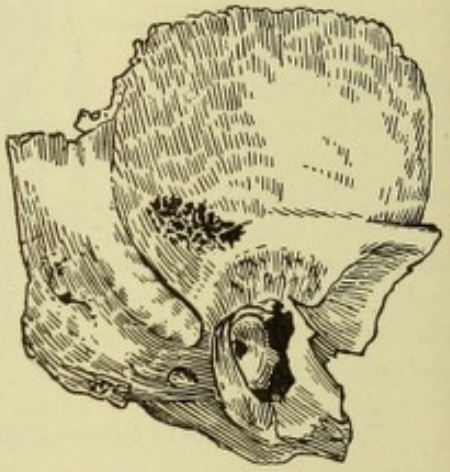

FIG. 115.—Caries of Squamous Portion of Temporal Bone (right side, actual size).

surface of the lung was covered with pus. There was also pus in the right lateral sinus. There were pus and serum in the pleural sac.

*Temporal bone.*—There was no trace of the membrana tympani nor of the ossicles. The bony wall of the right lateral sinus was carious. The upper surface of the petrous bone was of a bluish color. The cochlea and semi-circular canals were not examined.

Of Fig. 115 I can furnish no history.

*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 escape 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 whose results we must always stand in dread. Until the parts have healed, and some kind of a neoplastic membrana tympani has formed, we are not safe in giving a decidedly favorable prognosis.

Although the hearing power is often much better when the drum-head is gone or perforated, than when it is present in a cicatricial and thickened condition, it is much better to make every attempt to restore or close it. The presence of this membrane is essential to the safety of the patient from consequences much more serious than impairment of hearing.

*Treatment.*—It is impossible to give any specific rules for treating caries and necrosis of the temporal bone. 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.

It will often be necessary to open the mastoid, and to cut into the bony wall of the canal to remove dead bone that is obstructing a free outlet of pus. Those who will study the abundant literature of operations upon the diseased temporal bone, will, I think, be convinced that there is a large field here for skilful surgical interference. Life has been saved in many cases, a

very long and tedious suppuration prevented in others, by the timely creation of a fistula in the bone, with the result of securing that *sine qua non* in cases of the constant formation of pus, thorough drainage.

Of late the attention of the profession has been called to the alleged value of the sulphide of calcium, which drug, according to Ringer, has "the property of preventing and arresting suppuration" in cases of suppurations of the middle ear. Dr. Sexton[1] argues earnestly, for the value of this drug in cases of disease of the mastoid and temporal bone, as he does for its employment in furuncular and external applications. I am not at all convinced that this drug, or any other, has any such specific value as is claimed for it.

Dr. Theobald,[2] in a paper before alluded to on the constitu-

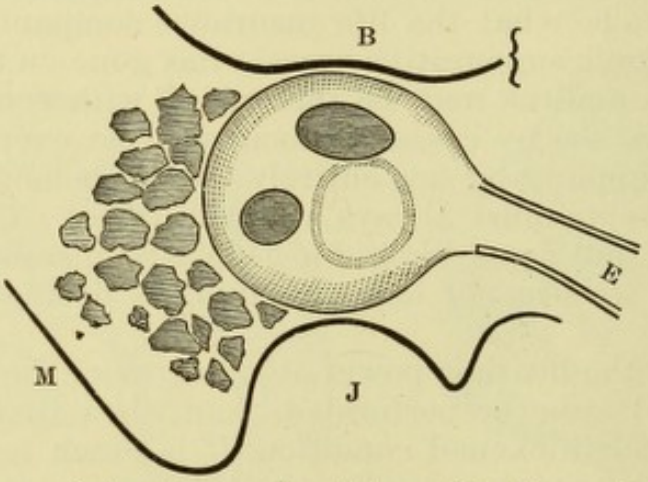


FIG. 116.—A diagram designed to show the relations of the Tympanic Cavity to the Mastoid Cells, the Jugular Fossa, and the Cavity of the Cranium. The inner wall of the cavity is exposed to view, with the round and oval windows and the promontory. M, Mastoid cells; J, jugular fossa; E, Eustachian tube; B, base of brain. (A. L. Ranney.)

tional treatment of ear disease, thinks the profession has gone too far in exclusively local treatment, and quotes a case of Dr. Buck's, from his book (p. 307) to support his views. It was that of a little girl of six years of age, who had alarming cerebral symptoms in connection with a severe attack of acute inflammation of the drum of each ear. The membranes of the drum were red and bulging. A free incision was made. On the following day the child was in a state of partial coma; pulse 140. Upon the advice of consulting surgeons mercury was given internally and externally (calomel and inunctions of the oleate of mercury), as well as bromide of potassium. An active dis-

[1] The Treatment of Diseases of the Middle Ear and Contiguous Parts by Milder Measures than those Commonly in Vogue. Medical Record, vol. xxi., No. 3, p. 57.

[2] Chapter XIV., his book.

charge established itself during the night, and the child made a rapid recovery. Dr. Theobald believes that the change in this case was due to the mercury, but I think we have all seen just such changes occur where no drug was used, but when the suppuration was encouraged by poultices, and the warm douche, or even when nothing was done. Dr. Theobald is an earnest advocate for the use of mercury in aural disease, and quotes with approval Sir William Wilde, who valued the bichloride of mercury so highly in acute and chronic aural disease. I have given mercury a fair trial in public and private practice, and as I have already said in this book, I shall probably never go back to its use except as a tonic, in persons who have no syphilitic taint, much as I value the experience of Dr. Theobald, who recommends it so highly in almost every form of inflammation of the ear. On the other hand, I am more and more in favor of the early search for retained pus, so that if found, it may be liberated in time.

Gruber[1] 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 my 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 inflating the tympanum, 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.

A patient with extensive 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

[1] Lehrbuch, p. 552.

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,[1] 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.[2]

Hessler[3] has recently collected nineteen cases of hemorrhage from the internal carotid, in consequence of caries of the temporal bone. One of these is Billroth's case, here quoted from Gruber. A case in Hessler's own practice led him to look up the literature of the subject, which he found uncollected. This was that of a woman, who died suddenly, while suffering from caries of each tympanum, from an enormous hemorrhage from the mouth, nose, and right ear. In thirteen of the cases collected by Hessler the diagnosis was rendered certain by a post-mortem examination. One of these was his own. In the six remaining cases, although a necroscopy was not had, it is probable that death resulted from hemorrhage of the carotid.

He closes his valuable article with an account of three cases, in which the section after death revealed complete absence of the osseous canal of the carotid, and although this canal had been surrounded by pus, no hemorrhage had occurred.

The first case quoted by Hessler is from Boinet (*Archiv gén. de Méd.*, xiv., 1837). The patient had suffered for seven years from chronic suppuration. He had then severe hemorrhages in two days and died. The second is from Chassaignac's treatise

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[1] Archiv für Ohrenheilkunde, Bd. VI., p. 116.

[2] 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.

[3] Archiv für Ohrenheilkunde, Bd. XVIII., p. 1 et seq.

on "Suppuration," I., page 529. He had suffered from aural disease for six months, suppuration and facial paralysis for six weeks. He also had tuberculosis of the lungs. He had three hemorrhages in three days and died. Plugging the external auditory canal only caused the blood to run out through the Eustachian tube. Two cases are quoted from Toynbee. In one of his cases, the patient also had phthisis pulmonalis. The fifth case is from Baizeau (*Gaz. d. Hôp.*, page 88. 1861). Here also was phthisis. The patient was a soldier, twenty-three years of age. For ten months he had had chronic suppuration of the ear. The hemorrhage occurred after coughing. The common carotid was tied, but the bleeding recurred and the patient died. In the sixth case, from Choyan, there is no mention of disease of the lungs. There were three hemorrhages, in a patient who had suffered for several months from chronic suppuration (*Archiv gén. de Méd.*, May, 1866). Broca, in 1866, reported a case of tuberculosis of the lungs, caries of the temporal bone, with several hemorrhages. The hemorrhage was stopped by ligation of the common carotid, but the patient died soon after from tuberculosis.

The remainder of this series of cases also tend to show, that fatal hemorrhage, from caries of the bony surroundings of the carotid artery, is especially apt to occur in phthisical patients. In one case, that of Piltz, the patient was syphilitic. His lungs were sound. The carotid was tied in three of the nineteen cases. In none of the cases, however, was the hemorrhage permanently arrested, but in one case death did not occur for two months and a half. The time from the first hemorrhage until death varied from five minutes to thirteen days in those cases, in which the carotid was not tied. In two of the cases in which the carotid was tied, death occurred in twenty and twenty-four days respectively. Thus far, no essential results have been obtained from treatment, either by the tampon, digital compression, or ligation of the carotid. The nature of the disease, forbids any but a bad prognosis. When the bleeding is not from the carotid but from the tympanum, or a polypus springing from this part, the prognosis is generally good. Thorough plugging the bottom of the canal, with the use of persulphate of iron, will generally arrest the hemorrhage, but here we are not dealing with a large vessel.

## 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,[1] twenty-five, or about one-third, were directly traceable to chronic suppurative processes in the middle ear. Lebert,[2] in his article upon this subject, considers that aural disease is the cause of cerebral abscess in about one-fourth of the published cases.

Toynbee's catalogue contains ten cases of cerebral abscess from aural disease.

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, but it has since been observed by myself.

A direct communication usually takes place between the diseased mastoid or petrous portion of the temporal bone and 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,

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[1] Reynolds' System of Medicine, vol. ii., p. 544.

[2] Virchow's Archiv, Bd. X., p. 391.

draughts of air, or the like; for the histories of many cases show that meningitis, cerebral abscess, and pyæmia may, from such exciting causes, be the determination of a purulent discharge from the ear.

The symptoms of disease of the brain 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, added to this chapter, was compiled from various sources, in order to show the variable character of brain symptoms supervening an 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 inward, 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[1] 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, 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, 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 only three inches from the left ear, which was the affected one, and the drum membrane was sunken. I

[1] Virchow's Archiv, Bd. IX., p. 382.

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. George 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.

Through the labors chiefly of Macewen, of Glasgow, great advances have been made in the diagnosis of cerebral abscess resulting from aural disease. What is much more important, lives have been saved by timely interference. The danger of exposing and cutting into the brain was formerly considered as very great, but surgical experience has shown this to be greatly exaggerated, and no aural surgeon should now hesitate to trephine the skull in the spheno-temporal fossa, in a case where there is reasonable grounds for believing that we may have cerebral abscess. I have great satisfaction in noting that what was said upon page 553 of the last edition of this work was prophetic. It was then said that "surgery has certainly something to hope for in the more careful search for pus beneath the skull." Operations for cerebral abscess are now well established among the legitimate and necessary procedures in surgery. Personally I have operated but once as yet, and then without success, but cases are being constantly reported[1] where a successful result has been obtained. One of the late ones will be found in a paper by Dr. Pritchard[2] of London.

### PYÆMIA.

It is well known that pyæmia, or metastatic abscesses (septicæmia), from the entrance of pus into the circulation through the mastoid veins or the lateral sinus, may result from aural

[1] Archives of Otology, vol. p.

[2] Transactions International Congress of Otology, Brussels, 1888.

disease. A case of the late Dr. Ely and myself, which resulted in recovery, is an interesting one. It has already been published,[1] but chiefly with the view of pointing out the interesting fact, that the recovery occurred without the use of medicine. It is important enough to be inserted in this connection, for it illustrates more than one point in aural practice. I quote from Dr. Ely's account of the case :

*Chronic Suppuration of both Middle Ears—Mastoid Periostitis—Wilde's Incision—Opening of Cells by a Probe—Relief for Seven Days—Chill—Pyæmia—Recovery.*—Louis S——, aged fifteen, has had chronic suppuration of both middle ears for many years. During the past year he has been treated in the clinic of Dr. Roosa and myself at the Manhattan Eye and Ear Hospital, and nothing unusual has been observed about his case until lately. On the afternoon of January 20th he was brought to me with well-marked mastoid periostitis on the right side. The cause of this inflammation was not evident. The redness, tenderness, and swelling were confined chiefly to the anterior two-thirds of the mastoid process, and the swelling was not very great. There was severe pain in that side of the head, and marked constitutional disturbance. An immediate operation was advised, but was declined by the family. The boy was taken into the hospital, however, and four leeches were applied. When seen by me at half-past eight the next morning, he was decidedly worse. There was high fever—a temperature of 104½°—and great pain in the right side of the head. With the assistance of the house-surgeon, Dr. Cox, I made a Wilde's incision, but found no pus. The bone exposed by the incision seemed sound ; but after considerable burrowing under the anterior flap of the wound, I detected a softened spot in the bone through which a stiff probe was gradually worked into the mastoid cells, and a small quantity of thick pus then escaped. After the fistula had been enlarged, a tent was inserted, a poultice applied, and the hot douche ordered to be used every two hours. The operation was performed under ether. The bad symptoms were immediately relieved. At 1 P.M. the temperature was 101½°, and it fell rapidly to the normal. The mastoid tenderness and swelling subsided. The patient seemed to be making a speedy recovery, and I considered him out of danger. The wound was syringed with carbolized water and the tent changed twice a day ; and the ear was douched frequently with hot water. Excepting that some pain persisted in the frontal and right temporal regions, there appeared to be a progressive improvement in all respects until January 27th. Early in the morning of that day he suddenly had a chill, and the temperature at 9 A.M. was 104½°. He complained of pains in various parts of the body, especially in the left knee-joint, the throat, and along the right external jugular vein. All these points were very tender, particularly the track of the vein, but there was no external redness or swelling. The discharge from the wound became less. Between this date and February 8th he presented well-marked symptoms of *pyæmia*. He had irregular chills and sweats, and a temperature varying irregularly between 99¼° and 105°. His tongue at first was brown and dry, and then became very red, dry, and glazed. There was great prostration, a rapid pulse, and a dusky pallor of the skin. There was marked increase of the previous deafness on both sides. He was restless at night, and may have had slight

[1] Archives of Otology, vol. x., p. 41.

delirium, judging from the account of his friends who sat with him; but no delirium was observed by any of his medical attendants. His pupils always appeared normal. He had some cough and complained of pains in his chest, but I could find nothing abnormal by physical examination. Several copious clay-colored stools occurred. His general condition was so alarming that I thought he would surely die; and this was the opinion also of Dr. Roosa, who saw him frequently in consultation with me. An unfavorable prognosis was given to the family.

Additional features of his sickness may be gathered from the following somewhat incomplete notes, which I made from time to time:

January 28th.—Pains the same as yesterday. Pains also in right axilla, along the inner edge of the right biceps muscle and in the right knee. All these points very tender.

January 29th.—Discharge from the wound more abundant, of dark brown color, and fetid. [This continued for five days.] Pains the same.

January 31st.—Pains and tenderness along each clavicle. A red and tender swelling about the size of a walnut has appeared over the left sterno-clavicular articulation; distinct sense of fluctuation.

February 2d.—Pains and tenderness along clavicles, shoulders, and arms. Less tenderness along jugular vein.

February 5th.—Red and painful swellings, apparently glandular, in the neck, below mastoid, right side. [Deep suppuration occurred in the tissues of the neck subsequently, and the pus was evacuated through the mastoid opening.]

February 12th.—Swelling over clavicle gone. [All who examined this swelling had diagnosticated fluid contents, but no incision was made into it.] Opened an abscess in the gum over the second molar tooth, right upper jaw, and evacuated considerable pus. The whole right side of the face was flushed, swollen, and tender. A probe in the incision passed about 1½ inches upward over the exterior of the bone. Patient sits up for the first time.

There were no unfavorable symptoms after this date. The convalescence was slow, and the patient was not strong enough to leave his room until February 20th. He went out February 26th. At that time there was a free discharge from the mastoid fistula and from the ear, and the hearing was $\frac{c}{40}$.

Below is a partial record of the temperature:

January 21st.—9 A.M., 104½°; 1 P.M., 101½°; 7 P.M., 101½°.
" 22d.—9 A.M., 101°; 7 P.M., 101°.
" 23d.—9 A.M., 100°; 7 P.M., 99½°.
" 24th.—9 A.M., 99°; 7 P.M., 99°.
" 25th.—9 A.M., 98½°; 7 P.M., 98½°.
" 26th.—9 A.M., 99°; 7 P.M., 98½°.
" 27th.—9 A.M., 104½°; 7 P.M., 101½°.
" 28th.—9 A.M., 104½°; 12 noon, 104½°; 7 P.M., 103½°.
" 29th.—9 A.M., 104½°; 12 noon, 105°; 10 P.M., 103¾°.
" 30th.—9 A.M., 100¼°; 2 P.M., 103°.
" 31st.—9 A.M., 100°; 19 P.M., 99½°.

From February 1st to February 8th.—The temperature varied between 99° and 101°.

This case is interesting not only on account of its fortunate termination, but because it serves to illustrate the natural course

of the disease in question ; for, throughout his illness, the patient took no drugs whatever. This plan of treatment was adopted at the outset from my conviction that no drug would arrest the septic poisoning, and that the large doses of quinine often used were capable of doing harm. This view was shared by Dr. Roosa in all my interviews with him ; but it evidently excited wonder in the minds of some of the medical visitors who happened to be attending the clinics at the time. This very common feeling of surprise at seeing any alarming sickness treated without the use of what is by so many considered essential, shows that many minds can profit by the study of just such a narrative as has been given above.

Aside from the matter of drugs, this boy, of course, had a great deal of medical treatment, in the best sense of the words. He had a quiet room to himself with an open fire ; some member of his family sat with him each night, and he had the efficient nursing made possible through the kind supervision of Dr. Cox, as well as the latter's constant medical observation. I visited him often myself, and every small detail regarding food, stimulants, dressings, etc., received thoughtful consideration. Fortunately, food was well borne during the entire period. The diet consisted of milk, to which was added a little sherry wine at first, and afterward a little whiskey. Poultices were kept applied over the jugular vein and upon the painful swelling over the left sterno-clavicular joint. The free action of the bowels was doubtless useful in eliminating the poison, as has been remarked of other similar cases. Might not large doses of quinine (through their astringent action) have tended to check these desirable movements of the bowels, in addition to the depressing effect they might have had upon the nervous system ?

As soon as the crisis of this boy's illness had passed, the improvement in the expression of his face and in his whole aspect was so striking that it would naturally have been attributed to any medicine that he might have been taking at the time. Still more natural would such an inference have been regarding the rapid disappearance of the abscess—for such I believe it was—over the clavicle.

Another interesting point is that the sanitary condition of the hospital was considered to be unusually bad then.

I examined this patient a few days ago (May, 1890). There is a very slight purulent discharge from each tympanum, which is carefully removed by the patient and occasionally by one of the surgeons of our hospital. He is in excellent health, hears conversation, addressed particularly to him, about two feet away.

Mr. Prescott Hewitt,[1] in 1861, related a case of pyæmia, 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 others reported in this volume, 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[2] has given us the fullest account of the inflammations of the sinuses that may lead to purulent infection.

At this writing, May, 1891, I have under my care, at the Manhattan Eye and Ear Hospital, a case of septicæmia, occurring after an operation upon the mastoid, in which there was profuse venous hemorrhage, probably from the mastoid veins. The patient is recovering. Another case occurring in the course of an acute otitis media suppurativa, is also in the same hospital, under the care of Dr. Emerson.

Dr. Hessler,[3] of Halle, has recently collected the published cases of pyæmia in acute suppuration of the middle ear. He includes but one of mine, and that he doubts somewhat. There are eight cases in his table. The case of mine which Hessler reports is that recorded in discussing the nasal douche. He is inclined to consider it a case in which two diseases happened to occur at the same time—an acute inflammation of the middle ear and a septic phlegmon of the left foot. I am tolerably familiar with the symptoms of pyæmia, and although the case was originally reported to show the harmful results from the use of the nasal douche, and not the symptoms of pyæmia, I well remember the discoloration of the veins of the neck, the chills,

[1] London Lancet, February 2, 1861. [2] Virchow's Archiv., Bd. IX., p. 381.
[3] Archiv. für Ohrenheilkunde, Bd. XX., p. 223.

the abscesses, and the pyæmic odor, which plainly marked this case as one of pyæmia, not only to me, but to Dr. Swift and Dr. Peters, who attended the case with me. The history shows that pus found its way into the circulation from the tympanum through the jugular vein. If Dr. Hessler had carefully examined the *Transactions of the American Otological Society* and the *Archives of Otology* he could have added two cases to his table from my practice, which, whatever my first case was, were typical cases of pyæmia. To return to my first case, however, coincidental phlegmonous inflammation of the foot seems to me out of the question as a diagnosis, just as much as is endocarditis, which another German authority made for me, in reviewing the case.[1]

Because it was not stated in the history that the chest was examined, Dr. Weber-Liel assumed that an endorcarditis might have been overlooked, as does Dr. Hessler. It is hardly necessary to say that the patient had no endocarditis, and that the patient's chest, as well as other parts of the body that are not mentioned in the case, were carefully examined. Hessler admits, however, that, not having himself seen my case, he may be mistaken in his opinion of it.

### 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 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 several cases of temporary paralysis of the seventh, which were probably due to pressure upon the nerve-trunk; for, the functions of the nerve were finally 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,[2] by squeezing the blood from the corpus striatum, or thalamus op-

[1] Monatsschrift für Ohrenheilkunde, 1869, p. 180.

[2] Reynolds' System of Medicine, vol. ii., p. 505.

ticus. The author has published two cases of hemiplegia, occurring in coincidence with chronic suppuration of the middle ear,[1] 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 $\frac{7}{48}''$ from the left. Under the usual treatment the membrana tympani healed, and 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 $\frac{1}{5}$ with the right eye, and $\frac{1}{4}$ with 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 sixty-two, 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.

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

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,[1] 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 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.[2] 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 OPHTHALMOSCOPE AS AN AID TO DIAGNOSIS IN DISEASES OF THE BRAIN RESULTING FROM AURAL DISEASE.

Dr. Kipp[3] called the attention of the profession to this subject. Since then I am constantly availing myself of the assistance of the ophthalmoscope, in cases of chronic suppuration with serious symptoms. I cannot say that I have been able as yet to make a diagnosis by the examination of the entrance to the optic nerve, the retina, and its vessels, that I did not make from the study of the general symptoms and of the ear, yet I think that a more general use of this assistance in diagnosis may develop important results. Whenever we have a case of acute or chronic suppuration of the ear, with symptoms of cerebral disease, such as severe pain in the head, vertigo, nausea, vomiting, or delirium, the ophthalmoscope may be of service in determining whether disease of the base of the brain exists or not. That there is effusion along the course or at the origin of the external muscles of the eyeball during the course of meningitis and meningeal hyperæmia from aural disease is well established. One such case is recorded on page 524 of this book, where recovery ensued. Dr. Kipp found double optic neuritis in four cates of meningitis from aural disease. Two of them recovered. In the first case the optic disks swelled so much as to completely

[1] British Medical Journal, June 26, 1869.

[2] The relations of epilepsy to aural disease will be discussed somewhat in the chapter upon Diseases of the Internal Ear.

[3] Archives of Otology, 1879, p. 147.

obliterate their margins. The arteries remained of normal size, but the veins became enlarged and tortuous. There was also paresis of the sixth nerve of the right eye. In five months there was no abnormal appearance in the optic papillæ except that they were whiter than normal. In twenty-six months the child was well as to her eyes, both optic disks and retinæ were normal in appearance, and vision was normal. There was still some discharge at intervals from each ear, and the drum-membranes were perforated. In the second case, which was a fatal one, optic neuritis appeared in ten days after Dr. Kipp saw the case. In this there was central caries of the mastoid cells, abscess of the right middle lobe of the brain, and thrombosis of the right lateral sinus. In the third case reported by Dr. Kipp optic neuritis was found after the patient had been suffering from acute suppuration with mastoid abscess for a month. It may have existed long before this, but the patient did not come under Dr. Kipp's observation for some time after the serious symptoms appeared. The disks became very much swelled, so that a glass of nine inches focal distance measured the hypermetropia at the optic papillæ, while at the maculæ the retinæ were of normal refractive power. In six months the patient was in excellent health, without discharge from the ears, and the optic disks were of normal color and flat. The vision was perfect. In the fourth case there was meningitis, thrombosis of the lateral sinus. The retinal vessels were found full and tortuous two days after the appearance of acute symptoms. The patient died on the eleventh day and before this had well-marked optic neuritis. Albutt [1] and Wreden [2] had previously noted optic neuritis in cerebral disease from otitis. Both of Albutt's cases recovered. In Wreden's case, the intra-cranial disease was caused by a neoplasm originating in the nasal cavity.

It is an exceedingly interesting fact, that even the serious forms of optic neuritis seen in connection with acute suppuration may be entirely recovered from. No especial drugging was resorted to in these cases, but the treatment was pre-eminently local. Had even small doses of any drugs been administered they might have been quoted, in spite of the energetic use of the knife, poultice, and drainage, as proofs of the specific power of medicines in arresting suppuration.

Dr. J. A. Andrews [3] followed up this subject by reporting four cases, in which optic neuritis was observed in connection with aural suppuration. In one case recovery occurred. Andrews

[1] On the Use of the Ophthalmoscope, Appendix, 42 and43.

[2] Archives of Ophthalmalogy and Otology, vol. v., No. 1, p. 75.

[3] Transactions of the American Otological Society, 1883, p.138.

would accept œdema of the optic disk in chronic suppurations of the middle ear, that were not behaving well, as an indication for opening the mastoid, and if not with the expectation of liberating pus, at least to establish free drainage from the middle ear. Andrews quotes a case from Zaufal ("Inaug. Dissertation," Zurich), of a student, aged sixteen, who suffered from purulent otitis media and optic neuritis. After the mastoid was opened the neuritis subsided and the patient made a good recovery.

An interesting discussion followed the reading of Dr. Andrews' paper, to which those specially interested are referred.

In one case of death from meningitis following acute suppuration of the ear, that came under my observation, the post-mortem examination showed that the pus might perhaps have been reached by trephining the mastoid process, although this part of the temporal bone gave no signs of disease during the progress of the case, and an incision was made down to the bone for the purposes of examination. After much consideration of these cases, I am greatly inclined to advise that a thorough search should be made for pus, and by an opening through the bone, in all cases where death seems to be threatened from a cerebral abscess. I can see no reason why the surgeon should sit with folded arms, when there is a certainty on one side that death must ensue without interference, and a possibility on the other that the use of the trephine might save life by the evacuation of an abscess. Surgery certainly has something to hope for in the more careful search for pus beneath the skull. Trephining for abscess of the cerebrum cannot be a more dangerous procedure than when undertaken for depressed bone, or for epilepsy. In saying this, I have no desire to retract anything of what was said in a preceding chapter upon the performance of unnecessary surgical operations. Most of the searches for the pus in abscess of the brain would probably result in failure. I have myself failed in the one case in which I attempted it, but one success would atone for many failures, for it would save a life.

The table on the following pages, 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.

*Table showing the Course and Symptoms of Fatal 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 rotary movements of the head. Was unable to swallow; died on second 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 25th, and died May 4th, 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 of 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 earache 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. Fourth day, vertigo and delirium; efforts to vomit. Fifth, 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. |

*Table showing the Course and Symptoms of Fatal Cases of Meningitis, Cerebral Abscess, and Pyæmia, resulting from Aural Disease*—(Continued).

| 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. | January 26th.—Earache on right side. Headaches and giddiness for last six months. Paroxysmal pain. February 17th.—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 5th.—Fever, vomiting. On the 7th seemed well. 8th, Bad symptoms recurred. 10th, Excruciating pain in 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 2d.—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 la'eral wall of sinus. Inflammation of lining membrane of 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. |

*Table showing the Course and Symptoms of Fatal Cases of Meningitis, Cerebral Abscess, and Pyæmia, resulting from Aural Disease*—(Continued).

| 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 of the 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 Ohrenheilkunde, 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. |
| 30 | Male. | 3½ | Scarlatina. Otitis media purulenta. | Symptoms of meningitis. | Œdema of pia mater. Left lateral sinus contained a thrombus. Carious bone in left aud. canal. Hemorrhagic infarction 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 sup. petrosal sinus, filling it 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. | Five days. |
| 34 | Female. | 21 | Chronic discharge from right ear for three years. | Daily chill. 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. |

Cases 29, 30, 31, reported by H. Schwartze, Archiv für Ohrenheilkunde, Bd. VI., p. 221.

Cases 32, 33, 34, reported by Von Tröltsch, Archiv für Ohrenheilkunde, Bd. IV., p. 108.

*Table showing the Course and Symptoms of Fatal Cases of Meningitis, Cerebral Abscess, and Pyæmia, resulting from Aural Disease*—(Continued).

| 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 int. (middle?) ear. | Cases 36 and 37 reported by Dr. Thos. F. Cock, American Journal of the Medical Sciences, vol. xxiv., 1852, p. 57. |
| 37 | | 20 | Discharge from ear for eight or nine years. | | Caries; phlebitis. Lat. 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 tymp. full of pus; 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. Tegmen 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 pet. bone. Caries of tymp. cav. and mast. Connective tissue growths in vestibule. | Eight months. |

## NEURALGIA OF THE MIDDLE EAR.

Neuralgia is usually understood to be a disease of the sensory nerves, characterized by paroxysmal pain, without the objective appearances of inflammation, and which occurs in the course of nerves. In this sense neuralgia of the ear is an extremely rare disease. Yet it does sometimes occur, and when it does, the pain is generally referred to the tympanic cavity and the osseous portion of the auditory canal. Its origin is sometimes to be found in carious teeth, and in the existence of malarial or syphilitic poisoning.

Acute inflammation of the middle ear, of a catarrhal or even of a purulent form, was formerly often mistakenly supposed to be neuralgia. Better means of diagnosis, and a consequently better knowledge of morbid appearances, have greatly diminished these errors, but even to this day the diagnosis of otalgia, figures more largely than it should.

The supply of sensory nerves to the tympanum, Eustachian tube and auditory canal, is so large, that it would be strange if we did not occasionally meet with a case of pain referred to these parts, without any redness of the drum-head and canal, or swelling of the tube. Undoubtedly, if the seat of pain could be examined in such cases, the nerve tissue or its covering would show a pathological condition, either to the naked eye or the microscope, yet there are no inflammatory symptoms, in the ordinary sense of the term, in neuralgia of the ear, except pain, with perhaps sensitiveness of the canal and mastoid process. Neuralgia of the ear may occur in debilitated and overworked persons, and also in chronic catarrhal and chronic proliferous inflammation, as well as in chronic suppurations in anæmic subjects, and in the course of secondary syphilis. In neuralgia of the middle ear from diseased teeth, like that of the eyeball and eyelids, there are no inflammatory symptoms, but in the earache occurring from difficult dentition, either the reflex process leads very rapidly to trophic changes, or the pain in the ear, like that of the gums, is of inflammatory origin from the start. The continuity of the mucous membrane of the mouth with that of the bony Eustachian tube and tympanum, which is especially close in young children, is sufficient ground for suspecting that the pain in the ear in such subjects, is simply an inflammation that has extended from the gums to the middle ear. Be this true or not, and I believe it is, infantile earache, occurring in dentition, is practically an inflammation, as generally understood, and not a neuralgia.

Great importance is ascribed by certain writers to the condition of the teeth in the causation of diseases of the ear. Sexton[1] says that of fifteen hundred aural cases seen by him "perhaps one-third owe their origin or continuance, in a greater or less degree, to diseases of the teeth." This is a surprising statement to me, for on a careful consideration of my own cases of aural disease, now reaching in public and private practice more than ten thousand in number, I have notes of but very few, not more than one in a hundred, where it seemed to me that the condition of the teeth had any positive influence in causing or maintaining the aural disease. The cases that I have seen, were chiefly among infant children, who suffered from acute otitis media, at the same time with an inflammation of the gums. I have, however, seen a few cases where ulcerating teeth produce what is apparently reflex neuralgia of the middle ear. I have also in my ophthalmic practice seen paresis of accommodation and keratitis instantly relieved, and ultimately cured, after the removal of carious teeth. I am very far then from denying that decaying teeth, or swelled gums, may produce reflex disturbances in the ear, but I think the number of cases of aural disease thus caused is small. Infantile earache during dentition is usually an acute catarrh or acute suppuration of the middle ear, and not a neuralgia. This inflammation is, I think, even after a consideration of the theories of Woakes,[2] caused by an extension of the inflammation of the mucous membrane of the mouth and pharynx to that of the Eustachian tube. When a reflex aural disease is induced by the condition of the teeth, it is usually of a neuralgic and not inflammatory character, although of course, if the disease of the nerve or of its sheath, or whatever neuralgia may be, be continued long enough, changes in other tissues may occur.

Dr. C. H. Burnett[3] reports the case of a physician, who consulted him on account of impairment of hearing, tinnitus, and a peculiar sense of discomfort in the left ear. The drum-head was "lustreless, opaque, and retracted." In a year neuralgia in the post-auricular region, with a constant and pounding tinnitus, synchronous with the pulse and a peculiar tapping noise not synchronous with the pulse. There was also ear-cough, but not excessive. *All of these symptoms came on and kept up during excessive pain in the first molar tooth in the upper maxilla of the same side.* This tooth was filled ten years before and the

[1] American Journal of the Medical Sciences, vol. lxxix., p. 18.

[2] Deafness, Giddiness, and Noises in the Head. Second edition, p. 16 et seq.

[3] The Specialist and Intelligencer, November 1, 1880.

aural symptoms had first shown themselves six months after the tooth was filled. An abscess finally formed, and the tooth was extracted, with instantaneous relief from all forms of tinnitus, tapping sounds, and neuralgia in the ear, and the ear-cough and the hearing became much better.

Bonnafont[1] devotes considerable space to neuralgia of the ear, and 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[2] 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.

I have seen and treated cases of neuralgia of the middle ear, which I thought to be of malarial origin. In one case, that of a physician of twenty-seven years of age, who had suffered for some months from acute pain referred to the tympanum and mastoid process, recovery promptly ensued on the use of quinine. I have seen a few others in hospital practice, but I have no notes of the progress of the cases. Each case of neuralgia of the ear should be studied by itself. The diagnosis is of great importance, for one of the most valuable of remedies for neuralgia, quinine, is usually very harmful when administered in the course of catarrh or suppuration of the middle ear. Indeed in large doses, it is also harmful in all the inflammations of various parts of the ear. Its use should be avoided in all persons who have hyperæmia of the auditory apparatus, or in those who readily suffer from inflammation of the middle ear. I have seen neuralgia in the ear in the course of syphilis, usually as one of the later manifestations. Here of course the usual anti-syphilitic treatment by means of mercury and potash will be of service.

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[1] Traité théorique et pratique des maladies de l'oreille. Paris, 1873, p. 557.

[2] Monatsschrift für Ohrenheilkunde, Jahrgang III., No. 9.

If the cause of neuralgia be once found, whether it be a decayed tooth, the poison of syphilis or malaria, or general anæmia, the treatment will be simple enough. From all I have seen, I cannot believe that there is any considerable number of chronic aural diseases of the non-suppurative variety, that are in any way caused by the condition of the teeth. It is not very rare, however, to find a neuralgic disease added to a chronic suppurative process, when there is no active inflammation going on, and also in the course of the non-suppurative disease of the same part. Until it can be proven that people with sound teeth have a particular immunity from disease of the ear, it is hardly proper to assume that what may be a coincidental condition, decayed teeth—ill-fitting and improperly constructed plates for false teeth—are actually causes of any considerable proportion of the cases of chronic aural disease.

I have carefully examined the teeth of my aural patients for some years, and I have failed to find that there was any striking connection between chronic disease of the ear and bad teeth. Indeed, some of the most distressing cases I have known, were in people with particularly good teeth.

### CASES.

The following case illustrates the subject of trophic changes in the middle ear, which were perhaps caused by a neurosis, in its turn produced by dental irritation. The patient lives in Italy, and I have never learned whether the diagnosis proved to be correct.

Case I.—*Deafness, Tinnitus, Itching, and Pain in the Left Ear for Two Years —Neuralgia of Jaw and Face on same Side, Disease about and in Last Molar Tooth.* —September 15, 1882. Mrs. ——, aged forty. Has had deafness, tinnitus, pain, and itching in left ear for two years. Neuralgia of jaw, face, shoulder, and arm of left side for some time. Dizziness and nausea quite often for some time; dizziness without nausea before. Has had a great deal of neuralgia before, and is subject to headaches. Hearing distance, right ear, $\frac{12}{15}$; left ear, $\frac{1}{15}$. Tuning-fork heard on vertex, but in left ear (?). Bone conduction better than aërial on each side. The patient has a hard swelling high upon gum above last molar tooth of left side. She has had an ulcerated tooth there with similar swelling, requiring lancing, further forward. Present swelling increasing in size; not tender. Right membrana tympani opaque; fair light spot; fair position; left membrana tympani opaque; fair light spot; fair position.

Inflation only felt after two trials with chloroform. Hearing distance left ear, after inflation, $\frac{12}{15}$.

*Diagnosis.*—Neuralgia and trophic changes in tympanum from irritation of fifth nerve.

*Advice.*—Inflation, and advised to have the gum and tooth treated.

CASE II.—*Primary Syphilis—Miscarriage—Nocturnal Pains in the Shin Bones—Sore Throat—Neuralgia of Tonsil, Ear, and Eyeball—No Impairment of Hearing on the affected side—Sub-acute Catarrh of the Middle Ear on the other side.*—Mrs. O——, aged twenty-four, February 21, 1884. Patient was married three years since. Three months after marriage she miscarried, and soon after had severe nocturnal pains referred to the shins, and closely following severe pains in the head. Two years after marriage she had sore throat. Six weeks ago she had a very sore throat, and severe pain referred to the tonsil, Eustachian tube, middle ear of the right side. This pain continues, although not constantly, and is much worse at night. The patient has been under careful treatment by mercury, potash, and great attention to the nutrition for the whole time since the miscarriage. She is in fair condition, but suffers very much from the pain in the throat and ear. Her husband states that he contracted syphilis two years before marriage, but that he had no symptoms at the time of the marriage. He had a chancre, alopecia, papular eruption, and indurated cervical glands. None of these symptoms, except the latter, now exist.

The hearing distance for the watch on the right side is about $\frac{10}{10}$. Aërial conduction better than that through bone. On the left side the hearing distance is reduced to $\frac{8}{10}$, and the aërial and bone conduction are about the same. *There is no pain whatever on this side.* The patient is not aware that she is at all hard of hearing. Does not know that she ever had any earache as a child. Both drumheads are sunken and opaque, and the light spots are small. The pharynx is secreting an excessive amount of muco-purulent material. It is also swelled. There has never been any dizziness in the course of the disease. The upper teeth are false. One of the molars on each side is absent; the other teeth are not sensitive. On inflation the hearing distance of the left ear became normal.

Thanks to the frankness and intelligence of the husband of this patient, I was enabled to get a full history of the syphilitic origin of this case, the wife being ignorant of it. My diagnosis was neuralgia of the fifth nerve of the right side, of syphilitic origin, and sub-acute catarrh of the left tympanum. It was a striking instance of the different forms of disease in one and the same person. On one side was a syphilitic, well-marked neurosis, and on the other a syphilitic catarrh.

While preparing these pages for the press, Dr. Ramsdell, one of the staff of the Manhattan Eye and Ear Hospital, called my attention to a case of severe neuralgia of the middle ear, which occurred in the course of a chronic suppuration of the tympanum. The pain was decidedly different from that occurring from an increase in the inflammation, for example, in mastoid periostitis, being of an intermittent character. It was relieved by large doses of opium, and the inflammatory process made no advance while the neuralgia was under full headway. A true inflammation of the lining membrane would have only been relieved by antiphlogistic means. The patient was an anæmic woman of twenty-two years of age.

# THE INTERNAL EAR.

# CHAPTER XX.

## ANATOMY AND PHYSIOLOGY OF THE INTERNAL EAR.

The Vestibule, Semi-circular Canals, Cochlea, and Auditory Nerve.—Physiology 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.[1]

The internal ear may be conveniently studied by dividing it into the following parts :

1. The vestibule.
2. The semi-circular canals.
3. The cochlea.
4. The auditory nerve.

We shall first study the osseous envelope of these parts, and then consider their contents; the latter being, of course, far more important.

### THE VESTIBULE.

The vestibule is considered by all authorities to be an essential part of the internal ear. A part answering to the vestibule is to be found in all animals in whom an auditory apparatus can be detected. It is the seat of the principal expansion of the auditory nerve upon the saccule. This saccule floats in the peri-

[1] In compiling this anatomical sketch, the text-book of Henle has formed the basis of the description of the microscopic anatomy of the labyrinth.

lymph, and communicates through that fluid with the membrane of the fenestra ovalis, and consequently with the air in the tympanic cavity.

The vestibule is an irregularly shaped osseous cavity, the diameter of which from above downward, as also from behind forward, is about one-fifth of an inch. It is about one-tenth of an inch between its inner and outer wall. The semi-circular canals open into it by five orifices behind the cochlea, by a single one in front. The fenestra ovalis is on its outer wall; above this is the anterior opening of the horizontal semi-circular

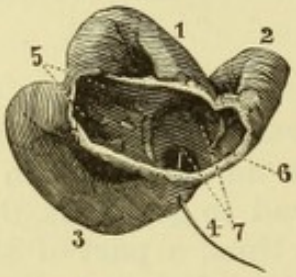


FIG. 117.—The Left Vestibule, with the Semi-circular Canals, from an Adult, seen from within (Rüdinger). 1, The horizontal semi-circular canal; 2, the upper semi-circular canal; 3, the posterior semi-circular canal; 4, a bristle is passed through the aqueductus vestibuli, and passes into the opening of two canals, and appears on the upper wall of the vestibule; 5, the mouths of the osseous ampullæ of upper and horizontal semi-circular canals; 6, the opening of the lower ampulla of the posterior semi-circular canal, below the numbers 6 and 7; 7, the lower opening, in which the bristle is seen, represents the opening of the common passage for two semi-circular canals.

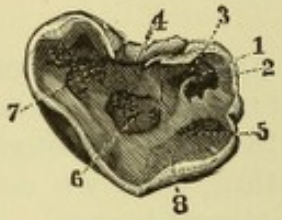


FIG. 118.—The Vestibule (after Rüdinger). 1, The osseous lamina spiralis of the cochlea, beginning below and posteriorly on the wall of the vestibule; 2, the scala tympani and the fenestra rotunda; 3, the scala vestibuli; 4, fenestra ovalis; 5, the posterior inferior wall of the lower ampulla, with the inferior macula cribrosa, which serves as a passage for the fibres of the vestibular nerve to the lower ampulla; 6, fovea rotunda, or recessus hemisphæricus; in its centre are a number of fine openings, the macula cribrosa media; through these the fibres of the middle branches of the vestibular nerve pass to the round saccule, which is the blind vestibular end of the scala vestibuli; 7, the upper portion of the recessus hemillipticus, in which is the upper macula cribrosa; 8, the lower portion of the recessus hemillipticus, which passes without any distinct dividing line into the semi-circular canals.

canal; on its inner are several minute holes, making up the maculæ cribrosæ for the entrance of a portion of the auditory nerve from the internal auditory canal. At the posterior part of the inner wall is the orifice of the aqueductus vestibuli, a fine canal penetrating the vestibule from the posterior surface of the petrous bone, and contains a tubular prolongation of the lining membrane of the vestibule, ending in the cranial cavity, between the layers of the dura mater.

The maculæ cribrosæ on the inner wall of the vestibule, are

to be seen with the naked eye on the newly born, but in the adult they are 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 semi-circular canals. The nerve-fibres to the posterior semi-circular canals pass through the inferior macula cribrosa, and those to the saccule through the macula cribrosa media. Finally, through the fourth macula cribrosa, passes the twig of the small branch of the cochlear nerve. The scala vestibuli of the cochlea begins on the anterior apex of the vestibule.

The outer wall of the vestibule is interrupted by the fenestra ovalis, but it is so completely and smoothly closed by the base of the stapes bone, that the inner surface of this wall of the vestibule appears even. On the inner wall are two depressions, called respectively the recessus sphæricus and the recessus ellipticus. A minute elevation between them is called the crista vestibuli.

The crista vestibuli runs above into the pyramidal elevation —*pyramis vestibuli;* below it divides into two branches, which enclose a space called *recessus cochlearis.*

Just above the recessus ellipticus opens the ampulla or flask-like orifice of the anterior vertical semi-circular canal. The recessus ellipticus is partly bounded below by a shallow furrow, *sinus subciformis.* The two vertical canals open at the junction of the posterior and inner wall. On the same line, but a little higher in the middle of the posterior wall, is the posterior opening of the horizontal semi-circular canal. The lower opening of the posterior vertical canal is in the angle formed by the posterior, lower, and inner wall of the vestibule. The anterior ampulla of the horizontal canal lies on the outer wall between the fenestra ovalis and the ampulla of the anterior vertical semi-circular canal.

### THE SEMI-CIRCULAR CANALS.

The semi-circular canals are half-elliptical or C-shaped canals which proceed from the vestibule and return to it again. They are three in number. The horizontal lies with its convexity directed laterally. The other two are vertical in position, forming a right angle with each other. The two openings of the anterior vertical semi-circular canal are near each other and at about the same height. The openings of the posterior vertical

canals are above each other. The horizontal canal is surrounded, as it were, by the two vertical ones.

There are considerable variations in different individuals, in the length and curvature of the semi-circular canals, yet the general shape of these parts remains the same.

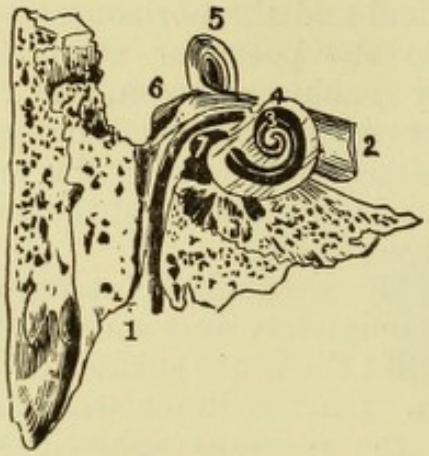


FIG. 119.—Section of Temporal Bone of Right Side through the Cochlea (anterior view, actual size). 1, Mastoid cells; 2, internal auditory canal; 3, modiolus and lamina spiralis; 4, cochlea; 5, superior semi-circular canal; 6, horizontal semi-circular canal.

The length of the anterior vertical canal, measured on the convex border, with the ampulla and the common crus, is about $\frac{4}{5}$ of an inch; that of the posterior is $\frac{1}{12}$ of an inch, of the horizontal $\frac{1}{6}$ of an inch. The part common (canalis communis) to the two vertical canals is from $\frac{1}{12}$ to $\frac{1}{8}$ of an inch in length. The diameter in a grown man varies from $\frac{1}{20}$ to $\frac{1}{15}$ of an inch.

FIG. 120.—Osseous Cochlea and Semi-circular Canals, with Stapes Bone. Left Ear of Adult (after Rüdinger).

FIG. 121.—Right Osseous Vestibule, Semi-circular Canals, Cochlea, and Ossicula Auditus of Newly Born (after Rüdinger).

Wharton Jones makes their calibre about one-twentieth of an inch in a direction from the concavity to the convexity of their curve.

Since the semi-circular canals all open at both ends into the vestibule, there would be six orifices were not one of the orifices common to two of the canals. There are, consequently, five. These openings are called ampullæ (flasks) from their shape, and are more than twice the diameter of the tubes. The inner

extremity of the superior vertical canal has a common opening into the vestibule with the posterior vertical.

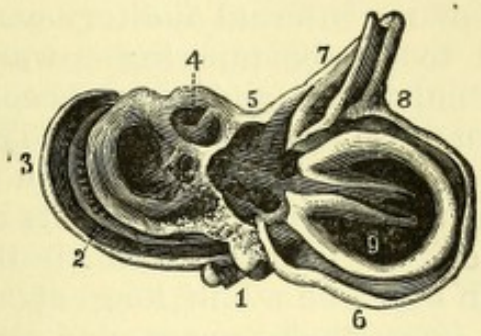


FIG. 122.—The Right Osseous Labyrinth of a Newly Born Subject opened on its Posterior Surface (after Rüdinger). 1, Cochlear fenestra; 2, the osseous spiral; 3, the osseous spiral canal of the cochlea—canalis spiralis cochleæ—divided by the spiral into two parts, scalæ, or stairways, the lower the scala tympani, the upper the scala vestibuli; 4, the basis of the internal auditory canal, with the entrance to the Fallopian canal and the maculæ cribrosæ. The latter receive the fibres of the auditory nerve, and the vessels entering with it into the labyrinth; 5, the osseous vestibule, opened on its posterior wall; 6, the posterior semi-circular canal; 7, the upper semi-circular canal; 9, horizontal semi-circular canal.

According to Henle,[1] in the later years of life the semi-circular canals increase in length; the horizontal canal increases

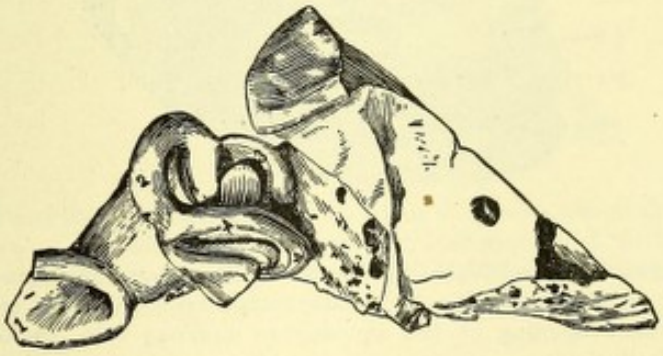

FIG. 123.—Section of Right Temporal Bone, showing Osseous Semi-circular Canals (actual size). 1, Internal auditory canal; 2, superior semi-circular canal; 3, external semi-circular canal; 4, posterior semi-circular canal.

the most, and the anterior vertical the least. The canals also increase very slightly in width; about 0.7 mm. according to Hyrtl.

## THE COCHLEA.

This part of the internal ear is so named from its resemblance to a common snail; a resemblance which is very marked. It is one of the most remarkable instances in the whole body of the compact packing of very important parts.

[1] Lehrbuch, p. 762.

The osseous cochlea lies in front of the vestibule, and behind the carotid canal, and forms the promontory by pressing out, as it were, the bone toward the tympanic cavity. Inward it strikes upon the blind end of the internal auditory canal. The cochlea is aptly compared to a tube tapering toward one extremity where it ends in a cul-de-sac, and which is coiled like the shell of a snail round an axis or central pillar. Then we must suppose this tube divided into passages by a thin partition running throughout its length, and spirally around its axis.

The tube of which the cochlea is formed—the canalis spiralis cochleæ, is about an inch and a half long, about one-tenth of an inch in diameter at its commencement, and about one-twentieth at its termination. It makes two turns and a half turn, in a di-

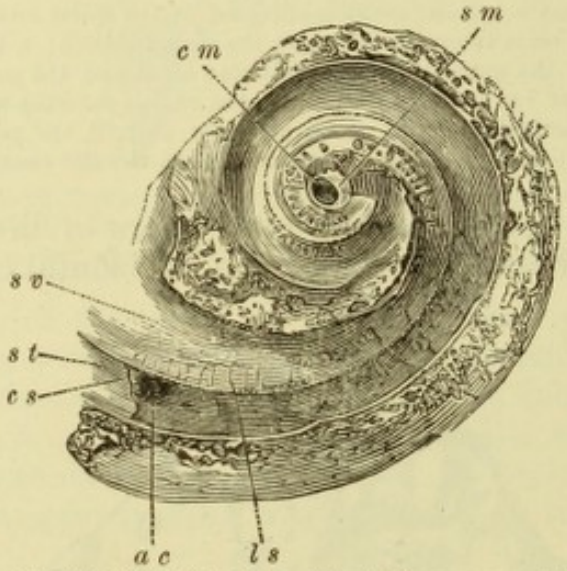


FIG. 124.—Osseous Cochlea (Right) of the Newly Born, opened from the Outer Surface (after Henle). *s v*, Scala vestibuli; *s t*, scala tympani; *l s*, lamina spiralis; *c s*, crista semilunaris; *a c*, inner opening of the aqueductus cochlea; *c m*, canalis centralis; *s m*, canalis spiralis modioli.

rection from below upward, from left to right in the right ear, and from right to left in the left ear. The apex of the coil is directed forward and outward. The base of the spiral tube runs into the vestibule. The cul-de-sac at the apex forms a kind of vaulted roof called the cupola.

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. 118, of the vestibule). The former space is therefore called the *scala tym-*

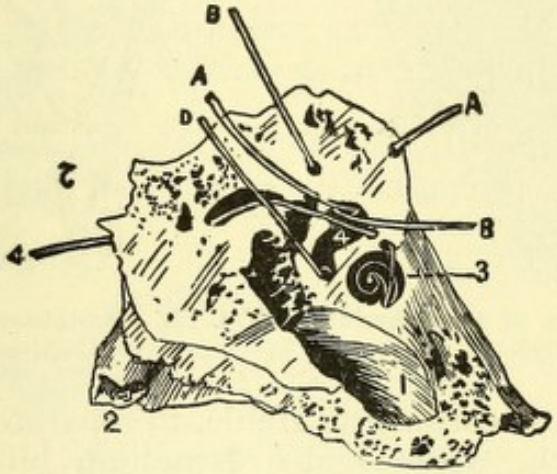


FIG. 125.—Section through Cochlea and Vestibule (left side, actual size. From Professor Darling's museum). 1, Carotid canal; 2, broken styloid process; 3, first turn of cochlea; 4, vestibule; *A*, *A*, superior semi-circular canal; *B*, *B*, external semi-circular canal; *C*, aquæductus Fallopii; *D*, auditory nerve channel.

*pani*, the latter *scala vestibuli*. In the scala tympani, just above the membrana tympani secondaria, which closes the fenestra rotunda, is an opening, called the entrance of the aqueduct to the cochlea. The two scalæ communicate at the apex of the cochlea by a common opening called the helicotrema (*a twisted foramen*). This communication exists in consequence of the want of a lamina spiralis in the last half coil of the canal.

Two very small canals, called aqueducts open by one extremity into the labyrinth, and by the other on the surface of the petrous portion of the temporal bone.

### PERIOSTEUM OF THE LABYRINTH.

The periosteum that covers the walls of the osseous canal is, with the exception of that on the outer wall of the cochlea, very delicate. Henle[1] 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

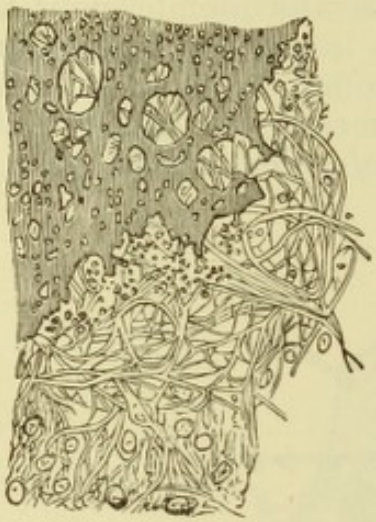

FIG. 126. — Periosteum of the Labyrinth (after Henle).

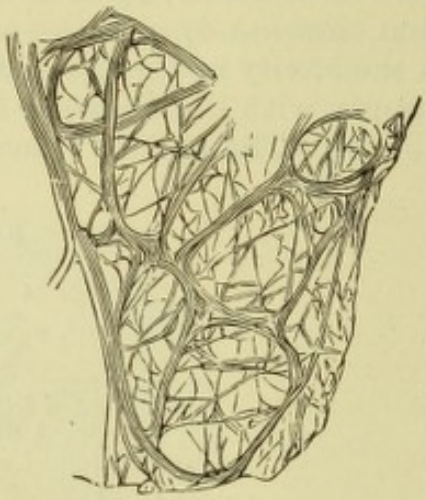

FIG. 127.—Periosteum of the Outer Wall of the Cochlea (after Henle).

is very difficult, according to Henle, to separate the periosteum of the labyrinth, without also detaching bits of bone. The periosteum is abundantly supplied with blood-vessels.

### THE MEMBRANOUS LABYRINTH.

*Utricle and Membranous Semi-circular Canals.*

The utricle is an elliptical tube, situated on the median wall of the vestibule. Its longest diameter corresponds to the height of the vestibule. By means of a fine vascular and nervous network, and a very delicate connective tissue, it is fastened to the recessus ellipticus of the vestibule.

The membranous semi-circular canals are but the lining of the osseous canals, and, of course, of the same shape. The membranous canals open into the utriculus with five openings, just as do the osseous tubes in the vestibule. At the ampullæ, the membranous canal fills up the osseous very completely; but there is some space between the other parts. The walls of these

[1] Lehrbuch, p. 774.

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 and also receives nerve-twigs.

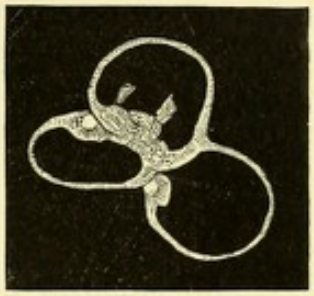

FIG. 128.—Utricle and Membranous Semi-circular Canals of the Left Side.

The wall of the membranous semi-circular canals is from 0.02 mm. to 0.03 mm. in thickness, and is composed of various layers.

The membrana propria is of reticulate and nuclear fibrous tissue, of which the periosteum also consists. It is perforated

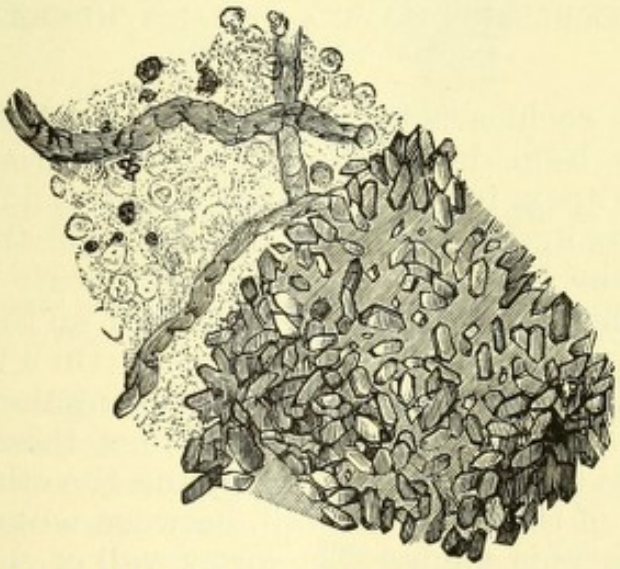

FIG. 129.—A Piece of the Wall of the Utricle, with the Otoliths (after Henle).

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, and consists of crystals of carbonate of lime, of varying shape and size. The largest are only 0.012 mm. long and 0.008 mm. broad. They are too small to allow the crystal form to be recognized. Henle says it is unknown how the otolith is fastened on to the wall of the utricle.

### SACCULE.

The saccule is of the shape of a broad flask with narrow neck. Its body (about $\frac{1}{75}$ inch in diameter) lies in the recessus sphæricus of the vestibule. The neck (*canalis reunicus*, about $\frac{1}{35}$ inch long and $\frac{1}{120}$ inch in diameter) of this bottle or flask proceeds from the lower wall, downward and backward, and sinks into the upper wall of the vestibular end of the ductus cochlearis, at nearly a right angle, so that a blind sac is formed at the junction of the two parts. Henle compares it to the passage of the œsophagus into the stomach. and of the small intestine into the 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, between which the insertion of the two others is made. The lower wall of the ductus cochlearis, which is turned toward the scala tympani, is called the tympanal; the upper, which separates the ductus cochlearis from the scala vestibuli, is called the vestibular wall.

On the osseous border of the lamina spiralis is a soft structure, only to be seen in the uninjured specimen of the cochlea, which lengthens the lamina spiralis toward the calibre of the ductus cochlearis. It is called by Henle the limbus laminæ spiralis. It is developed from the periosteum of the lamina spiralis. This structure gradually decreases in breadth and height from the base to the apex of the cochlea. The edge of the osse-

ous lamina recedes more and more at the same time from the free border of the limbus. This free border becomes a furrow, called by Huschke the *sulcus spiralis*, having, of course, two lips. The upper lip is the labium vestibulare; the lower, the labium tympanicum. The vestibular wall of the ductus cochlearis passes off from the upper surface of the lamina spiralis in a line nearly corresponding to the inner attachment of the limbus laminæ spiralis, so that the latter is almost completely drawn into the ductus cochlearis.

The upper surface of the vestibular lip of the limbus lamina spiralis is covered by striæ, which on front view resemble the anterior surface of the incisor teeth, and hence Huschke calls them the auditory teeth. These furrows, or striæ, are filled by

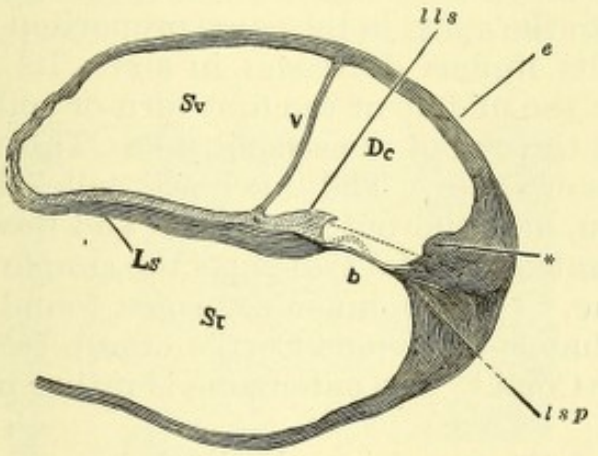


FIG. 130.—Transverse Section of a Cochlear Spiral, from a Cochlea softened in Hydrochloric Acid (after Henle). The dotted lines indicate sections of the membrana tectoria and the auditory rods; *l s*, lamina spiralis; *l l s*, limbus laminæ spiralis; *s v*, scala vestibule; *s t*, scala tympani; *d c*, ductus cochlearis; *l s p*, ligamentum spirale; *v*, membrana vestibularis; *b*, membrana basilaris; *e*, outer wall of ductus cochlearis; *, bulging of this wall.

small rounded cells. Their number may run as high as 2500. The limbus is composed of connective tissue, running in a radiate direction in the furrows, or striæ; beneath these furrows the connective tissue is reticulate.

Henle compares the labium vestibulare to a roof over the sulcus spiralis, and the labium tympanicum to a floor. Within the labium tympanicum run very fine nerve-fibres from the tissue of the auditory nerve to the ductus cochlearis. The labium tympanicum consists of two layers, which include the nerve-fibres between them, and then unite beyond it in a sharp border, from which the *membrana basilaris* proceeds. This membrana 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 the preceding figure, and being the part upon which rests the organ of Corti, has attracted very much attention from anatomists. It is a continuation of the labium tympanicum. It gradually increases in breadth from the base to the apex, in the same proportion that the lamina spiralis with its limbus decreases in size. Its breadth in the newly born, in the middle of the first turn or coil of the cochlea, is 0.17 mm.; at the end of the second, 0.45. This space is divided into two parts or zones. The inner was called by Kölliker, the habenula tectu, and the outer by Todd and Bowman, the zona pectinata. Henle gives the two parts the simple names of inner and outer zone. On the inner zone are found the structures making up what is known as Corti's organ, from their discoverer, Marchese Corti.[1] The outer zone is rather broader than the inner.

The basis of the membrana basilaris is a structureless membrane. On the outer zone especially are peculiar knobby points. Upon this structureless membrane are the parts known in their totality as Corti's organ. The fibres of this structure are arranged along the whole length of the membrana basilaris. There are spaces between them, so that they have a certain resemblance to the keys of a piano.

The ligamentum spirale is the means of attaching the membrana basilaris to the outer wall of the cochlear canal. The fibres of which it is composed are like those of periosteum.

The cavity of the ductus cochlearis is divided into parts by a membrane running parallel to the membrana basilaris. The upper part is filled with endolymph, the lower contains what Henle calls the terminal auditory apparatus. The membrane which divides the ductus cochlearis into two parts is called the membrana tectoria by Claudius, but Corti's membrane by Kölliker. The membrana tectoria is divided into three zones. The

[1] Corti was formerly prosector to Professor Joseph Hyrtl, and made the first exact microscopic examination of the lamina spiralis ossea, and membranacea.

middle zone is the denser; the inner is structureless and has numerous openings. The outer zone is made up of a very fine and friable network. It is probable, according to Henle, that the membrana tectoria is firmly fastened, and that it is not possible for it to press closely upon the parts covered by it.

### TERMINAL AUDITORY APPARATUS.

The most important, physiologically speaking, of this terminal apparatus are the auditory rods, called also Corti's teeth, or Corti's fibres. They are arranged in regular order, very like the cords, hammers, or keys of a piano. They are shaped like a Roman S, having slender cylindrical bodies and broad ends containing granular protoplasm. There are two rows of these fibres, an inner and an outer. The inner rods arise from the membrana

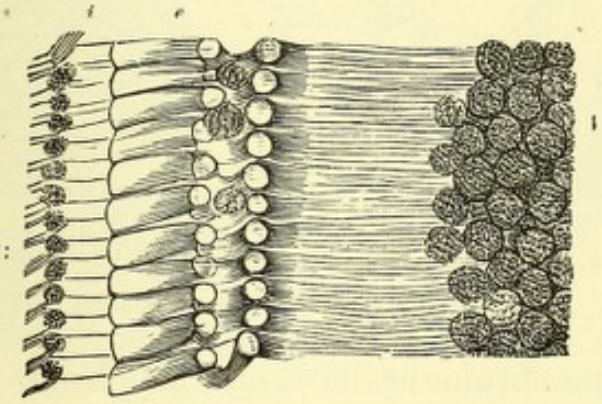

FIG. 131.—From the Terminal Auditory Apparatus of a Cat (after Henle). *i*, Outer ends of the inner fibres; *e*, outer fibres; 3, outer covering cells; 4, epithelial cells. (500 × 1.)

basilaris, on which their internal extremities are fastened, more or less abruptly, toward the membrana tectoria, without, however, being united to the latter. The outer rods or fibres join, with their inner extremities, the outer end of the inner fibres. Their external terminations rest on the membrana basilaris. There are two varieties of the inner row of fibres or rods; one is smooth and elliptical in shape, the other cylindrical and broader at each end.

The outer row of rods is cylindrical in shape, and they stand at a greater distance apart than the inner. The estimated number of inner pillars is 6000, of the outer 4500. The inner row of fibres is always shorter than the outer. They join together and form a roof over the inner zone of the membrana basilaris. The base of this roof is 0.1 mm. in breadth. The structure of these rods, as shown by the action of reagents, is a tissue as hard as cartilage.

Henle calls the terminations of the two rows of rods upon the membrana basilaris, the lower extremities; and the extremities which join to make the roof, the upper extremities. The cells found in the ductus cochlearis, auditory cells, are nucleated, round, and cylindrical. A layer of them covers the *sulcus spiralis*, Reissner's membrane, and the outer wall of the ductus cochlearis. Upon the inner pillars lies a single row of conical cells with large nuclei. They send processes into the rows of small cells lying next toward the sulcus spiralis, the granular layer. The ends turned toward the heads of the rods bear tufts

Fig. 132.

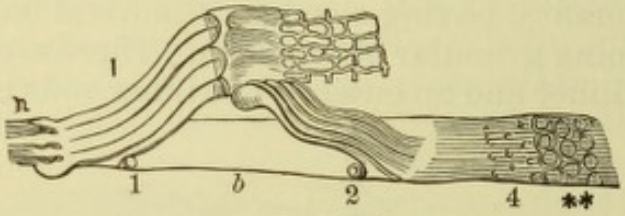


Fig. 133.

Fig. 132.—Profile View of Outer and Inner Rods.

Fig. 133.—Membrana Basilaris (*b*), with the terminal nerve-fibres (*n*) and the inner and outer rods; and 1, inner; 2, outer floor cells; 4, attachment of the roof cells; **, epithelium.

of stiff immovable cilia. These cells are called inner hair-cells. Their number is computed at 3300. On the outer rods lie three or four rows of double nucleated cells, connected by slender processes to the membrana basilaris and membrana reticularis, and bearing also tufts of cilia. Their number is computed at 18,000. The cilia of the cells are received in the lamina reticularis in corresponding rows of openings. Waldeyer regards the cells, as also the rods of Corti, as epithelial structures. Henle describes another layer of cells lying on the membrana basilaris as floor cells.

The membrana reticularis is the second of the component parts of the terminal auditory apparatus. It arises from the articulation of the rods or fibres, and extends to the outer wall of the cochlea parallel to the lamina basilaris. It is supposed to be a ligament to bind the rods together. The tissue of the lamina reticularis is not less firm than that of the rods, but it is delicate.

## AUDITORY NERVE.

*The Auditory Nerve* (*Nervus acusticus*). — The auditory nerve, or *portio mollis* (soft part of the seventh nerve), is the nerve of the sense of hearing, and is distributed exclusively to the internal ear. The auditory nerve arises by two roots in the

medulla oblongata. One ganglionic nucleus of origin is in the floor of the fourth ventricle. The other is in the *crus cerebelli ad-medullam.* The roots of the nerve are connected, on the under surface of the middle peduncle, with the gray substance of the cerebellum, with the flocculus, and with the gray matter at the border of the *calamus scriptorus.* The nerve winds around the restiform body, from which it receives fibres, and passes forward across the posterior border of the crus cerebelli, in company with the *portio dura,* or facial nerve, from which it is partly separated by a small artery. It then passes into the meatus auditorius internus, where some minute filaments connect them together.

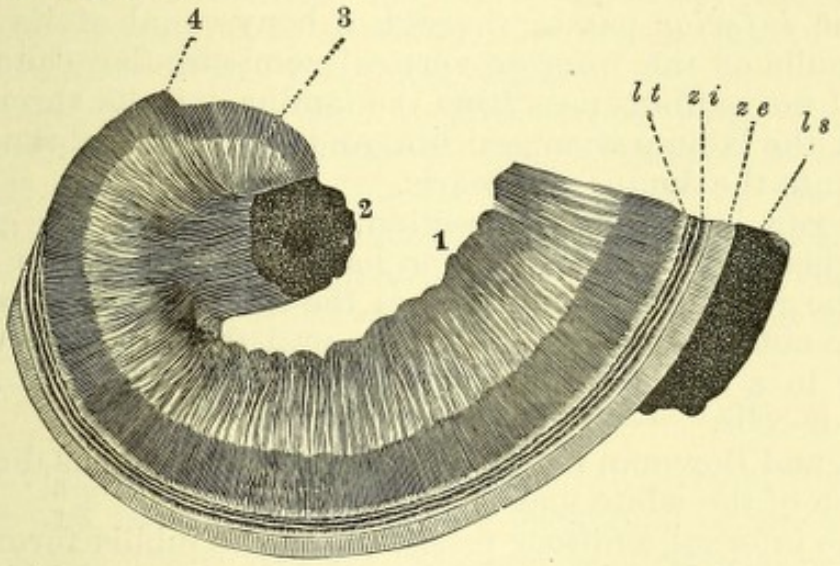


FIG. 134.—Expansion of the Right Cochlear Nerve, seen from the Base of the Cochlea, from a Labyrinth softened in Hydrochloric Acid (after Henle). 1, The branches entering through foramina; 2, twig passing into the modiolus; 3, network in the osseous lamina spiralis; 4, network on its border; *l t*, labium tympanicum; *z i*, zona interna; *z e*, zona externa of the membrana basilaris; *l s*, ligamentum spirale. (15 × 1.)

The auditory nerve is remarkable for the delicacy of its structure, which caused the older anatomists to give it the name of portio mollis. It has only a very thin neurilemma.

At the bottom of the meatus the facial nerve enters the Fallopian canal, the auditory divides into two branches, vestibular and cochlear.

The cochlear nerve gives off a small branch, which passes to the vestibular extremity of the ductus cochlearis, and through the fourth macula cribrosa, to the partition wall of the two saccules in the vestibule. From the trunk of the nerve a number of fine twigs arise, which pass through foramina direct to the lamina spiralis of the lower coil of the cochlea. The remainder of the cochlear nerve enters the modiolus, and is divided into anastomotic divisions. The fibres become separated from the

trunk in a line corresponding to the course of the canalis spiralis modioli, and permeate this canal. Here, by the addition of ganglion cells, they become gangliose striæ, and finally end, at almost a right angle to the trunk, in the osseous lamina spiralis.

The vestibular nerve, after a slight gangliose expansion, divides into three branches :

1. *Superior.*—This passes through the macula cribrosa superior, and ends by three branches to the utricle and ampulla of the superior vertical and horizontal semi-circular canals.

2. The *middle* passes through the macula cribrosa media to the saccule.

3. The *inferior* passes through a bony canal of its own to the ampulla of the inferior vertical semi-circular canal. The terminal nerve-fibres pass from the lamina spiralis through fine holes in the labium tympanicum, and in the membrana vestibularis into the ductus cochlearis.

They run in a radiate direction, pass through the granular layer, where some end in inner hair-cells and others run between the rods of Corti and across the tunnel formed by them, to end in outer hair-cells. There are probably other nerve-fibres running in a spiral course among the granular layer and the outer hair-cells.

Todd and Bowman regard the vestibular nerve as direct prolongation of the white matter of the brain.

In the internal auditory canal, the portio mollis forms a connection with the portio dura by means of a few fascicles of fibres, which constitute what Wrisberg called the "portio intermedia." It is not decided whether the connecting link proceeds from the auditory to the facial nerve, or from the latter to the former. Todd and Bowman 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.

The *internal auditory canal* (*meatus auditorius internus*) begins at about the centre of the petrous portion of the temporal bone by a large orifice with smooth rounded edges, and runs directly outward about one-eighth of an inch to end in a blind fossa.

There are four depressions in the fossa. These are perforated by fine foramina, through which the fibres of the acoustic nerve enter the labyrinth. Three of them correspond to the *maculæ cribrosa.* The fourth lies opposite the base of the cochlea. It is spiral-shaped, has spiral-shaped openings, and is called the *tractus spiralis foraminosus.*

## BLOOD-VESSELS.

The blood passes to the internal ear through the auditiva 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 foraminosus into the modiolus, and then go on between the layers of the lamina spiralis, and are finally lost in the spirals of the cochlea. The vestibular artery passes through the posterior wall of the vestibule in numerous fine twigs to the soft structures of the vestibule and semi-circular canals. The stylo-mastoid artery is said to give several small branches to the labyrinth. It is important to observe the fact to which 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.

## THE PHYSIOLOGY OF THE INTERNAL EAR.[1]

The vibrations of the atmosphere are conveyed through the ossicles and fenestra ovalis to the perilymph of the labyrinth. They pass as waves over the vestibule, semi-circular canals, and other parts of the labyrinth, and are there transmitted to the endolymph. A vibration passes from the vestibule into the scala vestibuli of the cochlea, and passing down the scala tympani ends as an impulse against the fenestra rotunda. The variations in pressure of the fluid of the labyrinth, which is surrounded by particularly firm bony walls, thus excited by the motions of the foot-plate of the stapes bone, are compensated for by a movement of the membrane of the fenestra rotunda. The helicotrema, the small opening through which the two scalæ of the cochlea communicate, allows the membrana basilaris with the parts lying upon it (Corti's organ) to be set in motion. Buck's investigations lead him to believe that "no communication exists between the two scalæ in the immediate vicinity of the cupola,[2] unless the opening spoken of so vaguely by the authors, be microscopic in size." This negative assertion has not been confirmed

[1] Foster: Text-Book of Physiology. Hartmann: Lehrbuch. Hensen: Handbuch der Physiologie von Hermann, Leipzig, 1880. Politzer: Lehrbuch.

[2] Treatise on the Ear, p. 12.

by other anatomists, and the opening is still described by those who have written since Buck's statement was made.

The exact function of the individual portions of the labyrinth, in spite of the investigations of the physiologists, is not yet positively settled. According to Helmholtz, the vestibule and ampullæ are adapted to the perception of noises, irregular vibra-

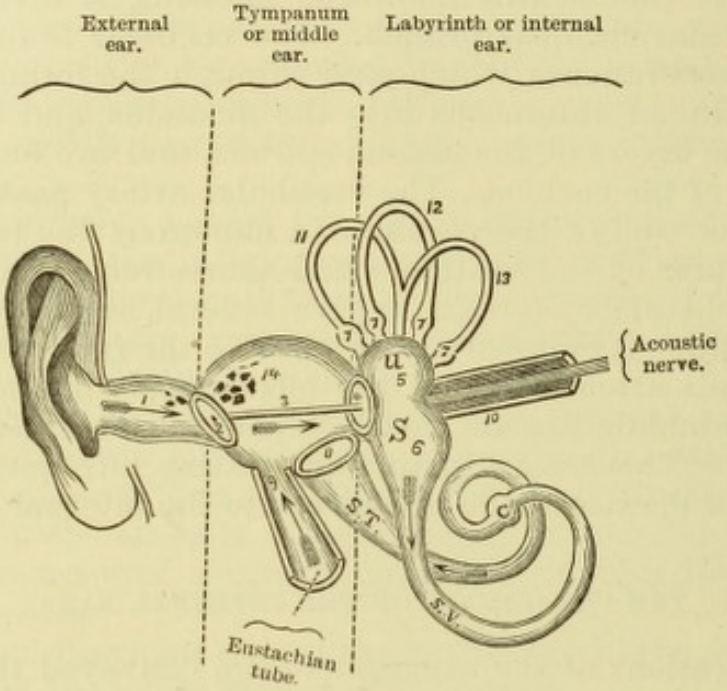


FIG. 135.—A diagram designed to illustrate the Physiology of the Labyrinth (Professor A. L. Ranney). 1, External auditory canal; 2, the membrana tympani; 3, the tympanic cavity with its chain of bones connecting 2 with 4; 4, the fenestra ovalis; 5, the utricle, communicating with the semi-circular canals (11, 12, and 13); 6, the saccule, communicating with the scala vestibuli of the cochlea (*s v*); 7, the ampullæ; 8, the fenestra rotunda, opening from the scala tympani (*s t*) into the cavity of the tympanum (3); 9, the Eustachian tube, allowing of the entrance of air from the pharynx into the tympanic cavity; 10, the internal auditory canal, transmitting the acoustic nerve; 11, 12, and 13, the semi-circular canals; 14, the opening of the mastoid cells into the tympanic cavity (3) and the external auditory canal (1); *s v*, the scala vestibuli of the cochlea; *s t*, the scala tympani of the cochlea; *c*, the cupola.

tions, while the cochlea perceives periodic vibrations—tones. Helmholtz also showed that it is probable, that the part of the cochlea near the fenestra rotunda vibrates more easily to high notes, or those with many vibrations in a second, while that in the cupola vibrates more readily to low tones. The membrana basilaris of the cochlea increases in width from the lowest winding of the cochlea to the cupola. Helmholtz says that the membrana basilaris has a system of cords corresponding to its stripes, of which, for certain tones, only a limited number vibrate. The perception of the high tones is caused by the lower section of the membrana basilaris, and of the low or deep ones by the superior

parts. This corresponds with the clinical experience, that patients deaf from exudations in the middle ear, encroaching upon the labyrinth, hear low tones, when they cannot at all perceive high ones. The case of atrophy of the acoustic nerve in the first whorl of the cochlea, reported by Moos and Steinbrugge,[1] is also strong evidence in support of this view. The patient was sixty-three years old. His ears were examined fourteen days before his death. He suffered from loss of hearing and constant tinnitus. The loss of hearing is said to have occurred suddenly. He could not hear the voice at all on the right side, and 3 metres on the left. He died of carcinoma of the right anterior central convolution, he also had carcinoma of the stomach. In the ear was found, as has been said, atrophy of the nerve-fibres of the first cochlear whorl. The external ear, and middle ear, except the junction of the stapes with the vestibule, were in a normal condition. There was rigidity of the articulation. There was also sclerosis of the cells of the mastoid process. The patient during life was found very deficient in the power of hearing high notes. It has been shown by Moos and others, that the power of hearing conversation well, involves capability of hearing high notes.

Although Helmholtz's theory of the function of the cochlea is not everywhere positively accepted, the weight of evidence seems to be in favor of the view, that it has a higher function than the vestibule, and that by it an analysis of tune is made. The place that Corti's rods long held as the terminal organs of hearing must, however, be abandoned, for Hasse found in birds that possessed the power of hearing musical tones and speech, that while Corti's cells were developed the rods of Corti were wanting.

The view that the cochlea alone is for the perception of tone, is put somewhat in doubt by Ranke's and Hensen's experiments. On microscopical examination of living heteropodes, Ranke found the auditory cilia vibrating rapidly and moving toward the otoliths, in the aural vesicle. Hensen, in experimenting upon crabs, showed that when tones were produced a certain number of cilia vibrated to certain tones.

The semi-circular canals seem to have nothing to do with the hearing function, but since the experiments of Flourens it is generally, although not universally, accepted that they are the parts chiefly concerned in maintaining the equilibrium of the body.

The greater number of authorities regard them as the organ of the sense of equilibrium, but this view is not everywhere

[1] Zeitschrift für Ohrenheilkunde, Bd. X., p. 1. Archives of Otology, vol. x., p. 1.

accepted. Böttcher, on the basis of experiments like those of Flourens, believes that the symptoms seen after injury of the semi-circular canals are due to a simultaneous injury of the cerebellum. Moos agrees with this author from clinical observations made upon patients. In accordance with the views of Lussana and Berthold, he thinks that the disturbances of co-ordination after injury of the semi-circular canals are excited by a reflex transmission of the irritation from the ampullar nerves to the cerebellum.

Hogyes, quoted by Politzer,[1] says that the terminations of the auditory nerve in the vestibule are a peculiar apparatus to regulate the movements of the eyes and probably also those of the muscles for the preservation of the equilibrium of the body. Lussana separated the semi-circular canals, without at the same time irritating the nerves of the ampullæ or vestibule, and even after the labyrinth was entirely destroyed, no disturbances of co-ordination were seen. Politzer's experiments with the superior semi-circular canal, showed that the fluid of the labyrinth could be influenced by pressure or exhaustion of the air in the auditory canal or tympanum. A manometric tube was placed in the superior semi-circular canal after having been filled with fluid. On pressure from the canal or tympanum the fluid arose, and on exhaustion it sank. These experiments were verified and amplified by Helmholtz and others.

### *Sensory Centre of Auditory Nerve.*

Ferrier[2] finds the sensory centre of the auditory nerve in the temporal lobe of the cerebrum. Its anatomical connection with the nuclei and roots of the nerve has not been proven. Ferrier observed on electric irritation of the superior temporal convolution on the exposed brain of cats, dogs, and monkeys, a sudden elevation of the auricle of the opposite side, and on destruction of the temporal lobe deafness of the opposite ear. Munk,[3] quoted by Politzer, got the same results, by experiments on dogs. He thinks they indicate a decussion of the fibres of the auditory nerve in the brain.

Munk believes, as quoted by Politzer, that if the parts of the temporal lobe, termed "hearing spheres," were removed, and the ear of the same side destroyed, the animal would be deaf. Munk also believes that the posterior part of the hearing sphere

[1] Text-book, translation, p. 682.

[2] The Functions of the Brain, p. 171. New York, 1876.

[3] Text-book, p. 684.

perceives low tones, and that the anterior section in the neighborhood of the fissure of Sylvius is for the perception of high tones.

### *Determination of Direction of Sound.*

It was formerly supposed that the direction of sound was determined by the aid of the semi-circular canals. It seems, however, from clinical experience, that the direction of sounds is determined by the two ears acting together, for many patients have assured me that simultaneously with the loss of one ear, they have lost in great if not complete measure, the ability to tell from whence sounds came. It is probable that the two ears are not necessary for the determination of the quality of tones. If this be true, there is no advantage in binaural stethoscopes, other than that which may be gained by having both ears closed to distracting external sounds.

# CHAPTER XXI.

## DISEASES OF THE INTERNAL EAR.

Difficulty in Diagnosis.—Clinical and Pathological Advances.—Differentiation between Diseases of Middle and Internal Ear.—Nervousness and Nervous Deafness.—Symptoms of Primary Disease of the Cochlea.—Acoustic Neuritis.—Atrophy of the Acoustic Nerve.—Cases.—The Tuning-Fork in Diagnosis.—Deafness to Certain Tones.—Double Hearing.—Electricity.—Syphilitic Disease of the Cochlea.—Cochlitis.—Cases.

With our present knowledge, any discussion of the diseases of the internal ear, is based upon a less secure foundation of pathological and clinical experience, than is the case in the consideration of diseases of the external and middle ear. Until the greater questions in the physiology and anatomy of the labyrinth are positively settled, we cannot be sure of our classifications of disease. But the great barrier to our accurate knowledge of diseases of the labyrinth—such a knowledge as we have in studying the affections of the optic nerve and retina—is found in the fact, that the otoscope as yet only enables us to see the tympanum and mouth of the Eustachian tube, while the otoliths, the semi-circular canals, and the whorls of the cochlea remain hidden by an apparently impenetrable bony case. In spite of all this, clinical and pathological study, are slowly giving us access to what was once as much a maze to the therapeutist, as to the anatomist. A certain class of diseases of the internal ear, can now be made out with as much accuracy as diseases of the heart, lungs, or kidneys. We can, in some instances, even classify the diseases of the semi-circular canals and cochlea, for some of them are to be plainly distinguished.

In this chapter, then, I shall endeavor to set forth in a simple manner, how we may, in many instances, differentiate between diseases of the middle and internal ear. It is not long since the average description of diseases of the tympanum and Eustachian tube, assumed that they belonged to the internal ear, for all the parts beyond the membrana tympani were classified as internal. It is a great step forward, to have clearly separated the middle ear from the labyrinth, the real internal ear. I have

no doubt that before many years, medical science will as clearly separate the diseases of the two parts as it has its anatomy. There is much to be gained in practice, by a careful consideration of what is already known of the differential diagnosis of the diseases of the middle and internal ear, and I shall attempt to make this as clear as my experience and deductions from that experience, will permit. I wish it to be understood, however, that I believe we are but in the infancy of our knowledge of this subject. Just as explorations in an hitherto scarcely traversed country, have a great attraction for the enthusiastic traveller, so I believe, will the medical explorer find very much to interest him in the diagnosis of diseases of the labyrinth and acoustic nerve, for this field is the *ultima Thule* of aural territory.

The affections of the internal ear may be classified in a general way, as follows: *Primary* and *secondary* diseases. The latter class has been somewhat discussed in the various chapters on "Diseases of the External and Middle Ear." They are generally recognized, and do not often excite discussion. I will, however, speak of some of their symptoms again somewhat fully in this chapter, after the primary affections have been studied.

Primary affections of the auditory nerve, or what were called cases of nervous deafness, were at one time supposed to be very common. This was chiefly due to the teachings of Kramer and the preceding authors. Wilde and Tröltsch, gave us more correct notions as to the relative frequency of the diseases of the central apparatus, and proved that the diseases of the middle ear were more common than those of the labyrinth—that so-called nervous deafness was comparatively rare.

Clinical experience has, however, brought me more and more to the conviction, that the rebound from the ideas of Kramer, who at one time classified the majority of cases of aural disease under the head of nervous affections, to those of Wilde and Tröltsch, the latter author tracing almost all cases to an inflammation of the middle ear, has been excessive, and that there is a larger proportion of cases, which are primarily affections of the labyrinth than has generally been believed by the profession for the past twenty years.

Before I discuss the symptoms and causes of affections of the nerve of hearing, a few words may be proper, as to what in general terms is understood by impairment of hearing, dependent upon disease of the central apparatus, or by nervous deafness.

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 auditory nerve is at all affected. There are certainly no symptoms of derangement of the auditory nerve, in the general debility, unsteadiness, and anxiety that are popularly denominated nervousness. Affections of this nerve make the subjects deaf, and sometimes cause them to stagger in their gait, but they do not always render them nervous or unsteady in the ordinary acceptation of those terms. Besides, it cannot be said that nervous people are especially liable to deafness from lesions of the labyrinth, any more than they are to atrophy of the optic nerve. On this point Mr. Hinton[1] 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 especially in the debilitated.

With this view I am in full accord. So-called nervous people are not especially apt to have a disease of the acoustic nerve, but their impairment of hearing often depends upon chronic inflammations of the tympanum, its ossicles, muscles, and lining membrane. The nervousness in some instances results from the distressing tinnitus, and the impairment of hearing, for there is no affliction more depressing than impairment of hearing. There are, however, symptoms more or less objective, that enable us to diagnosticate with tolerable exactness a disease of the internal ear. It is not wholly an undiscovered country.

### PRIMARY DISEASE OF THE COCHLEA OR OF THE TRUNK OF THE ACOUSTIC NERVE.

There is one symptom of this affection that is pathognomonic, and that is absolute deafness. There is no disease of the external ear, and none of the middle ear, I think, which will make a patient deaf to all sounds. No matter what may be the pathological condition, how firmly the auditory canals or tympana may be plugged, sounds conducted through the bones will still be heard; but when the cochlea and the vestibule with their contents are destroyed, no vibrations are perceived, and absolute deafness exists. But such cases are very rare. There are very few absolutely deaf persons in the world. Hence this pathognomonic symptom is seldom observed. When it is, of course a diagnosis is easily made. But the labyrinth may, I believe, be invaded by disease, and even the terminal filaments of the

[1] Nervous Deafness. Reprint from Guy's Hospital Reports, 1867.

nerve in the cochlea, or the nerve-trunk itself be diseased, and yet very considerable hearing remain. Reasoning by analogy, this would appear to be true, for we may have even advanced atrophy of the optic nerve and retina, and yet a fair degree of vision. It has been too hastily assumed, I think, that because considerable hearing power remained, therefore the cochlea could not be invaded. We must go much deeper in symptomatology than absolute deafness, if we desire to find the causes of disease of the acoustic nerve.

1. *The ability to hear the tuning-fork better and longer through the air than through the bones of the head, is a symptom of disease of some part of the labyrinth, either of the vestibule, the cochlea, or acoustic nerve.* But this symptom is not pathognomonic of primary disease of the labyrinth. It is always found when the labyrinth is invaded, but in many instances it is a temporary phenomenon dependent upon abnormal pressure exerted upon the labyrinth by the ossicles or the drum-head. If we add to the above symptom the word constantly, so that it shall read, the ability to *constantly* hear the tuning-fork better through the air than through the bones, we shall be nearer to a definition of a symptom of primary disease of the cochlea. Even then we must exclude cases where the pressure has become permanent, and where, after all, the disease of the labyrinth is secondary to one of the stapes bone, or other part of the tympanum. This much we may say, however, that better aërial than bone conduction indicates either primary or secondary disease of the central apparatus of hearing.

2. *The ability to hear better in a quiet place, when all distracting noises are absent, is a symptom of disease of the labyrinth.* It must be taken, however, when applied to primary disease, with the same limitations as to constancy as the test by the tuning-fork.

3. *The ability to hear conversation relatively farther than the tick of a watch, is also a symptom of disease of the cochlea or nerve.* These symptoms, namely better aërial than bone conduction, better hearing in a quiet place, relatively better capacity to hear the human voice than the tick of a watch, when found grouped together in the same patient, to my mind unmistakably stamp the case as one of disease of the acoustic nerve. It will be observed that I have said nothing of vertigo, of double hearing, of incapacity to hear one's own voice, which are generally considered to be symptoms of disease of the labyrinth. I have purposely omitted any enumeration of these more marked symptoms at this point, for I would like to impress upon my readers my belief that there is a class of cases of affec-

tions of the cochlea, or vestibule, or trunk of acoustic nerve, whether of one or of all, I do not pretend to know, which have no very marked symptoms, such as absolute deafness, vertigo, or double hearing. I will give instances of these in this chapter, and will lay stress upon them, for these cases, if I am right, are constantly mistaken for disease of the middle ear. It is from a long series of investigations, that I have come to the conclusion that such cases are more common than has been before believed.

I ought also to say, that in diseases of the labyrinth, noise not only impairs the hearing power, but it often also distresses and annoys the patient, whereas persons who are very deaf from disease of the middle ear, are delighted when they can be in a noise.

To repeat, whenever the following train of symptoms occurs in a case of impairment of hearing, I believe we may conclude, in the light of our present knowledge, that we have to do with disease of the internal ear.

1. *Tuning-fork* $C^2$ *is heard better through the air.*
2. *Hearing is better in a quiet place.*
3. *Conversation is heard relatively better than a watch.*
4. *Noise is annoying to a more marked degree than is usual to people who hear well, or to those who are deaf from disease of the middle ear.*
5. *Inflation of the tympanum renders the hearing worse.*

To make a clear diagnosis these symptoms must exist together. I will not deny that some cases with this chain of symptoms, may be secondary affections of the sensory apparatus, although I think these symptoms generally indicate that the primary lesion is in the labyrinth. It is no proof that a disease of the ear is situated in the tympanum, because the drum-head has not a normal appearance. I think this fact has been lost sight of, and that occasionally cases of disease of the nerve have been put down to the middle ear simply because a drum-head was sunken or opaque. How few so-called normal membrana tympani are to be found, only he who has searched for them among people with good hearing power, can certainly know. A disease of the tympanum in childhood may leave its traces upon the membrana tympani without sensibly impairing the hearing power. The condition of the ossicles and of the lining of the tympanum have the most to do with determining the hearing power, when the nerve is sound. To them and not to the drum-head should we look for information as to the middle ear. Besides, changes may occur in the drum-head, secondarily to disease of the membranous labyrinth and trunk of the acoustic nerve. Disease may travel outward as well as inward

## CASES ILLUSTRATIVE OF PRIMARY DISEASE OF THE ACOUSTIC NERVE, ACOUSTIC NEURITIS, OR ATROPHY OF THE ACOUSTIC NERVE.

CASE I.—I. P. H——, aged fifty-nine, farmer. Sent by Dr. G. W. Holmes, April 26, 1880. The patient thinks he has been growing hard of hearing for a year. The son (Dr. H.) believes that this period could be extended back to three or four years. He has some tinnitus, but this symptom does not seem to be a marked one. His ears have never received any treatment. He hears the watch R. $\frac{c}{48}$, L. $\frac{c}{48}$; my voice, in a room fifty feet long, twenty-five feet. The aërial conduction is said by him to be twice as loud as that through the bones. He has large auditory canals. Both membranæ tympani are depressed. The light spots are fully formed. There are opacities at the margin. Common air and vapor of chloroform, used by my attachment to Politzer's bag, redden the drum-heads, but the patient does not feel them enter the drum, nor does the hearing improve after the ears are inflated.

The points in favor of a diagnosis of disease of some part of the labyrinth or acoustic nerve in this case, to my mind are:

1. The lessened conduction by bone.
2. The fact that although his ears have never before been inflated, no improvement results from forcing air into the tympana.
3. The voice is heard much better relatively than the tick of a watch.

Those who are inclined to make a diagnosis of disease of the middle ear from the appearance of the membrana tympani alone, will perhaps make one in this case.

CASE II.—Mr S——, aged forty six, sent by Dr. E. Dupuy, October, 20, 1880. This patient is a large, well-developed man of great intellectual activity, who is engaged in great enterprises in the Western States. He leads a very irregular life, eats very rapidly and very much, takes long journeys very often, but he is not intemperate in the use of alcohol or tobacco. He began to have attacks of vertigo and nausea five years ago, so that he would be obliged to lie down for hours. He had to lie on his back; could not turn on his side or his belly. He thinks he observed tinnitus and impairment of hearing after the first attack. Ever since his hearing power has been variable. *He hears worse in a noise; low tones are heard best; music is disagreeable.* He has no pain in his ears; the attacks of vertigo are growing less frequent. Has a sense of general dizziness. Sometimes he falls in the street. He has flatulent dyspepsia. He never has had any venereal disease. Says he has been prescribed for by "twenty aurists."

For the watch his H. D. is R. $\frac{p}{48}$, L. $\frac{0}{48}$; voice, three feet. The tuning-fork "C" is heard on the teeth "slightly;" not at all on the forehead, nor on any point of the skull, except on the tip of each mastoid. The aërial conduction is much better than the bone on each side. His pharynx is granular. Both membranæ tympani are somewhat depressed; they are not of good color, and the light spots are small. The air enters each ear by Politzer's method, and after inflation the H. D. on the left side is $\frac{p}{48}$; before it was $\frac{0}{48}$.

This I believe to be a mixed case, that is to say, one of the middle ear and of the labyrinth. But I believe the disease of the middle ear to be of slight importance, and not to be the cause of the great loss of hearing and the head symptoms. In this case my diagnosis is based upon:

1. The suddenness of the symptoms.
2. The fact that the patient hears worse in a noise.
3. That he hears low tones best.
4. That music is disagreeable to him.
5. And that the aërial is better than the bone conduction.

The variableness of his hearing power, which, however, is never good, as I found by several careful examinations, is due, I think, to the catarrh of the tympanic cavities and Eustachian tubes, which he undoubtedly has. I do not think the symptoms of labyrinthine pressure are secondary to those of the middle ear, because he has submitted at various times to *anti-catarrhal* treatment, with no marked benefit. Speculation as to the pathology of the lesion of the acoustic nerve is perhaps useless; yet I cannot but suppose that in this case either an inflammatory or a hemorrhagic exudation has occurred. There is no record that the patient's urine was examined. I think it was with a negative result. A regular life was advised for the patient, but this he declined, and I anticipate that I shall one day hear that he has succumbed to central disease.

Case III.—J. J. Mc——, postal agent, aged forty. Sent by Dr. Collins, March 11, 1881. When a boy suffered from tinnitus. Until one year and a half ago heard well. Attention was called to his impairment of hearing by his friends. *Does not hear as well on the railway cars as other people.* His occupation keeps him on the railway more than half of the time. It is worse when he is tired; appears to be in good health; never has had venereal disease; temperate. H. D., R. $\frac{0}{48}$, L. $\frac{0}{48}$.

Voice, about one foot from the ear, not well even there.

The bone conduction is somewhat better than the aërial on both sides; both are feeble.

Membrana tympani of right side is hyperæmic; there is no light spot. Left side *Mt.* is pale, and there is no light spot; pharynx normal.

In this case, there is, I think, disease of the middle and internal ears, but I think that of the labyrinth predominates, on the following grounds:

1. Inability to hear better, or even as well as ordinarily, in the noise of a railway carriage.
2. Feeble bone and aërial conduction.
3. Absence of nasal and pharyngeal symptoms.

I think acoustic neuritis has supervened upon a chronic non-suppurative inflammation of the middle ear; that he had an

affection of the middle ear in childhood is shown by the testimony as to tinnitus, and the appearance of the drum-head.

Then again, the tuning-fork, although feebly heard through the air as well as through the bones, is rather better heard through the bones than the air. But that he had serious disease of the acoustic nerve is, I think, indicated by the fact that he not only did not hear better in the noise of a railway carriage than when in an ordinarily quiet place, but that he heard worse than people in general. The hyperæmic drum-head unattended by pain indicates, I think, hyperæmia of the whole apparatus, and I would classify this also as a mixed case, but one in which the nerve was predominantly and chiefly affected.

Case IV.—J. S——, lawyer, aged fifty-eight. Ten years ago the patient observed that he could not hear distinctly. He suffered also from "catarrh." He hears no better in a car or carriage. His sense of taste and smell are defective. His throat and nostrils have been treated a great deal, but he grows slowly worse. His hearing distance for the watch is $\frac{\text{Pressed}}{4\ 8}$ on each side. He hears conversation very well, in a quiet place, when it is addressed to him. The aërial conduction is better than that through the bone on each side. Both drum-heads are opaque, and the light spots are small.

Case V.—Mrs. L. X——, aged fifty-one. Has had much trouble during the last year, and has grown very "nervous." She also suffers from tinnitus aurium, but she does not consider herself hard of hearing, for she hears conversation easily. Is very anxious, fears she will have serious head trouble. Hearing distance $\frac{\text{Laid}}{4\ 8}$ on the right side, on the left $\frac{1\ 2}{4\ 8}$. Aërial and bone conduction are about the same on the right side. Aërial louder than bone on the left. The right auditory canal is eczematous to a slight degree. The right membrana tympani is opaque. The left is also, and there is a small light spot. The pharynx is normal. The patient has been treated through the nose and throat without benefit.

It is useless to multiply these cases. They are not rare, but they are commonly supposed to be cases of catarrh of the middle ear. They are, I believe, actually affections of the acoustic nerve or labyrinth. What their nature is, more exactly than this, I cannot say, but I suspect some of them to be cases of acoustic neuritis, and that they finally end in atrophic changes. I know of no local treatment that is of any use. What may be done by the injections of pilocarpine is yet to be shown. Politzer uses a two per cent. solution of the muriate subcutaneously. He injects four drops of this solution at first, and gradually increases the dose to ten drops daily. If the results are no better than those obtained by the hypodermic injection of strychnia in atrophy of the optic nerve, not much is to be expected from the remedy. Yet the prognosis in this class of cases is not so

bad as in a slowly advancing case of catarrh or of proliferous inflammation of the middle ear. The disease generally occurs after middle life, and I think many of the patients preserve the power to hear conversation addressed specially to them, lectures, sermons, and so forth, up to an advanced age. They hear badly in a theatre, however, where the dialogue is animated. Persons who, after middle life, lose much of their hearing from disease of the tympanum and Eustachian tube, soon become unable to hear conversation, and are much more disabled than those who suffer from chronic acoustic neuritis or atrophy. It is possible that there is a failure of the power of the tensor tympani and of the stapedius muscle in advancing life, which renders it impossible to properly regulate or focus, so to speak, the sound image upon the terminal apparatus. In such cases the patient's hearing for his *range*, is as good as that of those with active muscles, and young crystalline lenses. There may be indeed a presbykousis as well as a presbyopia, but these cases may be distinguished from those I am attempting to describe.

*Treatment.*—The treatment of acoustic neuritis, or atrophy of the chronic form, should be based upon the general condition and habits of the patient. Care and worry, indigestion, the menopause in women, will often be found to be at the origin of them, and no special treatment can be undertaken until each case is studied by itself. But inflation of the ears and active treatment by the Eustachian tube, invariably make these people worse, and such means are to be strictly avoided.

### POSITIVE SYMPTOMS OF DISEASE OF THE LABYRINTH.

From the report of recent cases treated by the muriate of pilocarpine, I am greatly inclined to give this drug a further trial. I am also disposed to hope for something from it in cases of disease of the middle and internal ear, from the very good results I have had from its use in choroiditis. It is best used hypodermically, using six to ten minims of a two per cent. solution at bedtime. It is necessary to produce considerable diaphoresis and to continue the treatment, occasionally allowing interruptions of two or three days, for four weeks.

When *absolute deafness* exists, we certainly have disease of the acoustic nerve. We may, it is true, have mere impairment of the hearing, and yet find disease of the labyrinth ; but if the deafness is absolute, or nearly so, we must conclude that the essential part of the organ of hearing is invaded. It is a very rare thing, indeed, that the impairment of hearing from disease of the middle ear becomes so profound that words spoken into the

ear through a tube cannot be distinguished; but in many of the cases of deafness from cerebro-spinal meningitis, from fevers, from apoplexy of the labyrinth, from injuries, no words, however conducted to the ear, can be made out by the patient, he cannot hear his own voice, and total deafness, not merely great impairment of hearing, exists. The auditory nerve may have some perception of sound in these latter cases; but these perceptions can only be compared to the flashes of light seen by amaurotic patients.

This is in accordance or in analogy with what we observe in diseases of the eye. When absolute blindness occurs, we know that we are dealing with an affection of the central or perceptive apparatus. Opacities of the cornea, cataract, iritis, do not destroy the perception of light. This is only done by diseases of the retina, optic nerve, or brain.

### SYMPTOMS OF DISEASE OF THE MIDDLE EAR AND LABYRINTH.

Other symptoms of disease of the internal ear, such as vertigo, nausea, vomiting, tinnitus aurium, double hearing, are also seen in affections of the middle ear, when the nerve expansion in the labyrinth is involved by undue pressure. A staggering gait, or loss of equilibrium, is also a symptom of disease of the internal ear, and especially of the semicircular canals. But even when this symptom occurs, it is not possible to determine from it alone whether the disease of the internal ear is a primary or secondary affection.

### THE TUNING-FORK.

As I have repeatedly said, the tuning-fork is very valuable as a means of diagnosis in suspected nerve-deafness. As we have seen in the second chapter, the tuning-fork is heard more distinctly if the ear be stopped with the finger or the like, while the hand is placed upon the forehead or teeth. If a person be affected with disease of the internal ear, it is a clinical fact that such a stoppage of the meatus does not usually at all intensify the sound of the tuning-fork. Besides, if one acoustic nerve be diseased, while the other is sound, or if one be affected much more than the other, the tuning-fork is heard more distinctly on the sound or better side, just the contrary from what is found in disease of the middle ear.

If a tuning-fork (pitched in bass C) be placed on the vertex or on the mastoid process, and allowed to vibrate until the notes are no longer heard, and its prongs be then brought close to the ear, if the ear be normal the tone will be heard again. This is called Renne's positive experiment. According to Lucae, in

those cases of impairment of hearing, where the fork is heard again after having ceased to be heard on the vertex or mastoid, when placed close to the ear, there is disease of the internal ear. When it is not heard again there is disease of the external or middle ear. I have had some experience with this test, and I believe it to be a good one. But like many other methods of using the tuning-fork for a differential diagnosis, when employed alone, it is not sufficient to enable us to speak positively as to its diagnostic value.

At my suggestion, Dr. J. B. Emerson, Surgeon to the Manhattan Eye and Ear Hospital,[1] undertook the examination of persons with normal hearing power, by means of the tuning-fork. The results he obtained are a positive contribution to the subject. It is to the tuning-fork that I think we must look as yet, for that much-to-be-desired means of making a diagnosis between a chronic affection of the middle ear and a similar one of the acoustic nerve. Fifty persons with normal hearing were carefully chosen from a hundred, said to have normal hearing. Two forks were used, one 32½ ctm. long, with cylindrical prongs and handle giving a note more than an octave below the middle C. $C^1$ = 264 double vibrations. This tuning-fork is called "A," in Dr. Emerson's tests.

Another fork, about 17 ctm. long, with rectangular prongs and conical handle, giving a note one octave above middle C, and called "$C^2$" = 528 vibrations.

The average duration of time in seconds during which these forks were heard is shown by the following table. The table was made up from fifty cases of persons who had no disease of the ears.

"In every case the A fork was *louder* when heard through *bone*, and the $C^2$ fork, when heard through *air*.

"The average *duration* in seconds was as follows:

| | |
|---|---|
| "A fork— | |
| Air conduction | 31 |
| Bone conduction | 18 |
| Excess in air conduction | 13 |
| "$C^2$ fork— | |
| Air conduction | 36 |
| Bone conduction | 16 |
| Excess in air conduction | 20 |
| "A and $C^2$ forks— | |
| Air conduction | 34 |
| Bone conduction | 17 |
| Excess in air conduction | 17 |

[1] The complete paper will be found in the Archives of Otology, Vol. XII., p. 63.

"A and $C^3$ are both heard *longer* through aërial than through bone conduction.

"The difference between air and bone conduction is less for the A note than for the $C^3$ note; A being heard about 1.75 times longer through *air* than through *bone;* while $C^3$ was heard about 2.25 times longer through *air* than through *bone.*

"For both A and $C^3$, the average duration is twice as long through the air as it is through the bone."

Dr. Emerson also examined fifty persons suffering from disease of the middle ear, with the same tuning-fork, and he concludes as follows:

1st. Relying on the statements of patients in regard to the *loudness* of tuning-forks, as a test in ear troubles, will lead to error unless account is taken of the fork used. As a rule, in normal ears high notes are heard louder through aërial conduction, and low notes louder through bone conduction. This is true also, to a limited extent, in diseased ears, as verified by the thirty-nine cases cited.

2d. The relative duration of aërial and bone conduction is a better test. In normal ears, in all cases the tuning-fork is heard *longer* through air than through bone, the proportion being greater for high than low notes; and for the *middle* C ($C^3$) it should be heard about twice as long through air as through bone, the average duration in my cases being for bone seventeen seconds, and for air thirty-four seconds. Any *marked* departure from this indicates disease.

3d. In external- or middle-ear disease this proportion is reduced, and in well-marked cases the average bone conduction remaining the same or being increased, the aërial conduction will be reduced until it becomes equal to, or much less than, bone conduction. In one hundred ears tested, the average duration was for bone seventeen seconds, for air thirteen seconds, or 1.3 longer through bone than air. This reduction obtained also in the thirty-nine cases in which air conduction was louder than bone, the average duration in those ears being equal.

4th. When the bone conduction is longer than aërial conduction, and yet much less than the average duration of bone conduction for normal ears, it is an indication not only of middle-ear trouble, but that the nervous apparatus is involved.

5th. If the proportion between bone and air remain the same, and the hearing power much lowered, it is probably an indication of disease of the internal ear. Air conduction markedly exceeding bone conduction, the bone conduction may be entirely lost, and yet air conduction continue to a limited extent.

The two following cases illustrate this:

Case I.—Mr. ——, aged forty-five. Chronic alcoholism. H. D., Right ear, $\frac{8}{48}$; A tuning-fork heard louder through bone, $C^2$ louder through air; duration of A tuning-fork through air, thirty seconds; duration of $C^2$, forty-five seconds; duration of A through bone, twenty seconds, of $C^2$ through bone, twenty-five seconds. Left ear, $\frac{8}{40}$; A tuning-fork heard louder through bone, $C^2$ heard louder through air; duration of A through air, thirty seconds, of $C^2$ through air, forty seconds; duration of A through bone, fifteen seconds, of $C^2$ through bone, fifteen seconds.

Case II.—Mr. ——, aged twenty-three. Meningitis. H. D., Right ear, $\frac{3}{40}$; A heard louder through bone, $C^2$ through air; duration of A through air, ten seconds, of $C^2$ through air, twenty-five seconds; duration of A through bone, three seconds, of $C^2$ through bone, five seconds. Left ear, $\frac{8}{40}$; A heard louder through bone, $C^2$ through air; duration of A through air, ten seconds, of $C^2$ through air, twenty-five seconds; duration of A through bone, five seconds, of $C^2$, ten seconds.

It is from experiments such as these, and long experience with patients, that I have come to the conclusion that the best method we have of diagnosticating or of assisting in the diagnosis of doubtful cases of disease of the internal ear, is the tuning-fork "$C^2$," generally known as "C," the second one described in Dr. Emerson's tests. *If the tuning-fork "$C^2$" be heard louder and longer through the air when placed near the ear, than it is when placed on the mastoid process, we probably have a disease of the nerve, while if it be heard better through the bone, we have disease of the middle or external ear. For the sake of brevity, we may say, if, in cases of impaired hearing, aërial conduction be better and longer than bone conduction, we have disease of the internal ear. If bone conduction, be better than aërial, there is disease of the middle or external ear.*

The test with musical tones of various heights is of importance in detecting partial defects in hearing tones, but it cannot be relied upon as an exclusive test, as some authors are disposed to make it.

Galton's whistle is a good means of testing the capacity for hearing high or low tones.

In some cases of disease of the middle ear, of one side, the aërial conduction disappears entirely, and the conduction through the bones is so intensified by the blocking up of the tympanum and the rigidity of the ossicles, that when the tuning-fork is placed upon any of the bones of the skull, even upon the mastoid of the sound side, its vibrations seem to the patient to proceed from the diseased ear.

### DEAFNESS TO CERTAIN TONES.

If Helmholtz be correct in his theories, 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 per-

sons were unable to hear the chirping of a cricket, which is the highest tone known. If we accept the theory of Helmholtz, that Corti's organ in the labyrinth is a resonance apparatus, and that individual fibres of the auditory nerve in the cochlea are tuned for certain notes, the pathology of such cases becomes clear. It should be remembered, however, that this symptom, as well as double hearing, like tinnitus aurium, may be merely secondary to an affection of the middle ear, which causes pressure upon and hyperæmia of the cochlea.

### DOUBLE HEARING.

One of the first, if not the first, accounts of this phenomenon, is by Sir Everard Home, who described it in an article on "The Membrana Tympani."[1] His case was that of "a music master" who perceived a confusion of sounds in his ears after catching cold. He discovered that the pitch of one ear was half a note lower than that of the other ; and that the perception of a single sound did not reach both ears at the same instant, but seemed as two distinct sounds following each other in quick succession, the last being the lowest and weakest.

Mr. Home naïvely remarks that "this complaint distressed him for a long time, but he recovered from it without any medical aid." This was a case of true double hearing, corresponding fairly well to double vision. Since then cases have been reported by Gruber,[2] Moos,[3] Knapp,[4] S. M. Burnett,[5] myself, and others. In Knapp's case the patient heard all tones of the middle octave of a piano two tones higher than in the sound ear. The ear was affected with suppuration of the tympanum. Burnett's case was also that of a professor of music, who observed that an A tuning-fork, when held before the right ear, sounded from $\frac{3}{8}$ to $\frac{1}{2}$ a tone flat. Ten years after he observed that the same fork, when held before the same ear, sounded one tone higher. His hearing distance was $\frac{1}{18}$ for the watch, and the membrana tympani was healthy in appearance. This patient seems to have been unable to detect this false hearing of one ear, unless he held a tuning-fork before the meatus. It was consequently rather a curious phenomenon than a source of annoyance to the subject of it.

It will be observed that the cases of Home and Knapp are instances of true double hearing—that is, two distinct sounds were heard simultaneously, one true and the other false. This is diplakousis, to which the addition of an adjective, *binauralis*, is

[1] Transactions of the Royal Society, 1800. [2] Lehrbuch, p. 626.
[3] Klinik der Ohrenkrankheiten, p. 319.
[4] Transactions of the American Otological Society. 1871.
[5] Archives of Ophthalmology and Otology, vol. v., p. 527.

only confusing. Burnett's case is one of false hearing. When the true notes are heard and then a false one, or when the last notes are repeated or echoed, we should speak of echo-hearing.

Double hearing and echo-hearing exist very often as symptoms of pressure upon the labyrinth from disease of the middle ear, or possibly from independent disease of the labyrinth, but such symptoms are generally complained of only by people of good musical education, and affect only the higher notes of the scale.

Sometimes the same condition prevails in both ears, and all notes are heard false. This should also be called echo-hearing.

In 1877 I saw and treated, for a short time, a patient who presented the following curious phenomena of hearing: With the right ear he can hear the high notes of a piano better than the low ones; in walking on the sea-shore he hears the crickets in the grass, but not the roar of the waves; he can hear the chirping of insects and the movements of their bodies easily; the tick of a watch is heard normally, $\frac{4}{4}^{8}$, and yet he cannot hear the tones of the human voice at all well. With the left ear, whose hearing distance for the watch is but $\frac{1}{4}^{8}$, the power of hearing conversation is so good that the patient, a young man of seventeen, carries on his studies at college with no particular difficulty.

*Acute Suppuration of Right Middle Ear—Hyperæmia of Labyrinth of Same Side—True Double Hearing.*—P. A. S——, aged twenty-five; pianist. October 18, 1875. Seen with Dr. E. G. Loring. This patient is suffering from an acute inflammation of the right middle ear, presenting the usual symptoms, but he also presents the phenomenon of so-called double hearing. In striking any musical instrument—piano, organ, or violin—he hears the half-note above in addition to the one struck. *He hears both notes together.* The false note gradually dies out, leaving finally only the sound of the note struck. He observes this when both ears are open, and when the sound one is closed. He has never tried closing the diseased ear. This phenomenon lasted about three weeks. It disappeared gradually, the false note being nearer and nearer to the true one, until it finally blended with it.

At my request this patient sent me an account of his case, which is here reproduced.

About the year 1851 (when only one year old), I was taken sick, and I ailed for about twelve or fourteen months, but I recovered. As long as I can remember back, I complained of my hearing; the left ear was all right, but it seemed to me that I could have done just as well without the right; hearing with one and hearing with both was all the same thing.

My parents took me to a physician, who cleaned and syringed it for me, but nothing else was done to it. When I was about six years (that is, after this physician had cleaned it), it began to discharge a little. It really did stop running, but the hearing never improved. I studied music, and could always boast

of as true an ear as any musician could wish for. In the autumn of 1874 I went to Germany to improve myself further in my profession, and one morning, sitting in a Leipzig Gewandhaus-Concert (this was in January), I felt a tickling in the defected ear, and to my surprise it had discharged again. I went at once to Dr. M——, who told me, "the drum of the ear was almost gone, and it had been an old complaint, but the running he could stop easily." He gave me some ear-drops, which had no effect on it at all. Then I had no pain. In July I returned to America. In August (the month after) I experienced the first pains; the inside, the whole frame and cheek-bone felt as if it would split. That time I came under the treatment of Dr. Loring, who then told me, "the drum was entirely gone." He stopped the pain, and the running also diminished, and I had good hopes of its being well soon. I kept on syringing with warm water and putting in ALUM, SODA, SALT, NITRATE OF SILVER, etc., as the Doctor saw fit to use. One day in December, 1875, the same old pain (which had kept me awake many a night) came back again, and to my astonishment found that my hearing was affected in the most alarming manner. Any sound that struck the ear felt as if I had got a box on the ear, but what most frightened me was that I heard incorrectly. For instance, when I struck *C* on the piano, I would hear this very *C;* but in addition I heard the C sharp, which is just half a note above. Now imagine my confusion; by striking the common chord of C (C, E, G), I not only heard this, but at the same time C♯, E♯, G♯, being the common chord of C♯. I feared very much I would have to give up my profession and take hold of some other occupation, which, I believe, would have been enough to drive me crazy.

At first these two notes (or chords) would sound about equally loud and keep sounding wrong until both died away, but after a week or so this wrong note C♯ would sound like a perfect C♯ only at the instant of the key of C being struck, but gradually as the sound diminished and the vibrations became fewer, this C♯ would get lower until, when the note became quite faint, I would at last hear nothing but the true C.

Playing on an organ this would not be the case, as the sound cannot be diminished in the same way as on the piano; there I would hear the wrong note, C♯, with the right one, C, as long as the sound could be heard.

On the violin it was worse yet (from the reason, I suppose, of its being nearer the head, and the notes being more acute). I could not for the space of four weeks play the violin at all, as I knew not when I played right or wrong, for on that instrument the wrong note C♯ predominated the one I should only have heard (C) by far. The C indeed sounded very faint. If anybody else played the violin, the wrong notes would not predominate quite so much.

With my own voice it was worse yet. If I played on the piano I could tell what notes I ought to have heard, but in singing I had no idea how near I sang the right note. So everything sounded double and confused.

The first time I became aware of this bad state was at an evening service at St. Luke's Hospital, where I played the organ. After service I told some one that the people had sung most awfully out of tune and something must also be wrong with the organ, when I was answered that the music had never sounded better. So playing on my piano, I found that my own hearing was the sole cause of these discords. I remained in this state for about two weeks. Then

instead of hearing a note with the additional HALF A TONE higher (C and C♯), I heard C and a note between C and C♯ (this tone cannot be produced on keyed instruments, only on strings); after a few days more the wrong note got to be nearer the right one, yet (perhaps $\frac{1}{8}$ above, and by and by $\frac{1}{16}$ above) still I heard both instantaneously. The harder I struck a key or note, the louder would the additional wrong one sound, but the better the ear got, the purer and clearer would my hearing be. At the end of about five weeks this haunting false note was quite gone, and ever after that I heard only the note I struck and nothing else, and now I attend to my profession, as well and cheerful as I can wish for.

*Deafness from Chronic Suppuration, Left Ear; Impacted Wax, Right Ear—Echo Hearing with One Ear.*—Miss L——, aged twenty. Had a discharge from left ear a long time ago, and has been deaf on that side since. Had a great deal of earache when small. Noticed impaired hearing in right ear about three weeks ago. Slight tinnitus at times, but no pain or discharge. No cause assigned. Since right ear has become deaf, she has been annoyed by "a disagreeable vibration like an echo" in her right ear, after singing a high note or hearing another do so. Has not noticed it in instrumental music. Does not sing herself higher than F or G.

H. D.—R., $\frac{12}{40}$, L., $\frac{2}{40}$.

Hears a whisper twenty feet with ease. Piano-test gives a negative result. Pharynx looks well. Has some impacted wax in both auditory canals. Drumheads are opaque. After removing wax and inflating ears, H. D. became—R., $\frac{40}{40}$, L., $\frac{5}{40}$. The echo disappeared on the same day, and two months after had not returned.

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, and, so far as my observation extends, tinnitus aurium is more frequent and disturbing in chronic disease of the middle ear, than in chronic affections of the labyrinth.

### PAIN AND SENSITIVENESS TO SOUNDS.

Pain is a marked symptom of acute inflammation of the membranous labyrinth. All affections of the acoustic nerve are, however, generally accompanied by extreme sensitiveness of the ear to loud, jarring, discordant, or even ordinary sounds. It is then necessary to keep the patient in a very quiet place. I have several times been compelled to order the patient away from the city to the quiet of the country. In all cases of this kind the auditory canal should be protected by plugs of cotton. Nausea, vomiting, and convulsions, as well as opisthotonos and delirium, may be symptoms of labyrinth disease, as well as of cerebro-spinal meningitis and of acute catarrh of the middle ear.

Voltolini 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,[1] 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, there is at least a strong suspicion 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. I have had very few opportunities of studying cases of cerebro-spinal meningitis, although I have seen a large number of deaf persons in whom the loss of hearing was said, upon good professional authority, to have occurred during the course of this disease. It is very much to be desired, for the clearing up of some points in the nature of this disease and its relations to the acoustic nerve and internal ear, that those who are accustomed to examine and treat cases of aural disease should have opportunities of seeing cases of cerebro-spinal meningitis in their acute stages. The bonds between specialism and general practice should be very close, if real advance in this or in other directions is to be made.

The symptoms of that form of inflammation of the membranous labyrinth that has been mistaken for cerebro-spinal meningitis, should be carefully considered in order that the practitioner may be able to clear up the doubts which have been thrown upon the existence of this disease. Gruber,[2] and Schwartze unite with me in believing that such a disease may occur. If we find a child suddenly taken with severe vomiting, which is followed by stupor or delirium, without paralysis, and with but slight opisthotonos, such as children have with acute otitis media, and if we see this child recover in a few days, except that it is absolutely deaf, and walks with a staggering gait, 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.

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[1] Monatsschrift für Ohrenheilkunde, Bd. I. and VI.

[2] Lehrbuch, p. 552.

## THE DIAGNOSIS OF DISEASES OF THE INTERNAL EAR BY THE MEANS OF ELECTRICITY.

In the former editions of this work considerable space was given to this subject, but I have become convinced that the conclusions of those who believe they were able to diagnosticate disease of the labyrinth by means of the galvanic current, are fallacious. I do not think it has yet been demonstrated that we determine the situation or character of a lesion in the ear, by means of electricity, and I do not advise the student of aural disease to concern himself with the various theories upon the subject.

I will now discuss some of the well known causes of primary disease of the labyrinth.

### DISEASE OF THE COCHLEA (COCHLITIS) FROM SYPHILIS.

Syphilitic affections of the middle ear are perhaps more common than those of the labyrinth. For example, in the course of the earlier symptoms, among which is pharyngitis, and so forth, we often have tubal and tympanic catarrh, which is not to be distinguished from an aural catarrh arising in the course of another disease, so far as the ear is concerned. There may be also in the course of the later periods of the disease, a syphilitic exudation into the tympanum, and about the ossicles. There is, however, a disease of the labyrinth and acoustic nerve occurring in syphilis. This disease has some characteristics of its own. It is analogous to certain forms of what are known as brain or nerve syphilis, such for example as lesions of the ocular motor nerves, and the medulla. I have given it the name of syphilitic cochlitis, simply because it seems plain to me that it is as well defined, as being chiefly a disease of the cochlea, as are certain affections of the semi-circular canals of the optic nerve and retina. The cases of diseases of the ear in inherited syphilis, which I have had the opportunity of studying, seem to me to be chiefly diseases of the peripheric and not of the central part of the organ of hearing. Just as we have disease of the cornea and iris as the more frequent lesions of the eye in congenital syphilis, so do we have tubal and tympanic catarrh, originating from the snuffles in infantile and congenital syphilis.

Mr. Hutchinson[1] is of the opinion that all the cases of aural disease occurring in the course of inherited syphilis, which he

[1] A Clinical Memoir on Certain Diseases of the Eye and Ear, consequent on Inherited Syphilis, p. 182. London, 1863.

inspected, are "due either to disease of the nerve itself or to some change in non-accessible parts of the auditory apparatus." I think that Mr. Hutchinson has not attached enough importance to the throat symptoms in his cases, and 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. After or during the course of the snuffles of syphilitic children, we are very sure to have catarrh of the middle ear. 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 Fifth 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——, aged twenty-nine, 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 fifth 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., $\frac{1\ 2}{4\ 8}$. 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 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 Politzer'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.

There are cases, however, of disease of the ear occurring as a result of syphilis, when all the marked symptoms are derived from the labyrinth. If diagnosticated at all early in their course, they are susceptible of relief and cure by the free use of mercury and iodide of potassium. My recent experience has been in such gratifying contrast to that which I had had when the first edition of this book was published, that I am very glad to report it for the purpose of illustrating what has just been said. In the cases now about to be quoted, I think we are perhaps justified in going a little farther in our classification than merely to state that there is disease of the labyrinth. We may, perhaps, diagnosticate disease of the cochlea, or at least say that the affection of the cochlea is predominant in certain cases, just as we may speak of disease of the semi-circular canals, when vertigo and staggering are the predominant symptoms. Syphilitic cochlitis may perhaps be a proper name for this class of cases.

Before quoting the cases in question, I will tabulate certain conclusions which afford a guide to the determination of the situation and character of the lesion where there is a doubt.

1. Disease of the cochlea, as of the other parts of the labyrinth, usually, although not always, manifests itself suddenly. The patient can definitely fix upon a time when he became deaf, and when he began to have *tinnitus aurium*. This is true even when one side only is affected. The one-sided deafness would not be so quickly recognized were it not usually accompanied by tinnitus, vertigo, and often by unsteadiness of gait. Sudden loss of hearing and the sudden occurrence of tinnitus, vertigo, and staggering, are not, however, entirely peculiar to labyrinth disease, since it is well known that we sometimes, although rarely, have the same symptoms in cases of inspissated cerumen and catarrh of the middle ear. They are therefore only of pathognomonic value in connection with the objective examination and tests.

2. The tuning-fork $C^2$ is heard more distinctly through the air than through the bones.

3. The examination of the membrana tympani and the employment of the methods for inflating the middle ear, will usually give us reasonable conclusions as to the situation of a given disease of the ear, so that at the least we may exclude collections of fluid in the tympanic cavity in making a differential diagnosis between disease of the middle ear and of the labyrinth.

4. The piano, or any very similar musical instrument, will

aid us in determining whether or not disease of the cochlea exists. The examination of cases that were unquestionably affections of the labyrinth shows that the power of appreciating low tones is the last to suffer, and the first to recover in most cases of disease of this part of the ear, so that these will be heard when the high ones are either not heard at all, or are heard "*false*" or doubled. From our present knowledge of the physiology of hearing, when these symptoms are present, we must conclude that the cochlea is the seat of disease, even if it be secondarily affected.

5. The diagnosis of *syphilis* of the labyrinth depends in a great measure upon the same kind of evidence as that from which we conclude that a case of optic neuritis or choroiditis is syphilitic; that is to say, the history and the presence of other symptoms such as an eruption, mucous patches, etc. It should not be forgotten, however, that the occurrence of labyrinth disease, in a person who has probably had the initial lesion of syphilis, even if no other symptoms are present, is a very suspicious circumstance, which should lead to a careful weighing of the indications for and against a mercurial treatment.

I prefer to say disease of the cochlea, instead of disease of the labyrinth, when the prominent symptoms, as in the cases now reported, are great impairment of hearing, the inability to hear certain tones, and the production of false ones. These are evidences, I think, of cochlear disease, whatever else we may have. Tinnitus is a symptom common to many forms of aural affections, while vertigo and unsteadiness of gait are chiefly to be referred to undue pressure from the base of the stapes upon the semi-circular canals, and not to disease of the cochlea. I think too much stress has been laid upon increased pressure upon this latter-named part of the ear, to the neglect of disease having its origin in the tone-perceiving apparatus—the cochlea. "Ménière's disease" has always seemed to me an unfortunate name, since it has been indiscriminately applied. It ought not to be used unless it refers to a case such as that in which a hemorrhage into the semi-circular canals was found. Of late, cases in which the cochlear symptoms are, at least, the predominant ones, are sometimes styled cases of "Ménière's disease," when they have very little in common with cases of hemorrhage. It is interesting to notice that we are always assisted in a diagnosis of supposed cochlear disease, if the patient have a musical education. I believe all the cases of double hearing that have been reported occurred in persons enjoying a musical training. Certainly other patients have had the same symptoms, but they have been unable to appreciate them. The power of hearing

certain tones can, however, be accurately tested in all patients except young children.

The pathological investigations of syphilis of the internal ear have not been numerous, but we are not entirely without them. Moos [1] reported a case of secondary syphilis, in which deafness, annoying tinnitus aurium, and osteocopic pains in the skull were complained of. The hearing was rapidly destroyed. Death. At the autopsy the right external and middle ear were found intact, sclerosis of the petrous portion of the temporal bone, periostitis in the vestibule and small-celled infiltration of the membranous labyrinth, anchylosis of the stapes to the fenestra ovalis. Trunk of the acusticus unchanged.

Gruber has also reported a similar case.[2] Gruber's patient died of typhus fever. A post-mortem examination of the ear showed vascular injection of a high degree in the soft tissues of the labyrinth as well as thickness of these parts, in connection with marked hyperæmia of the mucous membrane of the tympanum. The patient, who was syphilitic, and who had been very slightly hard of hearing at times from catarrh of the tympanum, became suddenly absolutely deaf, with occasional attacks of vertigo when he first became deaf. The vertigo disappeared, but the deafness remained.

I have never believed that the affection which I have denominated cochlitis involved the cochlea solely, but that it affected that part of the ear predominantly, just as a patient may have severe hyperæmia, and even inflammation of the external auditory canal, quite secondary to the main trouble in the middle ear.

It would be very convenient indeed, if we could separate diseased parts from each other by a line as distinct as that in facial erysipelas, or, to use a geographical comparison, as marked as the separation of Mexico from the United States by the Rio Grande; but to give the exact line of demarcation in disease is very often impossible. It must be named from the predominance of the symptom in certain parts or organs.

### CASES.

Case I.—*Sudden Loss of Hearing and Tinnitus—Primary Syphilis—Alopecia-Eruption—Anti-syphilitic Treatment—Cure.*—W. M——, aged thirty-seven. The patient states that five weeks ago, on one particular day, he observed that his hearing was impaired and that he had a noise in his ears. From that time to this he has grown worse. He also states that his hearing is worse at night.

[1] Medical Record, from Centralblatt für Chirurgie, August 19, 1877, from Virchow's Archives.

[2] Lehrbuch, p. 617.

About six months ago he had a chancre; three months later he had alopecia; and there is now a copper-colored papular eruption upon his wrists and arms.

Hearing distance: R., $\frac{0}{48}$; L., $\frac{\text{Laid}}{48}$.

The tuning-fork is heard better in the *left* ear. The pharynx is granular and in a hypersecretive condition. The drum-heads both show small light spots. The usual treatment for catarrh of the middle ears has been employed since the attack of tinnitus and the loss of hearing, but without success.

The patient was immediately placed upon anti-syphilitic treatment, which he carried out with but moderate faithfulness, but he began at once to improve. Two months after his tinnitus was relieved, and the hearing distance was: R., $\frac{\text{Pressed}}{48}$; L., $\frac{6}{48}$. After this he went under the care of Dr. Sturgis for other symptoms of syphilis, and he informed me that he heard very well.

Case II.—*Syphilitic Ulcer on Os Uteri—Loss of Hearing—Alopecia-Eruption—Recovery.*—Mrs. X——, aged thirty-one. April 8, 1875. Seven weeks ago this patient, who was brought to me by her husband, a physician, began to observe an impairment of hearing, accompanied by a dull pain and by tinnitus.

Hearing distance: R., $\frac{12}{48}$; L., $\frac{4}{48}$.

The husband, and the note of a physician who had supervised the treatment of the patient, state that she had not been well since the birth of her child in August last, when an abrasion (syphilitic?) was found on the *os uteri*. This, the husband says, was probably produced by infection from his own finger, upon which was the initial lesion of syphilis, contracted in attending a case of labor in a syphilitic patient.

The symptoms from which Mrs. X—— suffered before the loss of hearing were neuralgic pains about the eyes, hyperæmia of the optic disks, papular eruption on the chest, and alopecia. There are now traces of the eruption, and the patient has a poor appetite, pains in her legs, and some neuralgia about the eyes. The treatment was anti-syphilitic in the beginning, but has not been very thoroughly carried out of late. The pharynx is granular, and the left drum has no light spot. The usual treatment for catarrh of the middle ears has been pursued to some extent, but with no benefit, for the aural symptoms are increasing.

A thorough anti-syphilitic treatment was undertaken, and, according to a note from the husband and a verbal communication from the physician who first observed the case, the patient progressed steadily to recovery under this management. No local treatment was used after the case was seen by me. I hardly think general treatment would have been sufficient had the tympanic disease been predominant.

Case III.—*Venereal Sore—Loss of Hearing—Vertigo—Double Hearing—Recovery.*—Mr. U——, aged thirty-three. August 30, 1876. The patient states that toward the end of last June he observed dulness of hearing and tinnitus in both ears. Soon after he discovered that he was totally deaf as to the left ear, and the right ear has been gradually growing worse.

On August 1st he began to have attacks of vertigo and staggering, and has had several since. He had a venereal sore on his penis about February 15th, and says he had mucous patches in his mouth and throat about the middle of March.

Hearing distance: R., $\frac{0}{40}$; L., $\frac{0}{40}$.

He hears words when spoken distinctly *into* the right ear. The drum-heads

are both dull in color and have no light spots. The air enters both tympanic cavities freely upon the employment of Politzer's method, and reddens the drum-heads, but causes no improvement in hearing.

A diagnosis of syphilitic disease of the labyrinth on both sides was made by my associate, Dr. E. T. Ely, who saw him first; and after the patient had seen Dr. E. L. Keyes in consultation, he was put upon a course of inunction with the oleate of mercury, mercurial baths, and iodide of potassium internally, in steadily increasing doses.

On September 9th he was already better. He could hear the voice much better; the attacks of vertigo continued, but there was no more staggering.

A more complete examination showed some peculiar symptoms which throw some light upon disease of the cochlea, and which are therefore now detailed. The noises of the street *jar* the patient's head very unpleasantly. He cannot distinguish sibilants—*s* sounds like *f*, etc. The notes of the piano become discordant at fifth C. They do not sound *double*, but *false*. In the higher notes the seventh note sounds more like the octave than the octave itself.

September 12th.—There is a little more improvement in the hearing. He hears notes truly about an octave higher than on the 9th. When an upper note is struck he also hears with this the half note above. He still complains of the unpleasant effect of the noisy streets. The drugs have been steadily continued, and with no unpleasant effects. He is allowed to leave New York and go to the sea-side.

September 19th.—Patient now hears conversation with the right ear at ten feet. The left ear seems to have no power whatever. The dose of potash has now reached seventy-five grains three times a day.

October 5th.—Hears the voice at twenty feet with ease. All but the last two notes of the piano are heard correctly. In words *f* still sounds like *s*. Is taking one hundred and twenty grains potash at a dose three times a day. The patient fully recovered his hearing power for ordinary conversation, and resumed his profession. The recovery was confined to the right ear.

It is possible that we have not paid enough attention to the protection of inflamed or hyperæmic ears. Boiler-makers may protect their ears from the destructive hyperæmia caused by the concussions to which their work exposes them, by plugging the meatus; and telegraph-operators may suffer from an impairment of hearing induced by exposure to the continuous clicking of a telegraph instrument. In the case just reported, the patient experienced great relief from the change of residence from near the noisy pavements of New York to the quiet of the sea-side; and I believe where noise produces such a degree of irritation as was complained of in this case, we should carefully select a residence for the patient with a view to keeping him out of noise. In ophthalmic therapeutics a great deal of care is often necessary to protect the eyes from the light; and in acute aural disease, and perhaps in some forms of chronic affections, the same care should be exercised lest the ears be exposed to loud or continuous sounds.

CASE IV. is one that I saw at the Manhattan Eye and Ear Hospital, through Dr. E. T. Ely, who had charge of the patient at the Eastern Dispensary, and who diagnosticated disease of the labyrinth. Mr. L——, aged twenty-two. September 7, 1876. Complains that two days ago he was suddenly attacked by complete deafness in the left ear, accompanied by noises like "the blowing off of steam." These symptoms have continued, and he has also had slight vertigo and feeling of unsteadiness—most troublesome when he turns his face upward. He had a venereal sore on his penis two years ago, and subsequently sore mouth, falling of his hair, and iritis. Was treated for syphilis by reputable physicians.

Hearing distance: R., $\frac{18}{}$; L., $\frac{0}{}$. Tuning-fork heard only on the right side. Drum-heads somewhat sunken, with dull color and dull light spot. Air enters middle ears readily through Eustachian tubes, but it does not improve the hearing.

September 20th.—Patient has been treated for catarrh of the middle ears, without any benefit. Anti-syphilitic treatment was advised at his first visit, but he has refused it thus far.

The diagnosis in this case has not been subjected to the crucial test of treatment. Its syphilitic character cannot therefore be so strongly emphasized. Yet when a history of general syphilis is so distinct and a labyrinth affection occurs, I think we may safely conclude that the latter is at least *modified* by the venereal poison, if not actually caused by it.

CASE V.—*Syphilis—Sudden Deafness and Tinnitus—Symptoms of Disease of Cochlea—Benefit from Treatment.*—Mr. S——, aged twenty-eight. First seen March 24, 1877, with the following history: About one month ago he noticed deafness and tinnitus in the right ear, and, a few days later, in the left. Is not *sure* but that both sides were affected at the same time. Trouble advanced rapidly, and in three weeks he was so deaf that he "couldn't hear anything but loud noises." Never had any pain or discharge. Tinnitus at first was "like somebody tapping on a tumbler;" now it resembles "the wind blowing." Had some dizziness and nausea when first attacked. Never vomited. Never has noticed any unsteadiness of gait. Has no vertigo now, except when he runs or takes a very long stride in walking. Hearing is worse in a noisy place. Thinks he hears low notes better than high ones.

Had a chancre eighteen months ago. Gives no history of any secondary symptoms, except of "sores in his mouth." Has taken mercury and iodide of potash since a week after his aural trouble began, but without benefit.

Thinks he took cold a few days before his deafness began, as he had "a stiffness" of his neck and shoulders.

H. D.: R., $\frac{P}{48}$; L., $\frac{0}{48}$. Loud voice one foot behind back. Hears words, through speaking-tube, in each ear. Hears all notes of piano, but does not appreciate difference between low and high ones correctly.

Tuning-fork heard better on right side. Pharynx looks well. Has ulcerations on edges of tongue; Eustachian tubes pervious; no effect from inflation. Right drum-head pinkish, good light spot; left drum-head looks well.

*Diagnosis.*—Syphilitic inflammation of cochlea.

Was seen by Dr. Sturgis in consultation, who found "an undoubted history of syphilis," with objective evidences of the disease still apparent.

Patient was ordered to take a mercurial vapor-bath daily; daily mercurial inunction; iodide of potash, beginning with 60 grains a day, and gradually increasing.

April 6th.—R., $\frac{1}{48}$; L., $\frac{0}{48}$; voice, 2 feet.

April 13th.—R., $\frac{2}{48}$; L., $\frac{0}{48}$; voice, 2 feet R. E.; 6″ L. E.

April 21st.—R., $\frac{6}{48}$; L., $\frac{0}{48}$; voice, 4½ feet R. E.; 1½ feet L. E. Taking 339 grains iodide potash daily, with mercurial inunction each night.

May 25th.—R., $\frac{8}{48}$; L., $\frac{0}{48}$; voice, R., 8 feet; L., 4 feet. Taking 118 grains iodide of potash with 20 drops tincture iodine, three times daily. Inunction as usual.

June 4th.—R., $\frac{8}{48}$; L., $\frac{C}{48}$; voice, R., 4 feet; L., 3 feet. With face toward speaker, hears loud conversation 10 feet. Has always shown great difference in hearing power for different letters. Hears now *w* and *c* best.

June 25th.—R., $\frac{9}{48}$; L., $\frac{C}{48}$; voice, 6 feet right side; 4 feet left side. With back to speaker, hears loud conversation at 2 feet. Some sentences at 12 feet and more. Facing speaker, hears ordinary conversation easily at 4 feet, and some sentences at 20 feet. Has great difficulty with sounds of *m*, *n*, *b*, and *p*. Says he heard the crickets in the grass at the sea-shore but not the sound of the waves yesterday. Noises of street disturb him.

June 29th.—Left the city, with orders to continue treatment.

July 20th.—Writes that he has gained six pounds since June 29th.

August 12th.—Writes that he "hears everything quite naturally, except music." Sound of running water in ears continues. Gaining flesh and feeling remarkably well. Thinks his hearing is still improving a little.

The record of this case ends here for the present. The patient's highest daily dose of potash was 369 grains. The remedies agreed well with him, and only had to be interrupted a few times, for two or three days, on account of causing disturbance of the stomach. Inflation of the middle ears never produced any apparent effect.

Case VI.—*Syphilis—Sudden Tinnitus—Recovery.*—Mr. P——, aged forty-five. July 2, 1877. In July, 1876, noticed a ringing sound in his left ear upon arising in the morning. A few days later noticed the same sound in his right ear. The tinnitus has remained ever since, and has increased in intensity. In October he noticed that his hearing was impaired. The deafness has been increasing until three weeks ago, since which time it has appeared to remain the same. Has been treated for aural catarrh by two competent aurists (by one for a period of six weeks), without any benefit. Has been treated by electricity also, without benefit. Never had any internal medication. Has occasional dizziness. Health good in all other respects.

Had a chancre in July, 1876, before tinnitus was noticed. Sore appeared fourteen days after intercourse, healed slowly, and was accompanied by balanitis. Never has been aware of any secondary affection of any kind.

H. D.: R., $\frac{0}{48}$; L., $\frac{0}{48}$.

Loud voice, six feet at right side of head and twelve feet at left side. Tuning-fork heard alike both sides, as nearly as he can judge. All the notes of a piano "sound alike" to him. Band music sounds very discordant. General appearance of both drum-heads is healthy. Pharynx normal. Tubes open. No effect from inflation.

*Diagnosis.*—Disease of cochlea, both sides, of syphilitic origin?

Advised a half-drachm of twenty per cent. solution oleate mercury rubbed into skin daily, and iodide of potash in increasing doses, beginning with 5 grains three times a day.

August 14, 1877.—H. D., $\frac{P}{4\,8}$ both sides; heard conversation thirty feet behind back easily. R. E., notes of piano between sixth *c* and seventh *e* are not heard. Four uppermost notes heard naturally. L. E., notes sound natural up to sixth *g;* from there to seventh *e* they sound "all alike, and have no music in them;" above *e* they are natural again. Hears band music well now; before it was very discordant to him. Violin music is still discordant to him. His own voice sounds more natural to him. Is sure himself that he hears everything much better.

This patient left town at this time, expecting to return, but did not do so. The remedies disagreed with him sometimes, and he was unnecessarily timid about increasing the doses. He never took more than 42 grains iodide potash three times a day. A statement from this patient, in March, 1878, says that he considers himself well.

Case VII.—*Syphilis—Symptoms of Cochlear Disease—Slight Improvement.*—Mr. C——, aged thirty. Seen at Manhattan Eye and Ear Hospital. Patient was perfectly deaf so far as the voice was concerned. Could not hear the watch with which he was tested at all. The vibrations of the tuning-fork were also not heard. All communication with him had to be held in writing. He could hear finger-nails against the left ear after three weeks, and the tinkling of the street-car bells. In five weeks he could hear tuning-fork quite well with the left ear. Later he heard the watch $\frac{P}{4\,8}$ with the same ear. All his symptoms pointed to a disease of the labyrinth, and it was considered to be syphilitic. He had contracted syphilis a year before, and had been treated for it from the outset; still he had had secondary symptoms. Six months later he felt so well that he gave up treatment. Then he was taken with violent pains in his head, and observed impairment of hearing and tinnitus. In a week his hearing was "all gone." He resumed anti-syphilitic treatment, but the deafness and tinnitus have remained.

This patient was treated with mercury and potash in increasing doses, and carried out all directions faithfully for a long time. His general condition improved, but no change was evident in his hearing except that mentioned above. One day he came, saying that on the day before he had heard the word *Mexico*. On trial, he was found to hear this word every time it was spoken into his left ear. He did not hear any of the component letters of the word (as *x* or *o*) when spoken into his ear, nor was any other word ever found which he could hear. At this time he was taken with pulmonary hemorrhages, and specific treatment was stopped. He has been in failing health ever since.

It is undoubtedly true that affections occur in syphilitic patients (from suppression of the perspiration, for example), which would have occurred all the same had they not been syphilitic; and yet the exposure or imprudence having once caused the attack of inflammation, it immediately assumes the character of a syphilitic affection by reason of the syphilitic blood, whose

increased flow to the part and the exudation go to constitute the inflammation. The complete failure of the anti-catarrhal treatment, although all these patients showed some catarrhal symptoms, was another striking evidence of the real nature of the cases; for we seldom meet with cases of catarrh that do not respond to some extent to the use of the catheter, Politzer's method, and so forth, while in acute or sub-acute diseases of the labyrinth, this treatment often aggravates the symptoms.

# CHAPTER XXII.

## DISEASES OF THE INTERNAL EAR—(*Concluded*).

The Effects of Quinine.—Cerebro-spinal Meningitis.—Meningitis.—Disease of the Spinal Cord.—Parotitis.—Acute Inflammation of Membranous Labyrinth mistaken for Cerebro-spinal Meningitis.—Hemorrhages and Effusions.—Injuries.—Concussions.—Aneurism and Tumors.—Disease of Semi-circular Canals.—Pathology.—Treatment.

### THE EFFECTS OF QUININE UPON THE LABYRINTH.

In a paper read by me before the Society of Neurology and Electrology in April, 1874,[1] I classified four of the cases of disease of the internal ear then reported, as perhaps cases of congestion and inflammation of the base of the brain and labyrinth, caused by the internal administration of quinia. My remarks at that time led to a discussion, in which Dr. Jacobi and Dr. Hammond participated. To attempt a settlement of some of the questions involved, I undertook some experiments upon the human subject, as did Dr. Hammond upon animals. I believe these were the first experiments to determine the effects of quinine upon the ear. They have been followed by others, and considerable clinical experience has been published, as to effects of quinine upon the eye as well as the ear, so that the views of the profession are now clearer than before the subject was thus opened up.

I think large doses of quinine may cause temporary affections of the labyrinth, which are made known by tinnitus aurium and impairment of hearing. This congestion is not, however, confined to the membranous labyrinth, but it may also occur in the tympanic cavity and in the auditory canal. It is so well known that buzzing in the ear is caused by quinine, that many persons who are becoming gradually deaf from chronic catarrhal or proliferous inflammations of the middle ear, and who, 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 such patients have never taken

[1] American Journal of the Medical Sciences, vol. lxviii., p. 400.

quinine enough to cause, or even to cure any disease. I object, however, to the use of quinine in aural disease, in any considerable doses; for I have been convinced by experimental and therapeutical experience that it has a peculiar power of producing congestion of the ear. In 1874[1] I published a case, which is reproduced on page 168, which proves this. My experiments with quinine upon the healthy human subject were begun upon Dr. William A. Hammond May 7, 1874.

The optic papillæ and the membranæ tympanorum were the parts examined, as well as the ocular conjunctivæ and auricles. "The vision was normal, $\frac{20}{20}$. Refraction, emmetropic; pulse, 90; ocular conjunctivæ white, decidedly free from hyperæmia; palpebræ congested at outer and inner canthus. There was no tinnitus aurium. Membranæ tympanorum were entirely free from evidence of blood-vessels. (I will omit the details of the examination of the optic papillæ, since we are concerned only with the effect of quinine upon the auditory apparatus.)"

Dr. Hammond took gr. x. of sulphate of quinine at 8.30 P.M. At 9 P.M. the ocular conjunctivæ were congested at the outer and inner canthus; palpebræ conjunctivæ were markedly congested over the whole surface. There was no change in appearance of the drum-heads.

"10 P.M.—Head feels full; left ear rings; auricles burn; face is decidedly flushed; auricles are red, especially the lobe of right, where there is a localized congestion so marked as to resemble an ecchymosis. There is now a vessel along each malleus. The optic papillæ are pinkish from apparent enlargement of lateral vessels.

"10.30 P.M.—Right drum-head is very much injected along the handle of the malleus and the upper margin; left is less red, but still shows vascular injection. Both papillæ are pink, left more so than right; face flushed, eyes suffused, ocular conjunctivæ decidedly congested, slight headache, tinnitus in both ears.

"11 P.M.—The redness of the auricles is diminishing, especially the circumscribed spot on the lobe of the left one; the face still flushed; tinnitus continues; no headache; subject feels exhilarated; drum-heads still injected along the malleus; vision normal."

It should be said that Dr. Hammond, the subject of these experiments, is a very large and well-developed man, and that he smoked a mild cigar during the evening.

On May 28, 1875, I repeated the experiment upon Dr. E. T. E——, aged twenty-four, a man of about five feet six inches

[1] Transactions of the American Otological Society.

in height, well developed, in good health and vigor. He stated that he never had had otitis. The hearing distance is $\frac{48}{48}$ on each side ; refraction emmetropic. He has no tinnitus aurium. The drum-heads are free from vessels, and normal in appearance ; optic papillæ normal. At 11.05 A.M. Dr. E—— takes gr. x. of sulphate of quinine. At 11.35 there is a very fine vessel along the right malleus ; no change in the left. At 12.30 there is some redness at the periphery of the left drum-head, but the vessel on the right has disappeared. At 1 P.M. the redness has disappeared from both sides. No change is observed in the optic papillæ. There is no tinnitus, and no sense of exhilaration. No tobacco or other stimulant was used during the time of observation.

June 23, 1875.—Dr. C——, aged twenty-five, about five feet nine inches in height, rather spare. Refraction myopic, $\frac{1}{12}$ v. = $\frac{20}{20}$. Drum-heads absolutely free from congestion. No vessel on or along malleus. Optic papillæ are both flushed.

At 10.16 A.M. takes gr. xv. of sulphate of quinine. 11 A.M., a vessel is seen along malleus of right membrana tympani ; and left membrana tympani presents no change. There is slight vertigo. 11.30.—There is a sense of heat and tingling over the whole surface of the body. Sense of fulness in ears and head. The handles of both mallei are injected. The hands are tremulous, and the subject gives general evidence of nervous excitement. There are sounds of a high note in the ears. The ears feel warm. At 12.30 the injection of the malleus is disappearing, as are the vertigo and tremor. At 12.50 the mallei are still injected. Motions of the jaw cause peculiar and unpleasant sense of vibration in the ears.

Although these experiments are but three in number, they are sufficient, I think, to justify the view I expressed in the *American Journal of the Medical Sciences*, October, 1874, that the effects of quinine upon the ear were due to congestion. That view was contested at the time of reading the paper,[1] by Professor Jacobi, on the ground that some observations that had been made in Germany, as well as clinical experience, seemed to show that anæmia, and not congestion, was one of the effects of the use of quinine ; that is to say, it was claimed that contraction and not dilatation of the vessels was produced by the drug. Dr. Hammond's experiments upon animals, and, what is much more conclusive than even experiments upon animals, large clinical experience, some of which is given us by such observers as the late Von Graefe,[2] confirm the view deduced

[1] New York Society of Neurology and Electrology.

[2] Archiv für Ophthalmologie, Bd. III. 2, p. 396.

from my observations, that the tinnitus aurium following the use of quinine is the result of overfilled blood-vessels, and is not the anæmia of blood-vessels not containing the normal quality or quantity of fluid.

It should also be stated, that I have experimented upon two other physicians, giving each ten grains of quinine at a dose. I have no notes of these cases, but I may say that in one case congestion of the drum-heads and of the optic papillæ followed, with tinnitus aurium, while in the other *absolutely no effect was produced.* The former subject was a full-blooded man who had suffered from congestion of the cerebral meninges. The gentleman upon whom no effect was produced had been in the habit of taking quinine, and was rather anæmic.

Dr. Hammond[1] published some experiments on this subject in a paper in which he gives the literature of the subject, and particularly the experience of M. Mêlier (*Expériences et Observations sur les Propriétés Toxiques du Sulfate de Quinine. Mémoires de l'Académie Royale de Médecine*, etc., p. 722). Mêlier is very decided as to quinine causing deafness, as are other writers ; but observations as to the immediate effect of the drug upon the membrana tympani or other parts of the ear do not appear, except in the account of Dr. Hammond's own case.

The observations that have been made upon the fundus oculi, after the administration of large doses of quinine, indicate that the *secondary* effect of toxic, or large doses of this drug, is to empty the blood-vessels. It has been assumed, I think, that ischæmia of the retina is the first consequence of a poisonous or large dose. But the fundus oculi has not yet been examined in such cases, as soon as the loss of vision occurred.

The following case reported by me,[2] awakened such attention to the effects of quinine upon the eye as well as ear, that the experiments upon animals were continued, and clinical reports were furnished from various sources. They have, as it seems to me, nearly all served to confirm the views, that I was the first to clearly express, as to the possible danger from the use of this drug, and the opinion that congestion is the primary effect of a large dose.

*A Case of Poisoning from the use of the Compound Tincture of Cinchona, producing Permanent Contraction of the Visual Fields and Temporary Impairment of Sight and Hearing.*

On July 3, 1878, Dr. L. M. Yale asked me to see a case of loss of sight, of which the following history was obtained : Mr. B——, aged fifty, a man of very

[1] Psychological and Medico-Legal Journal, October, 1874, p. 232.

[2] Archives of Ophthalmology, vol. viii., p. 392.

intemperate habits as regards the use of alcohol. He had been accustomed for years to drink enormously of brandy and whiskey at intervals, but there were periods of varying length, from one to three or four months, of total abstinence from intoxicating drinks.

Mr. B—— was told that the use of the tincture of cinchona would relieve him from his periodic craving for alcohol. On June 24th of that year he began its use, with a view of correcting his intemperate habits. On that day, as well as on the 25th, 26th, 27th, and 28th, he continued to take the compound tincture in ounce and two-ounce doses, at short intervals, literally drinking it as a beverage from a quart bottle, in which he had caused an apothecary to place as strong a preparation as possible. On the 28th, although he had taken none of his ordinary alcoholic stimulants, his clerk thought from his conduct that Mr. B—— had been drinking heavily. Dr. Yale estimated that in these days the patient took an amount of the tincture which would be equivalent to 125 [1] grains of an alkaloid of cinchona. Mr. B—— has no recollection of any occurrence after the 27th. He is confident that he took no alcohol, except that contained in the preparation of cinchona, during these days. This, however, may be doubtful, for the clerk of the hotel to which he went when in what proved to be a semi-conscious state on the 28th, states that while he lay in bed he was constantly ringing the bell for liquor. It is possible that during this time some doses of alcohol were added to those of cinchona, although Mr. B—— does not believe this to be the case. On the morning of July 1st he was seen by Dr. Hills in the absence of Dr. Yale. He found the patient stupid or half-conscious, with flushed face and conjunctivæ, and apparently unable to see or hear. Mr. B—— remembers Dr. Hills' visit on Sunday, and knows that he was then blind and deaf. Dr. Yale saw the patient on Monday and Tuesday, July 2d and 3d. His hearing power improved so much in that time as to become apparently normal, but his vision remained very much impaired. On the day I saw Mr. B——, the 3d, he was groping about his room, apparently in excellent general health and with good hearing. V., R. E. = quantitative perception of light. L. E. counts fingers at one foot. The ophthalmoscope showed lessened size of the arterial vessels; no abnormity in the veins, lessened number of vessels on the papillæ, but no marked paleness. *No changes observed in the membrana tympani.* The patient was advised to take strychnia in increasing doses and nutritious diet. On July 6th he was able to walk about. V. = $\frac{20}{30}$ each eye, but the visual fields were very much contracted, so that vision was telescopic.

On July 16, 1878, both visual fields were found concentrically limited. The measurements, drawn on a blackboard 14″ distant, were as follows: Right field, vertical, 9 inches; horizontal, 7½ inches; limitation most marked on temporal side. Left field, vertical, 7 inches; horizontal, 8 inches; limitation more regular. B—— found this symptom rather novel than troublesome. The optic papillæ looked very pale, and the arteries were narrow. July 23d, V. = $\frac{20}{20}$, each eye. Patient states that he can see perfectly well in a straight line, but that when walking about a room he has some difficulty in seeing small articles of furniture.

September 10th.—The same condition is maintained. The strychnia was taken until $\frac{1}{10}$ grain had been reached at a dose, and was continued for two months. The visual field remains as on July 16th.

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[1] This amount was afterward found to be nearer 500 grains.

April 23, 1879.—Mr. B——'s condition remains substantially the same. He continues to abstain entirely from the use of alcohol, and carries on a large business successfully. His vision is still $\frac{20}{20}$ each eye. The visual field has increased somewhat in the left eye. It now measures 9 inches vertically and 16 inches horizontally. F. of R. E. 6″ vertically, 9″ horizontally. Limitation most marked at upper-inner quadrant. The optic disks are pale and the arteries small. There are no other ophthalmoscopic appearances.

Mr. B—— had taken no alcohol for some months prior to his beginning the use of the cinchona, and he took none until he became unconscious on the fourth or fifth day. Although he went about and transacted business on the fourth day, he has no recollection of what he did. When found he had an empty bottle (holding a quart) in his room, labelled and giving positive evidence of having contained cinchona. He certainly did not take many drinks, if any, after he reached the hotel, for the clerk, knowing his former habits, and supposing him to be suffering from an ordinary debauch, refused to answer his demands. It is *not known* that he took anything but the cinchona at any time after he began the treatment of the alcohol habit.

We have here, then, a case of hyperæmia of the vessels of the ear from the use of cinchona and alcohol—a hyperæmia which passed away without going on to an exudative process; but the same condition in the vessels supplying the retina continued until a true vasculitis, with its consequences, resulted.

The following case was considered to be one of chronic catarrh of the middle ears, with affection of the cochlea. While under treatment it happened to furnish an illustration of the effects of quinine upon the ears:

*Injury of the Cochlea from Cannonading—Effects of Quinine on the Ear.*—Dr. P——, aged fifty-one. In 1870 was exposed to heavy cannonading, after which he had sudden tinnitus and impairment of hearing on both sides. The symptoms passed away in great measure within a short time. Since then he has had the tinnitus only occasionally. The deafness has not been enough to annoy him until lately. Thinks the right ear has always been the worse. A year and a half ago he noticed that he heard the *click* preceding the striking of his clock, but did not hear the strike. Now he hears the strike, but not the click. Hears worse in a noisy place. Has been troubled with irritation and excess of secretion in pharynx for a long time. Health otherwise excellent.

H. D.—R. E., $\frac{1}{40}$; L. E., $\frac{5}{40}$. Voice, fifty feet behind back.

Tuning-fork placed on teeth is heard alike. Plugging either ear makes no difference. Placed on forehead or vertex is heard alike, but better on left side when plugged. Placed on mastoid heard better on left side than on right; plugging left ear intensifies sound of fork; plugging the right ear makes no difference. All the notes of the piano are heard well with the left ear. The right ear has partially lost its perception of some of the lower and some of the upper notes, but hears the others well.

Right drum-head: Opaque. Light spot, narrow and divided.
Left drum-head: Opaque. Good light spot.
Pharynx catarrhal.

Inflation for three weeks improved the hearing for the watch to $\frac{8}{40}$ on both sides.

One morning, while under treatment, the patient came complaining of great "stuffiness" and tinnitus in both ears. During the preceding twenty-four hours he had taken thirty-eight grains of quinine for neuralgia. The hearing for the watch was $\frac{1}{40}$ R. E., and $\frac{3}{40}$ L. E. There was intense redness along each malleus-handle. (The day before the hearing had been $\frac{8}{40}$ each side, and no redness of the drum-heads existed on that day, or had ever been seen before.) Inflation did not improve the hearing at all, although it had never failed to do so before. At the next visit the conditions were as usual.

Several weeks after stopping treatment, the hearing had relapsed to its former state.

In an inaugural dissertation Dr. Hans Brunner[1] has collected the cases of amblyopia caused by quinine, and also gives the result of experiments made with the drug. Until the observations of Briquet, Paris, 1855, who saw four cases of temporary blindness found in four persons from daily doses of from 3 to 5.0 grammes, they are not of any importance. Briquet thinks that impairment of vision occurs less frequently than impairment of hearing. Dr. Virsinier, of Louisiana, quoted by Brunner, has seen deafness occur without blindness, but never blindness unaccompanied by deafness. One of his patients, during an attack of intermittent fever of a pernicious variety, took 4.0 grammes of sulphate of quinine within six hours, and just as much during the same time in an enema. On the next day the patient was deaf and blind.

Dr. Baldwin, of Alabama, has warned the profession on several occasions of the dangers to sight, hearing, and even life, from large doses.

Weber-Liel,[2] quoted by Brunner, verifies my views as to *congestion* of the ears being caused by quinine. Kirchner,[3] in an article upon the effects of sulphate of quinine upon the temperature and circulation, states as the result of his experiments, that *quinine causes inflammatory processes and permanent pathological changes in the ear. He believes that the cause for these conditions is to be found not only in a hyperæmia of short duration, but also in paralysis of the vessels with congestion and exudation.*

I believe that the tinnitus aurium and impairment of hear-

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[1] Ueber Chininamaurose. Dissenhoffen, 1882. [2] Loc. cit., p. 36.
[3] Berlin. Klin. Wochenschrift, 1881, p. 725.

ing, following the use of quinine, depend upon congestion of the ultimate fibres of the auditory nerve in the cochlea, and that the redness of the drum-heads is merely an index of the former condition.

Since the publication of the last edition I have had the opportunity of carefully examining a patient with typhoid fever, who was profoundly under the influence of quinine, so that she could not hear ordinary conversation, a person with good hearing before the administration of the quinine, and who perfectly recovered her hearing power after the effects of the quinine had passed away. The patient heard the tuning-fork better through the air than the bone, indeed, the bone-conduction was nearly destroyed. This completes the chain of proof that the lesion in deafness from quinine is in the internal ear.

In the treatment of deafness from quinine I have used strychnia with great benefit. Mercury and potash should not be given, nor should depletives be used in any form.

Since the publication of the last edition of this work, I have seen a very interesting case of deafness following the use of quinine, which I reported in full elsewhere.[1] It was that of an officer of the navy, about forty-nine years of age, who, having excellent hearing, took twenty grains of sulphate of quinine one evening after a wetting from exposure to a storm, and woke up profoundly deaf. He never had had syphilis. The use of leeches and the internal administration of mercury was begun the day the deafness occurred, but the patient continued profoundly deaf, with very unpleasant head symptoms, until strychnia and alcoholic stimulants were used, when he immediately began to improve. He ultimately recovered the hearing of one ear in good proportion, but the other remains profoundly deaf.

Fortunately most of the cases of deafness caused by quinine fully recover. In some, however, most deplorable results occur. It is a drug that should never be lightly administered to any person, and especially to any one already affected with aural disease, unless in the rare cases of malarial neuralgia of the middle ear.

Kirchner found diminution in the perception of a vibratory tuning-fork placed upon the bones of the head, and also a diminished perception of the higher tones. Orne Green,[2] on reviewing the literature of this subject and giving his own large clinical experience, quotes my views and their corroboration by Kirchner with approbation, and states : *From our present knowledge, both clinical and experimental, we are justified in asserting that the action of quinine upon the ears is to produce congestion of the*

[1] International Congress of Otology, Brussels, 1882.

[2] Boston Medical and Surgical Journal, vol. cviii., p. 220.

*labyrinth and tympanum, and sometimes distinct inflammation, with permanent tissue changes.*

### DISEASE OF THE ACOUSTIC NERVES CAUSED BY CEREBRO-SPINAL MENINGITIS.

Cerebro-spinal meningitis has been generally supposed to be the cause of many cases of disease of the auditory nerves. That it frequently causes great loss of hearing, and sometimes absolute deafness, no one with the least clinical experience will deny. A large proportion of the deaf-mutes of the present day are said to have lost their hearing in the course of cerebro-spinal meningitis. I believe, however, that although the trunk of the acoustic nerve and the labyrinth may become diseased, and perhaps primarily in some cases, that the lesion of the ear that most frequently occurs in the disease is an inflammation in the tympanum. Judging from the analogous process that occurs in the eye, this seems a plausible view. We do not usually have optic neuritis when the eye becomes affected in cerebro-spinal meningitis, but choroiditis—a peripheric and not a central affection. The pathological investigations in this direction have been few, apparently because general pathologists are not much interested in the ear, and those who concern themselves with its diseases have few opportunities to make post-mortem examinations in cases of cerebro-spinal meningitis. The clinical facts are against the theory of disease of the nerves. There is scarcely ever facial paralysis in conjunction with the deafness. It is hard to conceive of suppuration of the trunk of the acoustic nerve, without any affection of the facial, and although this absence of facial paralysis does not prove Voltolini's view, nearly all the cases of loss of hearing said to result from cerebro-spinal meningitis, actually depend upon inflammation of the membranous labyrinth. It assists us to believe that the first lesion may often be in the tympanum. The evidence furnished by the drumheads, which are so often sunken, although not conclusive—for we may have secondary disease of the tympanum as well as of the labyrinth—is another point in the clinical evidence. Then the tuning-fork, in many cases, notably in deaf-mutes, is heard through the bones, when it is not at all perceived through the air. Disease of the acoustic nerve has, however, been found in post-mortem examinations of cases of this disease. Wiemeyer, quoted by Moos,[1] remarks that he does not consider it improbable that "the deafness and impairment of hearing may be produced by different causes," but he states that Luschka and himself found the acoustic nerve, up to its exit from the skull, so completely embedded in masses of exudation, that Professor

[1] Archives of Ophthalmology and Otology, vol. ii., p. 622.

Luschka felt justified in supposing that the inflammation and exudation following the course of the nerves might easily, in some cases, extend into the labyrinth. Moos, in this same paper, gives a report of the necroscopy of two cases in which there was found pus in each tympanum, also in the vestibules, and ampullæ, and the cochlea. Both the acoustic and facial nerves in the meatus auditorius were surrounded by pus. The second case presented similar appearances.

It has been pretty generally assumed that these cases were cases in which the trunk of the acoustic nerve was primarily affected, but it is by no means certain that the primary trouble here also was not in the tympanum whence it may have extended to the labyrinth and nerve.

The cases reported by Heller [1] show that he considers it possible, from his microscopic examinations, that the suppuration in the tympana and labyrinth may have occurred simultaneously with the changes in the cerebral and spinal membranes. Lucæ [2] reports a case which more fully supports the view of a primary affection of the labyrinth in cerebro-spinal meningitis than do any of the preceding cases. In his case there was merely congestion of the tympana, while the Eustachian tubes were in a normal condition and the labyrinths were in a state of suppuration. "The purulent inflammation of the base of the brain along the vessels of the acoustic nerve, up to the cochlea, was more exactly traced on both sides." Knapp [3] found "symptoms of hyperæmia or catarrhal inflammation of the middle ear, either during the febrile stage of the disease or during the period of convalescence" in many cases. Knapp also examined two temporal bones of a patient who had become deaf and died from cerebro-spinal meningitis. In one ear the outer and middle ears were normal, while the acoustic nerve was softened by suppuration. While the accompanying facial appeared to be normal, the acoustic nerve of the other side had not suffered, but numerous pus-cells were found around it. The labyrinth was not examined.

Moos,[4] however, reports the post mortem of a case of cerebro-spinal meningitis, in which the nerve was found to be sound, excepting some congestion of the sheath up to the meatus auditorius internus, while there was extension of the inflammation from the dura mater into both tympanic cavities.

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.

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[1] Archiv für Ohrenheilkunde, Bd. IV., p. 55.

[2] Ibid., Bd. V., p. 188.

[3] Transactions of the American Otological Society. 1873.

[4] Archives of Ophthalmology and Otology, vol. iii., No. 2, p. 177.

Professor J. Lewis Smith[1] says that "inflammation of the middle ear, of a mild grade and subsiding without impairment of hearing, is common." Dr. Smith also says that suppuration of the tympanum may occur. According to his statistics, about one in every ten patients becomes deaf.

I have seen congestion of the tympanum in recent cases of the disease under discussion, and I have seen many where the labyrinth was the seat of disease, but whether primarily or secondarily so, I cannot say. It is probable that the inflammatory process sometimes, and, as I think, generally, follows the blood-vessels into the tympanum rather than along the acoustic nerve, for in most of the cases I have seen there is still some hearing power by bone-conduction, to me a positive indication that some power remains in the acoustic nerve.

The following cases illustrate the clinical appearances :

CASE I.—*Cerebro-Spinal Meningitis—Bilateral Deafness—Both Drum-Heads Sunken.*—December 30, 1869. R. M. W——, aged thirteen, five years ago this winter had an inflammatory disease of the head and joints, and when he recovered from this affection became deaf. He does not hear words in any way. *He feels the tuning-fork placed on the bones in each ear.* The membranæ tympani of both sides are sunken ; the pharynx and nares are in a healthy condition ; air enters both tympanic cavities.

CASE II.—*Cerebro-Spinal Meningitis—Absolute Deafness—Both Drum-Heads Sunken.*—C. M——, boy, aged four years and eight months, heard and talked well until about a year ago, when he had a fit of sickness, which the parents described very imperfectly, but which was attended by some loss of power in the limbs. There was at one time some discharge of pus from one of the ears. The child does not seem to hear sounds at all ; the vibrations of a large tuning-fork are not perceived. Both drum-heads sunken and pinkish.

CASE III.—*Cerebro-Spinal Meningitis—Deafness Absolute—Membranæ Tympani Normal.*—May 22, 1872. D. W. K——, aged twenty-one, a little more than three months since was attacked by some disease of the head, and for two weeks was stupid or delirious. There were some little spots on the neck. When he became conscious, he could not hear ; he has remained deaf ever since. There seems to be absolutely no hearing power ; cannot hear the voice even when conveyed to the ear through a tube ; and is equally unconscious of the sound of the tuning-fork or the piano. The membranæ tympani are of normal color, transparency, and position ; air enters the tympanic cavities.

CASE IV.—*Cerebro-Spinal Meningitis—Sunken Drum-Heads.*—George S——, aged twenty-five months, when fourteen months old had congestion of the brain ; was unconscious, paralyzed, and had spots on the skin. Was found to be deaf when he recovered. Both membranæ tympani are sunken.

CASE V.—*Cerebro-Spinal Meningitis—Sunken Drum-Heads.*—May 31, 1873. John D——, aged nine, eight weeks ago to-day was seized with a pain in his head at about 8 o'clock A.M. The pain was said to be across the forehead. At 11 o'clock he had convulsions. There was spasm, especially of the hands and

[1] Medical Record, December 8, 1883.

throat, at 8 P.M. ; complained of headache, and at 11 P.M. he vomited. He became unconscious, and remained so until 4 A.M. Ten days after the attacks he was deaf, and still continues to be so. He states that there is a whistling sound in his ears. He took large doses of quinia, and soon recovered from all the symptoms, except a little uncertainty in his steps, and even now he has a somewhat tottering gait. He does not hear the watch at all ; but can distinguish sounds conducted into his ear through a tube. The tuning-fork, when placed upon the teeth, produces a buzzing noise. The drum membranes are very much sunken, and of a pinkish hue ; show a small light spot.

CASE VI.—*Cerebro-Spinal Meningitis—Normal Membranæ Tympani—Slight Amount of Hearing Power as Tested by Piano.*—March 17, 1874. D. B——, aged twenty-one, a little more than ten months ago was attacked with a chill, which was attributed to sitting upon a stone in the front of the house during the month of May. After the chill the patient became delirious, and his neck was stiff, and he had no use of his arms or legs. This state of things continued for one week. As soon as he became rational he was found to be deaf, and his left side remained paralyzed. He gradually recovered from the paralysis, though his deafness continues, and he staggers in his walk. Hearing distance : right, 0 ; left, 0. The tuning-fork is faintly heard in both ears ; he is sensible of the tones of his own voice, and talks in a natural tone, modulating fairly. He thinks his right ear is the better one. By means of a conversation tube connected with the keys of a piano, he is enabled, through the medium of the right ear, to distinguish the C, D, and E of the treble, as well as all the bass notes. With the left ear he cannot distinguish the treble, the bass notes alone being audible. This is in accordance with the law of acoustics, that the impression of the bass or low notes remains longer on the ear, thus proving that the patient had still a slight trace of hearing power remaining in the cochlea, and that the statement that he heard better with the right ear was correct. The membranæ tympani are transparent, the pharynx is granular. The patient has been for some weeks under competent treatment, but without perceptible benefit.

CASE VII.—*Cerebro-Spinal Meningitis—Normal Membranæ Tympani.*—May 2, 1872. Virgil T——, aged five, four weeks ago was seized with a severe pain in the head ; soon vomited, and was delirious at times, especially on waking from sleep. He complains of pain in the back and neck, and also of pain in his right ear. Four days after the attack began he was found to be deaf, which symptom increased after a second attack of pain. Apparently there is an entire absence of hearing power. There is nothing marked in the appearance of the drum membranes. He totters in his gait.

### INFLAMMATION OF THE ACOUSTIC NERVE AND LABYRINTH FROM MENINGITIS.

It is well known that inflammation of the base of the brain may extend to the trunk of the acoustic nerve and to the labyrinth. The following cases are examples of this form of disease of the internal ear :

CASE I.—*Meningitis—Gradual Deafness.*—June 25, 1870. W. K. J——, aged twenty-seven, complains of increased impairment of hearing. Had scarlet fever when a child, after which he felt a diminution in the hearing power. Last winter had congestion of the brain and hemiplegia of left side. His right ear became decidedly worse at this time. He has recovered from the hemiplegia. There is

no tinnitus aurium. The hearing distance on the right side, 0; left, $\frac{12}{48}$. Tuning-fork is heard better on right side. The right membrana tympani is sunken, and has no light spot. The left is also sunken, and exhibits two reflections of light. Inflation of the ears improves the hearing on the left side.

Case II.—*Basilar Meningitis—Bilateral Deafness.*—April 30, 1872. William R——, aged twenty-seven, says that seven weeks ago he could hear well, but after an attack of fever attended by delirium, he found, when restored to consciousness, that he had lost his hearing. There is a roaring noise in the left ear, but no other aural symptom. He can hear the watch when laid upon the right ear, but not at all upon the left. The tuning-fork is also heard more or less distinctly in the right ear. The right drum-head is somewhat sunken, the left very much so.

Case III.—*Meningitis—Inflammation of Cerebral Meninges and Labyrinth—Exposure to Direct Rays of the Sun.*—September 8, 1873. Laura ——, aged twenty-two months. The mother states that when the child was eight months old, and teething, she was unduly exposed to the direct rays of the sun, and was thereupon suddenly attacked with convulsions and was ill for three weeks afterward. The physician in charge observed that she was losing her hearing, and the mother thinks that she has not heard since that period. The drum-heads are both very much sunken and have no light spot.

Case IV.—*Basilar Meningitis—Effusion about Auditory Nerve—Intermittent Character of Attacks—Epilepsy—Deafness—Recovery.*—January 29, 1885. Moses B——, aged twenty-nine, merchant, previous to July last heard perfectly well. He has had intermittent fever at different times for two years; had also an attack of sunstroke. In July he lost the hearing in one ear, and for four weeks he was deaf with both ears. After a course of counter-irritation his hearing gradually returned. He has taken a large quantity of quinia. Some weeks ago, while at Petersburg, Va., his hearing power again failed, and at the present time he cannot hear words at all; even the ticking of the watch is not perceived. He cannot hear the tuning-fork when placed upon the head, but feels it when on the teeth. The drum-heads are somewhat opaque, and there is granular pharyngitis. He complains of a severe pain in the top of his head, and of a knocking sound in the interior. His countenance is very anxious, appetite poor, but he walks well. There is no history of syphilis. He had a severe fall upon his head, striking the occipital region, when he was seven years of age. I saw the patient first at my clinic at the University Medical College, and the next day at my office in consultation with his family physician. I advised iodide of potassium, but I did not see him again for two months, when, at the instance of Dr. William A. Hammond, he called upon me, and to my great delight I found that he could now hear conversation with ease, and the watch at twenty inches; hearing distance $\frac{20}{48}$ on each side. He had been under Dr. Hammond's care for about four weeks.

Dr. Hammond treated the case by means of the iodide of potassium mixed with the bromide. This treatment relieved the cephalalgia and epilepsy. Subsequently he administered arsenic in consequence of the intermittent type of the epilepsy. The hearing power was suddenly restored on one side, and the other soon became better also.

Through the courtesy of Dr. H. G. Miller, of Providence,

have been furnished with the following interesting history, and I was also afforded the opportunity of seeing the case :

CASE V.—*Meningitis—Inflammation of Both Auditory Nerves—Recovery of One.*—December 29, 1873. H. S——, a student of Trinity College, early in October had an acute affection of the cerebral meninges and of internal ear, leaving him totally deaf in one ear, and nearly so in the other. I saw him first about ten days after the commencement of the trouble. His condition then was : External and middle ears perfectly normal; subjective noises very troublesome, and extreme giddiness on walking, and especially on attempting to go down-stairs, and also on turning the head in either direction. Hearing distance : right ear, contact for a watch of 30′; left ear, 0. Tuning-fork heard by bone conduction in right; not at all in left. I put him on bromide and iodide of potassium, and soon began the use of the constant current. The right ear improved rapidly, and in about five weeks hearing distance became normal. For some time after that, however, through the two octaves of the piano, from middle C upward, he heard, in addition to the note struck, another less than a semitone above, which produced a most disagreeable clang, and rendered music very unpleasant to him. I then saw Dr. Blake in consultation about the left ear. We found in it perception for higher sounds than normal, and that this perception was prolonged by the continued current; and advised the continuance of the electricity, and also the use of valerianate of zinc and conium. Since that time there has been but little change. He has at times heard the watch faintly, but cannot always be sure of it. The auricle of the affected ear was quite numb. No further treatment was advised.

CASE VI.—*Meningitis—Deafness—Normal Membranæ Tympani.*—Sallie A——, aged thirteen, three months ago was attacked with severe headache and vomiting; delirium at times, but generally consciousness retained. In three weeks the fever subsided. There was no paralysis. She did not hear well after being ill a few days. Was attacked on Saturday, and on Wednesday it was observed that she did not hear words, even when spoken very close to her. The patient complained then, as now, of severe tinnitus aurium; does not hear the watch at all. The tuning-fork is heard well and naturally. Jarring sounds hurt her head. There are no marked changes on the membrana tympani.

### INFLAMMATION OF THE INTERNAL EAR FROM DISEASE OF THE SPINAL CORD AND MEDULLA, TYPHOID FEVER, AND SCARLET FEVER.

I have seen several cases of locomotor ataxia in which there was considerable impairment of hearing. In these cases the cause has not usually been a coincidental catarrh of the tympanum, but an affection of the acoustic nerve. The tuning-fork was heard better through the air, the voice better than the watch, noises were distressing, and the hearing was made worse by inflation. I have watched one such case for some eight years, and although the general symptoms of the patient have somewhat increased—that is, his locomotion is not so good, and his nutrition is more impaired—the hearing power remains about the same. With the same degree of disease of the middle ear, he would by this time have been much worse.

Typhoid fever sometimes produces disease of the middle ear,

sometimes of the labyrinth, and occasionally of both parts in the same subject. There is apparently an anæmia of the labyrinth after certain cases of continued fever, for while the symptoms are those of disease of the nerve, they partially recover as convalescence goes on. In some cases it is possible that the disease of the labyrinth is caused or increased by quinine which has been given during the illness.

Scarlet fever usually causes a suppuration of the middle ears, and no further disease, but in some rare instances the inflammation is not suppurative and attacks the labyrinth.

CASE I.—*Scarlet Fever—Deafness—No Change in the Pharynx or the Outer Ear.*—January 28, 1870. S. M. J——, aged five, had a mild attack of scarlet fever when he was eight months old; the mother discovered that the child was deaf four months afterward. There appears to be no hearing power. The tuning-fork causes no sensation. The pharynx and nares are in a healthy state, and the membranæ tympani show no changes.

In not extremely rare instances, as it appears from the tables of institutions for the deaf and dumb, pneumonia causes diseases of the internal and middle ear. I once saw, in consultation with the late Professor Little, a case where deafness followed pneumonia, which followed a mild attack of cerebro-spinal meningitis.

CASE II.—*Cerebro-Spinal Meningitis (?)—Pneumonia—Profound Deafness—Sunken Drum-Head.*—November 27, 1883. Maggie R——, aged five. Dr. Little's account of the case was as follows: "This child was taken sick about two weeks ago with symptoms that pointed toward cerebro-spinal meningitis. On the fifth day these symptoms subsided and an examination showed pneumonia of the left lung. Two years ago she had a similar attack. She now seems to be deaf." The father stated that the child had been deaf for a week; she complains of tinnitus in her left ear. When the child was taken sick she had fever and frequent vomiting. The latter symptom occurred for two days. On the fifth day pneumonia appeared. She recovered, and while convalescing, one week ago, deafness came on. She does not hear the voice or loud sounds conveyed through the air. It is impossible to learn whether she hears the tuning-fork by bone or not. Both drum-heads are sunken, and the left is congested and exhibits two light spots. Treatment was of no avail. On June 4, 1884, I saw her again. She was deaf to all sounds through the air, but seemed to hear the vibrations of the tuning-fork when placed upon the bones. This, I think, was a metastatic inflammation of the middle and internal ears, but I think the disease began in the tympana, and that some degree of power remained in the nerve. It is a case which throws some light upon the nature of aural disease in cerebro-spinal meningitis.

### DISEASE OF THE INTERNAL EAR FROM PAROTITIS.

Of a total number of five thousand cases of aural disease, seen in private practice, of which I have notes, only ten seemed to have been caused by parotitis. Specialists in this country and in

Germany have seen very few of such cases. Of late great interest has been shown in this subject, as shown by cases reported by Buck,[1] Brunner,[2] Knapp,[3] Moos,[4] Harlan, and others, but very little has been added to the statements of Toynbee, Hinton, and myself, made by the first-named author in his text-book, in 1860, by Hinton, in 1874, in his "Questions of Aural Surgery," and by myself in an article on "Diseases of the Internal Ear," in the *American Journal of the Medical Sciences*. Toynbee and Hinton, and lately Dalby, speak of disease of the ear after mumps as if it were a common one. In this they differ from the German and American authorities, who speak of it as a rare affection. Hinton says: "Next, or perhaps equal, in frequency to scarlatina, in this respect, stands mumps, which has an effect on the nervous apparatus of the ear which has as yet received no explanation, and affords no clue to the use of remedies; every part of the ear being normal, so far as examination can extend, but the function is almost abolished. '*But some cases* (the italics are mine) *of damage to the ear from mumps present an intermediate character, showing clear signs of a tympanic disorder mixed with the nervous symptoms. The similarity of the nerve affection that follows mumps to that which ensues upon parturition, is very striking; and the resemblance is increased by the fact that quite frequently the latter affection also is accompanied with symptoms of a catarrhal character.*'"

After all that has been written, it still remains doubtful as to how the ear is invaded, and whether the disease is generally a primary one of the labyrinth or of the middle ear. That it is occasionally at least a disease of the middle ear, the last of the cases reported by me,[5] and here reproduced, plainly shows. The first cases which I reported were observed before I knew the full value of the tuning-fork in diagnosis, and I am unable to say of some of them whether they are cases of disease of the internal or middle ear.

CASE I.—*Parotitis—Deafness of One Side—Patient first seen Three Years after the occurrence of the Mumps.*—H. A. H——, aged twenty-three, student of medicine. Three years ago the patient had a slight attack of the mumps. During it he lost the hearing of the right ear. Hearing distance: R., $\frac{\text{mastoid}}{4\ 8}$; and L., $\frac{4\ 8}{4\ 8}$. The membrana tympani appears to be normal. There is considerable *tinnitus aurium*. The patient was treated through the Eustachian tube for about two months.

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[1] American Journal of Otology, vol. iii., p. 203.
[2] Archives of Otology, vol. xii., p. 102.
[3] Ibid., vol. xi., p. 385.
[4] Ibid., p. 13.
[5] Archives of Otology, vol. xii., p. 1.

The tinnitus was usually diminished for an hour or so after the applications through the catheter.

In this case there was certainly disease of the middle ear. It will be observed that the watch was heard upon the mastoid process, while not upon the meatus. The case was seen in 1866, when I was not aware of the value of the tuning-fork in making a differential diagnosis of disease of the middle ear. Yet, from the results of the treatment, I am confident that there was an affection of the middle ear; also the nerve may have been affected.

CASE II.—*Disease of Labyrinth of One Side after Parotitis—Patient first seen One Year after Loss of Hearing occurred.*—June 14, 1871, Miss B——, aged twenty-one. Patient states that she had the mumps one year ago. After recovery, she observed a buzzing sound like that made by insects. She has not heard with the ear since. At this time there is an unpleasant fulness in the ear.

The hearing distance from the right ear is normal. From the left, it is $\frac{0}{48}$.

The membranæ tympani are normal. The tuning-fork is heard only on the right side.

The patient was seen again in September of the same year. She then stated that she had vertigo occasionally. In other respects the condition was the same.

The evidence is clear that the labyrinth was the chief, if not the only, seat of the aural disease in this case. The foregoing cases are those published in the *American Journal of the Medical Sciences*, loc. cit.

CASE III.—*Disease of Labyrinth of Both Sides after Scarlet Fever, Measles, and Mumps—Patient first seen Thirty-one Years after Loss of Hearing occurred.*—September 15, 1873, Henry N. X——, aged thirty-four. The patient states that when two or three years old he had the measles, scarlet fever, and mumps in one year, and that his hearing has been defective ever since. He never had any discharge from the ears, and he rarely had tinnitus.

H. D., R. $\frac{0}{48}$; and L., $\frac{P}{48}$ (?).

The tuning-fork is heard better on the better side. The right drum-head is somewhat sunken. The left one looks well.

Inflation of the middle ear produces no change in the hearing power.

The meagreness of the history does not enable me to say whether the loss of hearing was observed immediately after the attack of parotitis, or after the measles, or scarlet fever. The absence of ulceration at any time, however, inclines me to believe it to be a true case of loss of hearing as a result of parotitis.

CASE IV.—*Impairment of Hearing of Left Ear, occurring during attack of Parotitis—Disease of Right Ear had occurred previously from Scarlet Fever—Patient first seen about Five Months after attack of Mumps.*—October 1, 1875,

Mrs. J. S. C——, aged about thirty-five. The patient states that she had scarlet fever at the age of eighteen. She has suffered from greatly impaired hearing on the right side ever since. Last May she had the "mumps." During the course of the disease, she found that she was deaf in the left ear. She heard well on one day, and the next day she found herself deaf. There was no pain in the ear, and no discharge from it. She has suffered from tinnitus aurium since. She hears the watch on the right side (on that of the ear deaf from scarlet fever), $\frac{1}{4}\frac{5}{0}$. L. ear when pressed upon the mastoid, $\frac{m}{4\,0}$. She has naso-pharyngeal catarrh. Both drum-heads are of good color, and have good light spots.

The diagnosis made was disease of the middle ear on the right side and disease of the labyrinth on the left. The grounds for the diagnosis of the labyrinthine disease are, however, not given, except in the statement that the deafness occurred suddenly, and that inflation caused no improvement in the hearing. Unfortunately, I do not remember the case with enough clearness to give any more detailed account of the reasons for believing that the ear affected by scarlet fever was chiefly so in the middle part, while the other had a lesion of the nerve.

CASE V.—*Impairment of Hearing of One Side after Mumps—Inspissated Cerumen—Hearing Improved after its removal—Patient first seen Ten Years after the Parotitis had occurred.*—October 12, 1875, C. H. T——, aged twenty-eight. The patient states that he had the mumps ten years ago. After that he observed that the watch was heard better in front of the right ear than of the left. He did not regard the condition of his ear very much until last summer, when he had a sore throat and dyspepsia, when his attention was again called to his ears. He then observed a drumming noise in the left ear, and some impairment of hearing. The hearing distance was found to be R., $\frac{4}{4}\frac{0}{0}$; L., $\frac{\text{Pressed}}{4\,0}$. The tuning-fork was heard better in the worse ear. The pharynx was granular. The right drum-head was very much sunken, and there were opacities in it. The light spot was of good size. The left membrana tympani was covered by hard wax. When it was removed the drum-head was found to be sunken, and it had no light spot. On removal of the cerumen, the hearing distance arose from $\frac{P}{4\,0}$ to $\frac{5}{4\,0}$, and after inflation to $\frac{1}{4}\frac{4}{0}$.

The history and examination show that this was a case of disease of the middle ear. It is probable that the hearing power was only slightly impaired, until the attack of inspissated cerumen, which reduced it so much as to call the patient's attention to it. From my data, I believe that the average hearing power of the side affected by the parotitis was $\frac{1}{4}\frac{5}{0}$.

CASE VI.—*Double Parotitis followed by Absolute Deafness—Patient seen Thirty-two Days after occurrence of Deafness.*—February 26, 1875, Mabel O——, aged four and a half. The patient had parotitis about thirty-two days ago. She recovered promptly. Five days after began to suffer from impairment of hearing, and in twenty-four hours she became deaf. For two or three days there was

some unsteadiness in her walk, also occasional vomiting. The little patient was very weak.

The patient was found to be absolutely deaf. The drum-heads were normal in appearance. No improvement resulted from treatment. That this was a case of disease of the labyrinth is indisputable.

CASE VII.—*Sudden Deafness of One Ear after Mumps—Patient seen a Year after the Disease occurred.*—May 3, 1880, R. W. H——, of Australia, aged twenty-three. The patient states, that he became deaf rather suddenly in the left ear, after an attack of mumps about a year ago. He also had a low fever. Just as he was recovering from the mumps, he found that he was hard of hearing on the left side. He could hear the ticking of a watch however. He has remained hard of hearing from that time. H. D., R., $\frac{48}{48}$; L., $\frac{0}{48}$. The bone conduction for tuning-fork C is better than aërial on the left side. Both membranæ tympani are opaque. No improvement to the hearing resulted from inflation.

This is, I think, a clear case of disease of the middle ear after parotitis; that the internal ear may also have been affected, will not be denied. Yet the probabilities are, that the disease was situated exclusively in the middle ear. The tuning-fork test is, I think, very reliable in determining the situation of the lesion, and that certainly positively indicated disease of the middle ear.

CASE VIII.—*Parotitis Three Weeks before—Deafness Two Weeks since—Dizziness for One Week—Dulness of Hearing in the Right Ear also, which soon passed away—Constant Tinnitus.*—June 25, 1881, W. D. C——, aged forty-one, sent to me by Dr. J. W. S. Gouley.

H. D., R., $\frac{30}{40}$; L., $\frac{P}{40}$ (?). The tuning-fork is heard only in the right ear. It is not heard at all by aërial conduction on the left side.

As I said, in discussing this case in the *Archives*, although it had become one of the labyrinth on the left side, it may have begun in the middle ear, for on the other side there was a slight affection of the middle ear, which passed away. I see no reason why a slight affection of the middle ear may not have extended and become a serious affection in a part that tolerates only a very slight lesion; certainly the labyrinth is in direct communication by blood-vessels with the tympanic cavity, which, in turn, through the auditory canal and the mastoid process is directly connected with the parotid gland.

CASE IX.—*Parotitis a Year before Patient was seen by the Writer—Hearing was found to be Impaired soon after.*—March 11, 1882, Janet R——, aged twelve, sent to me by Dr. J. W. S. Gouley. The patient had parotitis on both sides a year ago. She make a slow recovery. Her hearing was found to be impaired soon after, and it has remained so. Her general health is fair.

H. D.: R., $\frac{48}{48}$; L., $\frac{3}{40}$. She cannot say in which ear the vibrating tuning-fork

is heard, when placed upon the forehead or teeth. In the left or bad ear the bone conduction is better than the aërial.

The drum-heads are slightly sunken and the light spots are small. The hearing is diminished immediately after inflation.

The patient was seen a few times, but as she seemed to be rather worse for treatment of the middle ear, she was dismissed unimproved.

This case seems to me to be a clear one of disease of the middle ear, although I will not undertake to say that there was not also a lesion of the labyrinth. The fact that she invariably became worse after inflation of the ear inclines me to think so. But the fact that there was still considerable hearing power left in the ear, inclines me to the belief that the affection was primarily in the middle ear.

Case X.—*Parotitis on Each Side—Chill Fourth or Fifth Day after—Great Impairment of Hearing—Recovery of One Side after Inflation of the Middle Ears—Improvement in the Other.*—Robert B——, aged eight, was brought to me by his mother on April 24, 1882, with the following history: About three weeks before he was attacked with mumps, affecting each side. On the fourth or fifth day after the mumps appeared, he had chilly sensations one evening, probably in consequence of the lowering of the temperature of the room in which he was. The next day he had a high fever; he vomited; and on that day it was observed that he did not hear well. His hearing has not become worse since, perhaps he is slightly better. He was treated by his attending physician by being kept warm, and injections of a warm solution of chlorate of potash were daily made to his throat. He did not improve much, however. On examination it is found that he hears loud conversation four feet behind his back. Watch: R., $\frac{L}{48}$; L., $\frac{1}{48}$.

The tuning-fork is heard much better through the bones than through the air, on each side.

The right membrana tympani is of good color. There is a well-formed light spot, and it is not sunken. In the left membrana the light spot is small.

On inflation of the middle ear by Politzer's method, the hearing distance for the watch becomes $\frac{1}{48}$ on the right side and $\frac{1}{48}$ on the left, while the voice is now heard 30 feet.

The patient remained under observation until June. He was treated by the use of Politzer's method of inflation, by syringing the naso-pharyngeal space with a solution of chlorate of potash; and he took cod-liver oil. He then went abroad with his parents. He was directed to continue the treatment, according to circumstances, during the summer. When he returned in October, he could hear general conversation with ease, but on the right side the watch was only heard when laid upon the ear, and on the left side for 8 inches. R., $\frac{L}{48}$; L., $\frac{8}{48}$. Voice, 30′. About a month afterward, while under treatment, after the escape of quite an amount of dark-colored viscid material from his nostrils, the patient said that sounds were unusually loud. On examination the next day it was found that the hearing distance of the right ear was $\frac{5}{48}$, and the left $\frac{30}{48}$. After inflation the hearing distance of the left ear became normal, while the right remained unchanged. At the present time the patient has passed through an

attack of inflammation of the auditory canal and tympanic cavity from exposure to cold, but his hearing has become normal on the left side, while it remains impaired on the right.

February 9th.—R., $\frac{12}{48}$; L., $\frac{48}{48}$. Voice on right side, with normal ear closed, 20 feet. The patient is still under treatment.

October, 1890.—This patient has now become a young man. The tuning-fork still shows that the situation of the disease is in the tympanum and not in the labyrinth. He hears conversation well. The right ear is still better than when the note of February, 1883, was made.

This case of impairment of hearing after mumps is a very plain one. It is undoubtedly a case of disease of the middle ear and not of the nerve. The tuning-fork and the results of treatment indicate this. Yet he had symptoms that are sometimes associated with an affection of the labyrinth. It is quite possible that such an affection might have occurred in the course of any acute disease, if the patient were exposed to a chilling of the body. I am confident, however, that a similar process would sometimes be found, if all the cases of impaired hearing occurring after mumps were observed by an otologist as early as this one was. Most of the cases seen by an aurist are only seen some time after their occurrence, when the history is very vague. The chief symptom is said to be sudden deafness. In this case the deafness was sudden. Had not inflation come to its relief, within a few weeks, this might have been called a metastatic case; and I believe the labyrinth might have been invaded by the extension of the inflammatory process through the fenestræ. I see no reason as yet to change the opinion expressed in this book,[1] and in my article, from which I have quoted, that in some cases the occurrence of inflammation of the ear after mumps is by direct extension of the inflammation to the auditory canal, middle ear, and labyrinth. That there may be a form of so-called metastatic inflammation, I do not deny. Whether the channel of communication is through the blood, cannot as yet be determined. To my mind the probabilities lie in that direction. The theory of a metastatic inflammation in these cases is usually not based upon the study of the symptoms at the time they occurred, but upon reasoning from analogy: for example, it is said, because the testes and breasts are sometimes affected by metastatic inflammation, therefore a disease of the ear, occurring after mumps, is also a metastatic affection. Hinton, as is seen by the quotation, thought a catarrhal inflammation of the middle ear one of the causes, in some cases at least, of the impair-

[1] Fourth edition, 1878, p. 539.

ment of hearing *often* seen after mumps. As I have shown, my last case was certainly of this character.

Every one admits that cases of extension of suppurative inflammation of the parotid gland to the external auditory canal are not uncommon. Probably this extension may take place through the fissures of Santorini. If a suppuration may extend in this way, why not a catarrhal process? We are not without examples of the extension of an inflammation to the middle ear from the auditory canal and outer layer of the drum-head. Every physician at all accustomed to see much of aural disease has seen cases where from a draught of cold air, the entrance of cold water or irritating substances, an inflammation has been set up in the middle ear by extension, and where the symptoms in the auditory canal have passed away long before those in the middle ear have been relieved.

As a result of my observations I conclude—

1. An acute catarrh of the middle ear may occur during the course of mumps, and be attended by fever and vomiting.

2. This catarrh may extend from the parotid gland, through the auditory canal and outer layer of the drum-head, or through the mastoid process.

3. An affection of the labyrinth may occur simultaneously, or by extension from the middle ear.

4. It is probable that there are cases where the disease during the course of mumps is transferred to the labyrinth, in the same manner that an inflammation sometimes occurs in the testes and the breasts, but this cannot be considered as proven until more detailed experience is furnished of cases observed a few hours after the impairment of hearing occurs.

Noyes showed an interesting case of deafness after mumps at the New York Ophthalmological Society. It occurred in an adult. The loss of hearing was accompanied by a staggering gait. Only one ear was affected, and on this side there was also metastatic orchitis.

### ACUTE INFLAMMATION OF THE MEMBRANOUS LABYRINTH MISTAKEN FOR CEREBRO-SPINAL MENINGITIS.

As has already been said, Voltolini[1] was the first writer to call attention to the subject. The discussion which his views have excited has been at times a heated one, but it has done great good in calling the attention of general practitioners to the possibility of mistaking a disease of the ear for one of the brain or medulla.

The symptoms of epidemic cerebro-spinal meningitis, as given

[1] Monatsschrift für Ohrenheilkunde, Jahrgang I., No. 1.

by Clymer,[1] are "great prostration of the vital powers, severe pain in the head and along the spinal column, delirium, tetanic and occasionally clonic spasm, and cutaneous hyperæsthesia, with, in some cases, stupor, coma, and motor paralysis, attended frequently with cutaneous hæmic spots." 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,[2] "The children are attacked quite suddenly, and without apparent cause; consciousness is soon lost as a rule, but the head is frequently grasped with the hands. There is severe fever, a fixed countenance. They bury the head in the pillow. There are 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, 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? 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."[3] 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?" It is no answer to Voltolini's arguments to say, as has been said, that cases of inflammation of the membranous labyrinth are "abortive" cases of cerebro-spinal meningitis. Voltolini went too far in thinking that there was no such disease causing deafness as cerebro-spinal meningitis; but because so-called "spotted fever" does exist, and transmits dis-

[1] Reprint from the American edition of Aitken's Science and Practice of Medicine, 1872.

[2] Monatsschrift für Ohrenheilkunde, loc cit.

[3] Archives of Ophthalmology and Otology, vol. ii., No. 1.

ease 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 optic neuritis. But here, also, gaps in our knowledge are to be filled, a task that must be performed by the post-mortem examinations made by the practitioners of the present or future.

Case I.—*Severe Headache and Vomiting—Partial Delirium—Deafness in a Few Days—No Paralysis—Recovery from all Symptoms but Deafness.*—May 3, 1873. Sallie A——, aged thirteen. 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.

Case II.—*Convulsions—Deafness.*—March 25, 1872. Martha ——, aged eleven, when sixteen months old, had some kind of convulsions, and since has been deaf. Had spoken words and given other evidences of hearing before this. She never had any disease of the head, nor discharge from the ear. She cannot now hear the ticking of a watch, nor words spoken into the ear; but the vibrations of a tuning-fork are plainly perceived. Both membranæ tympani are sunken.

Case III.—*Inflammation of Labyrinth from Cold, Induced by Lying Down while in a State of Perspiration.*—June 9, 1873. George O'B——, aged thirty-one, agent, one day last summer lay down while in a state of profuse perspiration. The next day he observed a singing noise in his right ear, and that then he did not hear well on that side. There were also darting pains across his head and the back of the auricle. Is anxious and worried. States that he had an acute inflammation of the head some time since. Hearing distance: right ear, 0; left, $\frac{4}{8}$. The membranæ tympani show no signs of disease. The tuning-fork is heard most distinctly on the left side.

Case IV.—*Pain—Paralysis—Deafness.*—Maria L——. aged three, when two years and a month old, awoke one night screaming with pain. She did not roll her head, or become unconscious, but lost power over her limbs, and had general febrile excitement. She was ill for one week, but it was two months before she could walk. On recovery she was found to be deaf, and is now almost, if not entirely, devoid of hearing. The membranæ tympani of each side altered in curvature and color.

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 these.

### HEMORRHAGES AND EFFUSIONS.

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 aged twenty-two 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 semi-circular canals and the cochlea. I have seen several such, and some where no vomiting occurred, but sudden deafness with absolutely no prémonition. We are still in need, however, of post-mortem investigations to establish our theories founded on clinical experience. Inasmuch as such patients do not usually die of disease of the labyrinth, we have not the same facilities for clearing up a diagnosis that we have in fatal affections.

## INJURIES OF THE OSSEOUS LABYRINTH.

In the chapter upon fractures of the temporal bone, it was seen that there were such injuries which involve the tympanum only, but there are also cases in which both the osseous and membranous labyrinth are injured, and absolute deafness results.

CASE I.—*Severe Fall—Complete Deafness on One Side—Normal Drum Membranes.*—September 14, 1865. E. M——, aged eleven, five years ago, or when six

years old, had a severe fall down stairs, striking his head, and he has been totally deaf on the right side ever since. The drum-heads of both sides are normal. He cannot hear the ticking of the watch on the right side, except when upon the mastoid region, the meatus being closed. The air is easily forced through both tubes by Politzer's method and by the experiment of Valsalva, but no improvement to the hearing results.

Case II.—*Profound Deafness from Blows on the Head.*—St. Vincent's Hospital, January 6, 1868, a patient under the care of Dr. J. L. Little. This man, aged forty-five, was severely beaten in a fight some few months since; he was unconscious for four days, and, when restored to consciousness, was perfectly deaf, in which condition he still remains. His gait is irregular; he finds great difficulty in keeping his head in an erect position, even when supporting it with his hand. Marks of blows are still traceable over one eye and the right mastoid process. There seems to be an entire absence of hearing power, as found by all the tests capable of application. He seems very much dejected, but is well nourished. Both membranæ tympani, especially the left, appear sunken, and have lost their transparency. Air enters both ears by Politzer's method; the pharynx is in fair condition.

I think we may fairly conclude, in this case, that the blows produced an inflammatory action in the nerve, as well as in the meninges of the brain and the parts of the middle ear, and this is probably the ultimate lesion in the case of blows and falls. The blood-vessels are perhaps at first ruptured; and we know, from post-mortems in similar cases, that suppurative inflammation of the labyrinth and basilar meningitis have resulted. In ophthalmic practice we observe cases in which atrophy of the optic nerve follows severe injuries upon the side of the head; but this atrophy sometimes presents no ophthalmoscopic appearances at first—or at least very few, and may affect but one nerve. In other cases, hyperæmia or inflammation precede the atrophy.

### CONCUSSIONS OF THE LABYRINTH (BOILER-MAKERS' DEAFNESS).

Workmen employed in hammering large iron plates, such as are used in making the boilers of large steam-engines, are very apt to lose much of their hearing power. So many of these cases are seen at ear infirmaries, that at one time "Boiler-makers' Deafness" figured as a separate disease of the ear in the statistical reports of one of our institutions where aural disease was treated. Examination of such cases has shown me that the lesion causing the impairment of hearing and deafness must be sought for in the labyrinth, and that it is probably due to concussion of the fibres of the nerve in the cochlea and semicircular canals.

Concussions of the labyrinth, from cannonading, such as are

sometimes experienced by soldiers and sailors, the impaired hearing and extreme sensitiveness of the ears sometimes observed in telegraph operators, belong to this class of labyrinth affections.

There can be no hesitancy in believing that the continual recurrence of a kind of sound, that has no musical, but, on the contrary, an unpleasant character, must at last cause a hyperæmia of the ultimate nerve-fibres of the cochlea. The incessant shock of the drum-head by the blows from dozens or even hundreds of hammers upon vibrating plates must agitate these fibres in such a manner as to finally put them out of tune, as certainly as the constant use of a piano will at last loosen its strings. Clinical experience confirms this view, and my own observations and investigations in reference to boiler-makers' shops seem to demonstrate the following facts :

I. Boiler-makers are nearly all hard of hearing.

II. The impairment of hearing is generally attributable to some lesion of the labyrinth, probably of the cochlea.

Superadded to this serious trouble, tympanic or middle ear catarrh or impacted wax are very frequently present, but these must be regarded as purely coincidental. Boiler-makers are constantly exposed to sudden and marked changes of temperature, and hence often catch cold, intensifying and increasing by this means the aural affection.

Should a man, already suffering from disease of the middle ear, begin to work in a boiler-shop, he will, of course, suffer in a much greater degree, and the organ be more susceptible of additional injury, than a man who is in the enjoyment of a sound organ of hearing. Dr. D. R. Ambrose has shown me a case which confirms this view. In the same way, a telegraph operator who has pharyngeal catarrh, and consequently a swelled Eustachian tube, which is not always capable of performing its proper function, will be more sensitive to, and suffer more acutely from, the concussions of the instrument, than he who has a healthy throat. The existence of tympanic and tubal catarrh will cause the Eustachian passage to be less pervious, or even at times entirely closed ; and thus aggravate the unpleasant conditions existing when waves of sound that have to go but a short distance, and are besides inclosed in tubes, and thus increased in intensity, impinge upon the molecules that make up the ultimate fibres of the auditory nerve.

Those who work inside the boilers as riveters, and who thus have shorter waves of sound striking upon their ears, lose their hearing power most completely, as is evidenced by the testimony of all old boiler-makers. It is not easy, in the absence

of post-mortem investigations, to define the exact nature of the lesion, but it may be a passive congestion of the contents of the cochlea.

Boiler-makers speak in graphic language of the effects of the din upon their ears. Said one of them to me: "Those heavy hammers jar every nerve in the body." They do not find much relief from wearing cotton in their ears, except when first entering the shop. An experienced workman, however, told me that all old boiler-makers had learned to equalize the pressure and reduce the shock by opening the mouth frequently. Of course, by this procedure they open the Eustachian tube more freely.

My reasons for believing that the lesion in these cases is situated in the nerve predominantly, are that the aërial conduction is always louder than the bone conduction, as tested by the tuning-fork "$C^2$," and that it is heard longer than by bone conduction. The only apparent exceptions to this rule were those in which, in addition to the lesion of the acoustic nerve, there was also inspissated cerumen. When the wax was removed, however, and the cases were transposed into their proper place, of diseases of the acoustic nerve produced by concussion, the tuning-fork was heard through the air louder and longer than through the bone. I consider all the other tests that we as yet have, for the differential diagnosis of affections of the middle and internal ear, as so much inferior to this, although of great corroborative value, that I am constrained to consider all observations upon boiler-makers that have not been made in this way, as so defective as to tell nothing of the true seat of the disease. In addition to the test by the tuning-fork, the examination of the hearing power by the voice shows that these patients hear better in a quiet place than in a noise. As has been suggested by many writers, there is no doubt that something might be done to avert the consequences of those concussions in producing disease of the acoustic nerve, if workmen could be induced to wear ear protectors; but from some reason or other, they are, as a rule, quite averse to wearing cotton in their ears, or any contrivance for protecting their ears from the effect of a great and constant concussion. Almost all boiler-makers say that they were deafer at first than after they had become accustomed to the occupation; and they all say that they hear better after a period of rest, for example from Saturday to Monday.

That excessive sound must necessarily be as harmful to the nerve of hearing, as is excessive light to that of sight, is a natural deduction from our knowledge of the effects of the waves that produce those two senses, and all experience con-

firms the belief that there may be an acoustic neuritis produced by noise, as well as an optic neuritis caused by exposure to a glare.

The cases upon which my conclusions as to boiler-makers' deafness depend are as follows :[1]

CASE I.—*Boiler-maker Twenty Years—Disease of the Acoustic Nerve.*—John F——, aged thirty-five. Has been in the business for twenty years. Hearing was good when he began; began hearing noises in his ears; then became hard of hearing gradually. Cannot now hear a lecture. Does not hear better in the noise of the shops, but he assists his ears by watching the lips of those speaking to him. Was most deaf after working in a boiler. Did not use cotton, because it made him worse when removed. Hissing tinnitus all the time. Hearing: R., $\frac{P}{4\,8}$, aërial conduction best; air duration, 23 seconds; bone, 11 seconds. L., $\frac{3}{4\,8}$, aërial conduction best; air duration, 20 seconds; bone, 9 seconds. M. T.: R., good color, good light spot, not sunken; L., sunken, two light spots, good color. Says that he has never had catarrh.

CASE II.—*Boiler-maker Thirty Years—Disease of Acoustic Nerve.*—X. Y——, forty-six years of age. Has been in the business for thirty years. Hearing was good when he began his work. Now cannot hear well when spoken to. Thinks he hears better in a noise, because people speak louder. No pain at any time, but has noises, and hearing failed gradually. Has used cotton, but does not like it. Hearing: R., $\frac{P}{4\,8}$, aërial conduction best; watch not heard on mastoid; aërial conduction, 26 seconds; bone, 12 seconds. L., $\frac{L}{4\,8}$, aërial conduction best; watch not heard on mastoid; aërial conduction, 21 seconds; bone, 8 seconds. M. T.: R., opaque, no light spot, vascular along handle of the malleus; L., opaque, sunken, no light spot. Pharynx sound.

CASE III.—*Boiler-maker Twenty-four Years—Disease of Nerve—One Side of the Middle Ear and Nerve on the Other.*—Forty-seven years of age. Has been in the business twenty-four years. Hearing was good before he began it. Sissing tinnitus. Deafness came on gradually, but was worse when he was "holdnig on"; no pain. Cotton did no good. Hearing: R., $\frac{0}{4\,8}$, aërial, but no bone conduction; duration of aërial conduction, 6 seconds; bone, 0. L., $\frac{0}{4\,8}$, aërial, feels something; bone conduction distinct; duration of aërial conduction, 0; bone, 12. M. T.: R., opaque rim, vascular malleus, no light spot; L., good color, vascular malleus, no light spot. Pharynx catarrhal; uvula elongated.

CASE IV.—*Boiler-maker Twenty-four Years—Disease of Acoustic Nerves.*—Fifty-one years of age. Has been in the business twenty-four years; previous to which his hearing was very sharp, now is very poor. Sissing tinnitus; does not hear any better in the shop or car. Wears cotton at times. No pain in ear. Health good. Voice at four feet. Hearing: R., $\frac{0}{4\,8}$, aërial feeble; no bone conduction; aërial duration, 5 seconds; bone, 0. L., $\frac{P}{4\,8}$, aërial feeble; no bone conduction; aërial duration, 6 seconds; bone, 0. M. T.: R., opaque (wax); L., opaque on periphery, no light spot. Pharynx in good condition.

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[1] Reprinted from Archives of Otology, vol. xii., p. 111.

CASE V.—*Boiler-maker Twelve Years—Disease of Acoustic Nerve.*—Aged twenty-five. Has been in the business twelve years. Hearing is good; no pain or noises. Hearing: R., $\frac{6}{48}$, aërial best; aërial duration, 21 seconds; bone, 7 seconds. L., $\frac{10}{48}$, aërial best; aërial duration, 20 seconds; bone, 10 seconds. M. T.: R., good light spot, opaque on periphery and above; L., good light spot, opaque. Catarrhal pharynx.

CASE VI.—*Assistant in Boiler-shop for One and a Half Year.*—Works ten hours per day. Thinks his hearing is good enough. Hears ordinary conversation with his face away from the speaker about twenty feet. Hearing: R. E., aërial conduction louder; air duration, 10 seconds; bone, 5 seconds. L., $\frac{10}{48}$, aërial conduction louder; air duration, 16 seconds; bone, 4 seconds. M. T.: R., small light spot, opaque; L., small light spot, vascular. Pharynx healthy.

CASE VII.—*Boiler-maker Thirteen Years—Disease of Middle and Internal Ears.*—Has been in the business thirteen years. Hearing always good. Never protected his ears. Had a pain in left ear once, but no discharge. Whispers heard by others not heard by him. Does not hear better in noise. Hearing: R., $\frac{L}{48}$, bone conduction best; aërial duration, 10 seconds; bone, 9 seconds. L., $\frac{P}{48}$, bone conduction best; aërial duration, 13 seconds; bone, 7 seconds. M. T.: R., good color and light spot; L., sunken, opaque, small light spot. Tonsil enlarged. Pharyngitis.

CASE VIII.—*Aged Eighteen—Boiler-maker for Fifteen Months—Disease of Acoustic Nerve.*—Has been in business fifteen months. Hearing good when he came. Not so good now. Hissing tinnitus. No pain. Does not hear better in noise. Hearing: R., $\frac{5}{48}$, aërial best; aërial duration, 12 seconds; bone, 9 seconds. L., $\frac{12}{48}$, aërial best; aërial duration, 14 seconds; bone, 7 seconds. M. T.: R., small light spot, prominent short process; L., no light spot, prominent short process Slight pharyngitis.

CASE IX.—*Thirty Years a Boiler-maker—Inspissated Cerumen—Disease of Acoustic Nerve.*—Aged forty-nine. This subject is what is technically called a "holder-on." His duties keep him inside of the boiler holding on to the rivets. The shock of sound is much greater here than in the open air of the shop. Thirty years a boiler-maker. Three and a half years in navy. Ears were good when he went into the present business. Hears better when he gets away from noise. Voice, 6′. Watch, $\frac{0}{48}$, each side. Tuning-fork: R. E., aërial louder, 8; bone louder, 3. L. E., aërial louder, 8; bone louder, 4. Inspissated cerumen on each side. After removal of large plugs of very hard wax, H. D. for the voice increased to 18′, and the watch was heard, when pressed on each side, $\frac{P}{48}$. The duration of the aërial conduction was increased, but no change in the intensity with which it was heard.

It is interesting to note in this case that the aërial conduction was louder and longer, even when the ear was plugged with wax. This shows a more marked lesion of the nerve, than the other cases in which inspissated cerumen was found—for in

these latter the bone conduction was better until the wax was removed, when the aërial conduction was found to be as is usual in those suffering from *boiler-makers' deafness.*

CASE X.—*Boiler-maker Thirty-one Years—Disease of Acoustic Nerve.*—James L——, forty-seven. Boiler-maker thirty-one years. First job was that of riveter, and in twenty days could not hear well; tinnitus like bees; never had earache; healthy; rheumatism; voice 20′. Hearing: R., $\frac{8}{48}$; L., $\frac{8}{48}$, aërial conduction better each side; R., aërial, 12 seconds; bone, 8 seconds; L., aërial, 9 seconds; bone, 9 seconds. M. T.: R., good light spot, good lobe; L., good light spot, good lobe. Both opaque on periphery. Healthy pharynx.

CASE XI.—*Boiler-maker for Twenty Years—Inspissated Cerumen removed from Both Sides—Disease of Acoustic Nerves.*—Aged thirty-nine. Has been twenty years in the business. Ears were sound when he began; had an occasional earache as a boy. He can't hear a whisper; does not hear well in a boiler-shop. Watches the mouth and gestures. Hears the voice in a quiet room 40′. Watch: R., $\frac{0}{48}$; L., $\frac{0}{48}$. R. side the aërial conduction is better; on the left *the bone conduction is better.* R., aërial conduction is heard 12 seconds; bone, 6 seconds. L., aërial conduction is heard 12 seconds; bone, 8 seconds. Pharynx is sound. Inspissated cerumen is found on each side. After it is removed the watch is heard better on each side; *e.g.*, R., $\frac{P}{48}$; L., $\frac{P}{48}$. Relative distinctness of bone and aërial conduction not changed. Duration of the sound about as before.

CASE XII.—*Boiler-maker Twenty-five Years—Inspissated Cerumen Both Sides—Disease of Acoustic Nerves.*—Aged forty-three. This man has been a boiler-maker twenty-five years. He had good hearing when he began his work. Never had an earache. Hears the voice in a quiet room 30′. Watch $\frac{\text{Laid}}{48}$ on right side, $\frac{15}{48}$ on left side. R. side, *bone conduction much more distinct;* L. side, the same. Duration: R, aërial conduction, 5 seconds; bone, 12 seconds; left side, aërial, 14 seconds; bone, 11 seconds. Inspissated cerumen, each side, removed. After removal of wax watch was heard $\frac{3}{60}$ and $\frac{4}{60}$ on the right and left sides respectively, instead of $\frac{C}{60}$ and $\frac{P}{60}$. *The aërial conduction became better in each ear.* Duration as follows: R., aërial, 18 seconds; bone, 13 seconds; L., aërial, 22 seconds; bone, 12 seconds.

As is seen, the peripheric trouble (inspissated cerumen) masked the disease of the acoustic nerve in this case, but when the wax was removed the lesion of a boiler-maker's ear was found to exist.

In Case VII. the bone conduction was decidedly louder than the aërial, but the tuning-fork was heard much longer through the air than through the bone. The left drum-head was sunken and opaque, and there was considerable throat trouble. From these data I conclude that there is disease of the *middle* as well as of the internal ear in that case.

*Table showing Result of the Examination of Twenty-four Ears of Twelve Boiler-Makers.*

| Length of Time a Boiler-maker. | Hearing Distance. | Aërial Conductio . | Bone Conduction. | Duration of Aërial and Bone Conduction. | Diagnosis. | Remarks. |
|---|---|---|---|---|---|---|
| Case 1, 20 yrs. | Cannot hear ordinary conversation. R. Pressed, L. 3/48. | Better than bone. | ..... | Aërial: R. E. 23 sec., L. E. 20 sec.<br>Bone: " 11 " " 9 " | Disease of internal ears. | Has hissing tinnitus. |
| " 2, 30 " | R. 0/48, L. Laid/48. | " | ..... | Aërial: " 26 " " 21 "<br>Bone: " 10 " " 8 " | " | ..... |
| " 3, 24 " | R. 0/48, L. 0/48. | " | None on right side. | Aërial: " 6 " " 0 "<br>Bone: " 0 " " 12 " | Disease of internal and middle ear. | Pharynx catarrhal; uvula long; *mt.* vascular along malleus. |
| " 4, 24 " | Voice 4 feet. R. 0/48, L. 1/48. | Feeble. | ..... | Aërial: " 5 " " 6 "<br>Bone: " 0 " " 0 " | Disease of internal ears. | ..... |
| " 5, 12 " | R. 6/48, L. 14/48. | Better than bone. | ..... | Aërial: " 21 " " 20 "<br>Bone: " 7 " " 10 " | " | Thought he heard very well. |
| " 6, 1½ " | Voice 20 feet. R. 3/48, L. 10/48. | " | ..... | Aërial: " 10 " " 16 "<br>Bone: " 5 " " 4 " | " | " |
| " 7, 13 " | R. Laid/48, L. Pressed/48. | ..... | Better than aërial. | Aërial: " 10 " " 13 "<br>Bone: " 9 " " 7 " | Disease of middle and internal ears. | Left *mt.* sunken; small light spot; pharyngitis. |
| " 8, 15 mos. | R. 5/48, L. 12/48. | Better than bone. | ..... | Aërial: " 12 " " 14 "<br>Bone: " 9 " " 7 " | Disease of internal ears. | Slight pharyngitis. |
| " 9, 30 yrs. | Voice 6 feet. R. 0/48, L. 0/48. | " | ..... | Aërial: " 8 " " 8 "<br>Bone: " 3 " " 4 " | " | Inspissated cerumen, each side. |
| " 10, 31 " | Voice 20 feet. R. Laid/48, L. 3/48. | " | ..... | Aërial: " 12 " " 9 "<br>Bone: " 8 " " 9 " | " | ..... |
| " 11, 20 " | Voice 40 feet. R.* 0/48, L. 0/48. | Better on right side after removal of wax. | Better on left side. | Aërial: " 12 " " 12 "<br>Bone: " 6 " " 8 " | " | Inspissated cerumen, each side. |
| " 12, 25 " | Voice 30 feet. R. Laid/48, † L. 1/48. | Better on each side after removal of wax. | Better *until* wax was removed. | Aërial: " 5 " " 14 "<br>Bone: " 12 " " 11‡ " | " | ..... |

* Pressed after removal of wax. † 3/48 and 4/48 after removal of wax. ‡ After removal of wax, aërial became R. E. 18 sec., L. E. 22; bone remains nearly the same: R. 13. L. 12

From all the observations I have been able to make upon this subject, I think I am justifiable in drawing the following conclusions :

1. The hearing power of persons working in such a din as that of a boiler-shop invariably becomes impaired.

2. The lesion caused by this occupation is one of the membranous labyrinth, or of the trunk of the acoustic nerve.

3. Persons thus affected do not hear better in a noise. Their hearing power is better in a quiet place, and becomes better after prolonged absence from the exciting cause of their impaired hearing.

4. The cases of inspissated cerumen, catarrh of the middle ear, occurring among boiler-makers, are such as occur among those employed in various occupations and only mask and complicate the fundamental primary trouble, so long known as boiler-makers' [1] deafness.

Other occupations of a similar nature, that is, occupations amid continuous concussions, undoubtedly cause the same lesion. A recent visit to an establishment where two engineers were employed for the production of electric light, showed me that since they had been engaged in an occupation exposing them to the sound of regular concussions from the striking of metallic plates together, they had become somewhat hard of hearing.

### CASES OF TINNITUS AURIUM AND IMPAIRMENT OF HEARING FROM OTHER KINDS OF CONCUSSIONS.

CASE I.—*Tinnitus Aurium, without Impairment of Hearing, Occurring from Listening to a Telegraph Instrument—Hyperæmia of Acoustic Nerve?*—W. G. B——, aged thirty-seven, states that he has been a telegraph operator for about twenty years, and that he has had tinnitus aurium for about two years. Hearing distance : right, $\frac{4}{4}\frac{8}{8}$; left, $\frac{4}{4}\frac{8}{8}$. Both membranæ tympani have good light spots ; there is some granular pharyngitis. The patient is confident that the vibrations of the telegraphic instrument have caused the noise in his ears. The sound of the instrument is very unpleasant to him, and he is obliged to protect his ears, while at work, by cotton plugs. Indeed, his ears have got into such a sensitive condition that jarring sounds of any kind are extremely annoying to him. The patient is in good general health.

CASE II.—*Impairment of Hearing of One Side, ascribed to Occupation as Telegraph Operator.*—May 4, 1870. Mr. B——, aged twenty-seven, about a year ago

[1] For an account of my first examination of the hearing of boiler-makers, the reader is referred to this work, edition of 1877, and to the *American Journal of the Medical Sciences*, 1874, vol. lxviii., p. 380.

discovered that the hearing power of his left ear was somewhat impaired. Three months ago he was troubled with a continuous noise in that part of his head. He is a telegraph operator, and has been accustomed to use his left ear—leaning his head over the machine on that side and intently listening. He believes that this is the cause of his loss of hearing. The drum-heads look very much alike, both exhibiting peripheral opacities, but in other respects having a normal appearance. The pharynx and nares seem to be healthy. Inflation of the ears has no effect upon the hearing. The watch is not heard at all on the affected side, nor is the tuning-fork.

Case III.—*Exposure to Cannonading—Tinnitus—Impairment of Hearing for the Watch, but not for Ordinary Conversation.*—February 11, 1868. W. R. X——, aged twenty-five, observed some difficulty in hearing ten years ago; and, after being exposed on a gunboat to severe cannonading, while an officer in the navy, he became worse, although he has scarcely any tinnitus aurium. Hearing distance: right ear, $\frac{1}{4}$; left ear, $\frac{1}{8}$. Both drum-heads appear to be normal. Air enters each Eustachian tube freely, but inflation causes no improvement in the hearing power.

I have had ample opportunity to test the hearing power of this patient in conversation, which he hears so well (in spite of the fact that his power of hearing the watch is much impaired), that he has never been considered, by any but his most intimate friends, as very hard of hearing. Persons who can hear the watch no better than he, are usually, if not always, very much troubled to hear conversation, even when addressed especially to them; and yet the patient in question can join in general conversation carried on in an ordinary tone, and can hear lectures, and so forth, with perfect ease.

My friend Dr. Rhoades, surgeon in the United States Navy, informed me that, during an experience in several naval engagements large and small, during our late civil war, he never saw a rupture of the membrana tympani from cannonading. He has seen sailors who said they were hard of hearing from cannonading. These men usually complained of tinnitus. Some of them got better, and some worse. Sailors usually keep the mouth open during the firing.

The following case also illustrates the effect of concussion of the labyrinth. It is possible that an injury of the labyrinth more readily occurs when the membrana tympani is in a relaxed condition, as was probably the case in this instance, the subject being surprised by the wave of air that unexpectedly forced upon the endolymph. Any one who has received an unexpected whisper in the auditory canal, may remember how long a tinnitus aurium continued which it seemed to produce.

Case IV.—*Loss of Hearing from a Kiss upon the Ear.*—Mrs. H——, aged forty-two, seen through the kindness of Dr. O. B. Douglas. Last winter (1878),

her husband came up behind her as she sat reading, and kissed her suddenly upon the right ear, taking her completely by surprise. She suffered a great shock and had a roaring in the ear for some time. The incident made her very "nervous" for two or three weeks afterward. During the past summer she was told by her relatives that she was becoming deaf on the right side. She paid no attention to it until six weeks ago, when she tried her right ear with her watch and found she could not hear it. She gives satisfactory evidence of having heard a whisper well with the right ear during last winter and spring. Has had occasional tinnitus during the past few months after taking cold. Enjoyed music very much formerly, but does not now. The piano practice of the children at home annoys her. Whistling is particularly disagreeable. All noises disturb her somewhat, so that she has "felt afraid that she was becoming nervous." General health is good. Menstruates regularly. No cardiac trouble detected. Father died of paralysis.

H. D., R., $\frac{P}{40}$; L., $\frac{40}{40}$.

Tuning-fork on teeth or vertex seemed louder in the left ear. Is slightly intensified in right by plugging, but much more in left. Aërial better than bone-conduction on each side.

The drum-heads are about alike and show nothing to account for deafness. Air enters the right drum by both catheter and Politzer's method, but does not alter the hearing. All notes of the piano are heard, but she says they do not sound "clear," even with both ears open. Dr. Douglas examined the naso-pharyngeal space and the mouths of the Eustachian tubes and found nothing abnormal.

This seemed to be a case of deafness from affection of the labyrinth, with no apparent cause except the kiss upon the ear. The concussion from the kiss may have caused the loss of hearing at once; or, as seems more likely, it may have produced changes in the labyrinth, which, in combination with the general nervous shock, served as a foundation for a gradual loss of hearing subsequently—as, for instance, by some atrophic process.

Mr. Hinton was inclined to think that in all instances of loss of hearing, apparently from slight causes, it might be found that some previous source of injury to the ear had existed. He quotes some cases to illustrate that view. He speaks of a concussion sometimes jarring the labyrinth, not into complete paralysis, but into a state of extreme liability to this condition.[1]

### ANEURISM—TUMORS.

Aneurism of the basilar artery, cerebral tumors, and, in fact, all varieties of intracranial disease, may cause tinnitus aurium and impairment of hearing; but all such cases require special study, and hardly demand a detailed notice. Griesinger says that the symptoms of disease of the nerve, or its expansion, aris-

[1] Questions of Aural Surgery, p. 268.

ing 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. Von 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 [1] is recorded, however, which Dr. Jackson quotes, of tumor of the left cerebral hemisphere, where there has been deafness of both ears. Dr. Jackson thinks that deafness does not result from intercranial tumor, or other adventitious product, unless the auditory nerve is actually involved or pressed upon.

According to Schwartze,[2] it has been estimated by Calmeil that impairment of hearing occurs in about one-ninth of all cases of cerebral tumors. Aural symptoms occurred, in 77 cases of tumors of the cerebellum, 7 times ; in 26 cases of tumors of the pons, 7 times ; in 27 cases of tumors of the middle lobe, 3 times ; but not once in 27 tumors of the anterior lobe, nor in 14 cases of the posterior lobe, and 4 of the fourth ventricle.

Deafness of one side, according to Cruveilhier, quoted by Schwartze, was one of the first symptoms in a number of cases of central tumors. Schwartze further says, that impairment of hearing on both sides not unfrequently occurs in tumors of the cerebellum, and when from the situation of the tumor we know that it does not press directly upon the nerve-trunk of the opposite side, nor upon its origin in the medulla, and when there are no symptoms of paralysis of other cerebral or spinal nerves, Schwartze thinks that there may be a neuritis or œdema in these cases.

### DISEASE OF THE SEMI-CIRCULAR CANALS.

In the beginning of the preceding chapter it was said, that it is now possible to diagnosticate disease of the cochlea and of the semi-circular canals, as distinguished from diseases of the other

[1] Royal London Ophthalmic Hospital Reports, vol. iv., part iv., p. 420.

[2] Handbuch der pathologischen Anatomie, by E. Klebs. Gehörorgan, by Schwartze.

parts of the labyrinth. I think this has been shown to be true as regards the cochlea. As to the diseases of the semi-circular canals, the late P. Ménière,[1] of Paris, reported a case which has become classical. The deductions from it have not always been justified by the facts. The term Ménière's disease has been used so indiscriminately, especially by neurologists, that it has confused our ideas as to the significance of vertigo, nausea, and inability to walk without staggering, when they occur in connection with sudden loss of hearing. In one of Ménière's cases he found a kind of bloody exudation in the semi-circular canals, while the brain, the cerebellum, and the medulla were sound. This case was that of a young woman, who, while menstruating, took cold from riding on the top of a diligence. The other cases, nine in number, are clinical accounts of cases of sudden deafness, in which it is probable that the semi-circular canals were pressed upon or diseased, for there was vertigo and a staggering gait. Some of these cases were perhaps of tympanic origin, certainly some were cerebral rather than aural, and the pressure upon the semi-circular canals was not from any exudation within them. As has been seen in the preceding pages, aural vertigo is by no means always dependent upon disease of the labyrinth.

Ménière read his first paper upon the subject before the Academy of Medicine in Paris, January 8, 1861, and in it he claimed that the lesion causing the following train of symptoms, namely, vertigo, dizziness, uncertain gait, nausea, followed by deafness, was situated in the semi-circular canals. Whether or not cases were all to be referred to the labyrinth as their point of origin, they cannot, with our present knowledge of pathology, certainly be referred to the semi-circular canals. There is a vertigo of tympanic origin, also one proceeding from primary disease of the labyrinth, as well as one from the cerebrum. All of these forms may be accompanied by sudden deafness. The deafness from the impaction of cerumen is sudden in occurrence, so also that from exudation or hemorrhage into the tympanum, as well as that from hemorrhage into the labyrinth. These all may be accompanied by vertigo. A classification, then, which groups under one head of disease, all cases of vertigo attended by deafness, is crude, and should be rejected. Each case should be studied by itself, when it will be possible, in many instances, by a careful study of the principles that have been laid down in this and similar works, to determine the seat and nature of the lesion. Ménière did an inestimable service to the profession in directing attention to the ear as the seat of disease, formerly

[1] Gazette Médicale de Paris, 1861, pp. 29, 55, 88, 239, 279, 597.

supposed to be in all cases situated either in the brain or the stomach. The profession must now go further and determine what part of the ear is affected in individual cases.

Dr. Ormerod[1] has called attention to the fact, obvious to any one who reads Ménière's cases, that "the paroxysms of vertigo and vomiting are more sudden, more violent, more definitely paroxysmal" than the vertigo from chronic disease of the middle ear, and that what Hughlings Jackson calls the "vital symptoms"—perspiration, pallor, and faintness—are more marked. Yet, as this writer admits, the vertigo from acute disease of the middle ear may be paroxysmal and severe, although then the severity of the symptoms, taken in connection with others, may be of value in making up a diagnosis as to the seat of the lesion, it cannot be said to be a pathognomonic guide. As before said in this work, I have seen the most alarming vertigo—faintness approaching to coma—from syringing the ear.

CASE I.—*Sudden Deafness—Vertigo—Infantile Earaches—Syphilis Years previously.*—E. R. L——, aged fifty-one. November 26, 1881. The patient states that as he attempted to dance at a ball a year and eight months ago, he found he could not hear a sound. He rubbed his ears vigorously and the power of hearing returned. The next morning he had vertigo to such an extent that he could not get out of bed, could not even hold up his head. There was also nausea for a day or so. When he finally got about he staggered in his gait. He has been an overworked man for five or six years. He had syphilis twenty-one years ago—chancre, eruption, alopœcia, sore throat. H. D., Right ear, $\frac{\text{pressed}}{4\ 6}$; left, $\frac{6}{48}$. Bone conduction is better than aërial on the right side. The aërial is the same as bone on the left. Hears worse in a noise. Right membrana tympani, poor light spot; left, opaque, light spot only on periphery. His head is now improving. Tinnitus aurium is not very troublesome. When he had vertigo, the sensations were of turning to the right. No vertigo for the past six or seven weeks. The second examination showed that the aërial conduction was better on each side. There is a history of earaches as a child. The drum-heads are cicatricial. He has been subjected to thorough treatment by mercury several times, he says. His ears feel better after inflation.

This was a case of chronic disease of the middle ears, in which the labyrinth, especially the semi-circular canals, became secondarily affected, by pressure, it may be supposed, and not from any disease in them. To call such a case one of Ménière's disease, is not to give any very definite idea of its nature. The history of earaches, the appearance of the drum-heads, the syphilitic disease of years before, combine to give us an accurate notion of the causes and nature of the disease.

CASE II.—*Sore Throat—Great Loss of Hearing—Inability to Walk Straight.*—General X——, aged forty-four. Seven years ago while he had a sore throat,

[1] Brain, vol. vi., p. 33.

he found himself very hard of hearing, with inability to walk straight. "He could not control his lower limbs." Noise made his hearing much worse. Hearing distance: Right ear, $\frac{4}{48}$; left, $\frac{10}{48}$. Aërial conduction better than by bone on left side. Both drum-heads are tympanitic. He can now walk pretty well.

In this case there may have been a tympanic hemorrhage, such as I have seen in the course of acute catarrh, which caused the want of ability to walk—for I have seen failure of power of maintaining the equilibrium from such a cause—or the lesion may have been in the medulla. That it was of tympanic origin seems to me more probable. The proper way to describe cases of vertigo and inability to walk straight in cases of aural disease is to speak of them as of peripheric (external auditory canal), tympanic, labyrinth or cerebral origin. It is possible in many cases to make such an analysis of the cases of pressure upon, or disease in, the semi-circular canals. These cases are not of the severe type of those presented by Ménière, but they are such as are constantly, as it seems to me, improperly and insufficiently described by this name. More serious cases of the same character may be found in other parts of this book.

### EPILEPSY AND AURAL DISEASE.

The relation of aural disease to epilepsy, has been mentioned in the discussion of foreign bodies and ear cough, but it cannot be said that the subject has yet been fairly studied, except from the point of the reflex origin of epilepsy from suppuration of the tympanum, foreign bodies in the auditory canal, and so forth, although I have seen cases of epilepsy apparently caused by such diseases, and I have also seen epileptics who suffered from chronic non-suppurative disease of the middle ear. Ormerod found that of 100 cases of undoubted aural disease, as determined by Dr. Urban Pritchard and Mr. Cumberbatch of St. Bartholomew's Hospital, "seven had had *bona fide* epileptic fits." This the writer states is a large proportion, for Niemeyer, as he says, estimates that there are only six cases of epilepsy to every 1,000 persons, while Russell Reynolds maintains that this estimate is far too high. I have no doubt, as suggested by Ormerod, that aural disease and disease situated not only in the peripheric portions, but in the labyrinth, may excite epilepsy; but more investigation is required upon this subject.

*Pathology.*—In passing over the subject of the causes of disease of the internal ear, we have alluded to the pathology of the affection; but it may be well to tabulate the post-mortem appearances that have been found in the labyrinth. Inasmuch as

very few of these appearances have been accompanied by the history of the case, they have not the importance that they would otherwise have had. Yet they may be of service as a basis for future investigation.

| | |
|---|---|
| Absence of auditory nerve | 1 |
| Atrophy of auditory nerve | 10 |
| Suppuration | 1 |
| Tumor upon | 1 |
| Hemorrhage upon | 2 |
| Thickened membranous labyrinth | 11 |
| Atrophy of membranous labyrinth | 22 |
| Congestion | 1 |
| Suppuration of membranous labyrinth | 3 |
| Serum in labyrinth | 3 |
| Opaque fluid in labyrinth | 3 |
| Black pigment-cells too abundant | 5 |
| Distention of blood-vessels of cochlea | 3 |
| Fluid, opaque | 4 |
| Pus in cochlea | 1 |
| Thickened lamina spiralis | 1 |
| Osseous wall of semi-circular canals incomplete | 3 |
| Enlargement and congestion of blood-vessels (Hinton [1]) | 4 |

Hyperæmia of the various parts, or of the whole contents of the labyrinth, has been found in typhus and puerperal fever, in acute tuberculosis, and in cases of poisoning by carbonic oxide gas; also in meningitis, and in cases of disturbances of circulation from disease of the heart, and in emphysema of the lungs. Hyperæmia of the labyrinth may result from vaso-motor disturbances of innervation.

According to Erb,[2] atrophy of the acoustic nerve occasionally occurs in tabes dorsalis.

Tumors—sarcoma, neuroma, and gummata—may enter the *meatus auditorius internus*.

*Treatment.*—In addition to what has already been said as to the treatment of disease of the internal ear, it may be proper to add, that before any treatment is entered upon, the situation of the lesion and its cause should be made out if possible. Without this all treatment will be like working in the dark, and worse than useless. True inflammation of the membranous labyrinth should be treated by absolute quiet and rest, leeches to the mastoid and tragus, pedeluvia, and purgations. The use of quinine and cold applications to the head should be avoided,

[1] Questions of Aural Surgery, p. 255.

[2] Ziemssen's Handbuch, p. 142.

as well as all inflations of the tympanum. Syphilitic affections of the labyrinth, if treated at an early stage and vigorously, by the mercury and iodide of potassium treatment, may recover. Traumatic affections of the labyrinth are usually hopeless from the start, as far as restoring the hearing is concerned; but much can be done by quiet, leeches, counter-irritation and the like in removing the symptoms of tinnitus, vertigo, double hearing, and so forth.

Chronic affections of the labyrinth are, unless of a syphilitic origin, so far as my experience goes, utterly hopeless. 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,[1] which he entitles "Recovery from 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 ears 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." In my opinion the loss of hearing was caused by the quinine, and the partial recovery due to the fact that its use was suspended.

Beard and Rockwell[2] 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 nerv-

[1] Archives of Ophthalmology and Otology, Bd. I., No. 2.

[2] A Practical Treatise on Medical and Surgical Electricity, pp. 571–72.

ous 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 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:[1] "I have tried it electricity in nearly all reported cases, *but without a shade of improvement.*"

Dr. Sexton 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.

The anæmia of the labyrinth that sometimes occurs after typhoid fever, and perhaps after other serious diseases of an exhaustive character, may be successfully combated if it be not treated by the usual means for disease of the middle ear. Inflation, either by the catheter or Politzer's method, should be avoided. Counter-irritation over the mastoid, and tonics will often be of service; while quinine, salycilic acid, and other agents which excite tinnitus aurium should be avoided. The patient should be kept away from noisy places, and avoid any exposure to loud sounds. It is well to cause such subjects; on going into the open air during convalescence, to wear cotton or wool in the external meatus, in order to protect their ears from the shock of noises.

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[1] Archives of Ophthalmology and Otology, vol. ii., No. 1.

# DEAF-MUTEISM

AND

# MECHANICAL ASSISTANCE TO THE HEARING.

# CHAPTER XXIII.

## DEAF-MUTEISM—MECHANICAL ASSISTANCE TO THE HEARING.

Acquired and Congenital Cases.—At what Age are Children Conscious of Sounds?—Causes.—Tables of Examination of 147 Cases.—Hearing-trumpets.—Audiphone.

THERE is no logical reason for the discussion of deaf-muteism in a treatise upon the diseases of the ear, as a subject apart by itself, any more than there is for the consideration of blindness in a work upon the eye. But long-established custom among writers on otology renders it proper that a few pages should be given to this important theme in this text-book. I shall, however, say nothing upon methods of instruction of deaf-mutes, but refer my readers to the appropriate treatises and authorities for knowledge on this subject.

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 trustworty, because they are taken from the statements of persons who are seldom exact observers—the parents or friends of the children. The late Dr. George M.

Beard and myself [1] examined two hundred and ninety-six cases of deaf-muteism, with their histories, in the schools of New York City, and Hartford, Conn., and the result of our examination was, that about sixty-one per cent. of these cases 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.

Children appear to be conscious of sounds during the first days of their life, while at the third month they show an appreciation of particular sounds, such as chirping, whistling, and the like. From the first month to the third is perhaps the earliest period at which an opinion can be formed as to the hearing of an infant. I find on inquiry among mothers, that their opinions vary excessively upon this point. Some affirm that they can decide whether their children have good hearing within a few days of their birth, while others say that a month or two is required. Infants seem to hear sounds conducted through solid media almost immediately ; that is, within a few days after birth, while hearing of tones through the air appears much later. They will very soon notice a jar, such as a stamp on the floor, while for the human voice time is needed. Moreover, an inflammation of the ear, if not of the suppurative variety, may run its entire course in a young child, and never be recognized by 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 there are many more cases of children becoming deaf after birth, than of intra-uterine deafness.

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

[1] American Journal of the Medical Sciences, vol. liii., p. 401.

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 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.

Some asylums for the deaf-mutes in this country are not attended by physicians competent to examine and treat the ear. Many of the inmates require constant and special care of their ears; especially is this true of those affected with suppuration of the ears, of whom there are about twenty per cent. in the asylums. A certain and valuable degree of hearing might be obtained in a few of these cases by intelligent local treatment.

Deaf-mutes should be taught to speak by imitation of the lips of the speaker. The sign language has been for so many years the means for educating deaf-mutes in this country, that lip training has not yet obtained its proper place with us; but it is fast winning it. The next generations will exhibit many more deaf-mutes who can converse with any member of society, and who will not be limited to the comparatively few who know the language of signs. I know an accomplished young lady, entirely deaf from acute suppuration of the middle ears, with whom I have often conversed, who takes her full part in the conversation of a large family.

*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,"[1] 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 diseases, and in about the same proportion, as obtains in impairment of hearing or deafness occurring at a time of life that prevents the subjects from becoming dumb as well as deaf. Of the 296 cases examined by Dr. Beard and myself, in only 22 cases was the drumhead found to be normal, and in 200, or more than two-thirds of

[1] On the Etiology of Acquired Deaf-Muteism, by Clarence J. Blake. Reprint from Boston Medical and Surgical Journal.

the whole number examined, there was chronic pharyngitis or tonsillitis. Of the 114 acquired cases, the membrana tympani was perforated in 29 cases. Thus, suppurative inflammation does not seem to cause as large a proportion of deaf-muteism as is usually supposed. In some of the cases, however, the membrana tympani had once been perforated and had healed. In Blake's statistics,[1] forty per cent. of those examined, 41 in number, were classed by him as acquired cases. In 12 of these acquired cases the membrana tympani was perforated or destroyed on one or both sides. In 13 of the 17 cases, the deafness was traceable to the pharyngitis of scarlet fever or measles.

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, 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. It is not probable that deaf-mute parents are likely to beget children who do not hear, for the simple reason that in the large proportion of cases, the deafness depends upon inflammatory action, which is not transmitted, except possibly as a tendency or by anatomical conditions. Deafness dependent upon imperfect development of the ear or brain may be inherited.

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 :

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[1] Reprint from Boston Medical and Surgical Journal.

1. Inflammation of the middle ear, resulting in suppuration, or adhesions, anchylosis of the ossicula auditus, and so forth.

2. Inflammation of the nerve or labyrinth, resulting in suppuration or thickening of the membranous labyrinth, deposits in it, and so forth.

3. Arrested development, or absence of some parts of the essential part of the auditory apparatus.

These are the causes which are shown in the table given by Moos,[1] in his account collected from various authorities, of 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, as well as at their homes. It was not until the seventh century that the deaf-mutes were thought worthy of an education. The twentieth century 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 particulary to the suppurative forms of disease.

According to the census of 1880, there were in the United States 33,878 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.

The following table shows the results of an examination of the hearing power and membranæ tympani of 147 deaf-mutes, with a statement of the causes assigned for their loss of hearing.[2]

[1] Klinik der Ohrenkrankheiten, p. 341.

[2] Archives of Otology, vol. xiii., No. 1, March, 1884.

*Examination of Deaf-mutes with the Tuning-fork and Aural Speculum.*

| No. | Age in years. | Cause stated by parents or guardians, and age at which they say deafness appeared. | Right aërial conduction. | Right bone conduction. | Left aërial conduction. | Left bone conduction. | Right membrana tympani. | Left membrana tympani. | Remarks. |
|---|---|---|---|---|---|---|---|---|---|
| 1 | 17 | "Born deaf." | Yes. | Feels it. | Yes. | Feels it. | Good light spot, good color, obscured by soft wax. | Sunken, opaque, small light spot. | Has a brother who is deaf; hears the voice through the speaking-tube now, could not do so formerly. |
| 2 | 9 | "Born deaf." | ? | Yes. | ? | Yes. | Sunken, small light spot. | Sunken, no light spot. | |
| 3 | 16 | "Born deaf." | ? | Yes. | ? | Yes. | Sunken, small light spot, fair color. | Sunken, very small light spot, fair color. | |
| 4 | 12 | "Born deaf." | ? | ? | ? | ? | Obscured by wax. | Obscured by wax. | Has a deaf sister. |
| 5 | 12 | "Born deaf (?)" abscess in ear at 1½ years. | Yes. Duration 6″. | Yes. Louder. 18″. | Yes. Louder than left bone con. 12″. | Yes. 13″. | Obscured by wax. | Opaque, wax in canal. | Answers are sometimes contradictory; hears words spoken into left ear. |
| 6 | 14 | "Born deaf." | No. | No (?). | No. | No (?). | Opaque, small light spot. | Good color, good light spot. | Feels the tuning fork up to the ear when it is applied to the hand. |
| 7 | 15 | "Congenital (?)" | None. | Yes. | None. | Yes. | Opaque, large light spot. | Sunken, opaque, good light spot. | Has a cousin and uncle also deaf. |
| 8 | 11 | "Born deaf." | No. | Yes. | No. | Yes. | Good light spot, sunken. | Small light spot, sunken. | |
| 9 | 13 | "Born deaf." | No. | Yes. "Like a band of music." | No. | Yes. | Sunken, small light spot. | Sunken, small light spot. | Tuning-fork felt to wrist only; "like a steamboat." |

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| 10 | 15½ | "Born deaf." | None. | Feels it. | None. | Feels it. | Good light spot, sunken. | Congested small light spot, sunken. | Has two sisters deaf-mutes; says bones of hand feel tuning-fork same as mastoid; his ear is more sensitive to A sharp than to any other tone. |
| 11 | 10 | "Born deaf." | No. | No. | No. | No. | No light spot. | A small dot-like light spot. | Can hear vowel sounds and some consonants, but does not give any evidence of hearing or feeling the tuning-fork; says she does not feel the tuning-fork when it is applied to the back of hand. |
| 12 | 13 | "Born deaf." | No. | No. | Yes. (?) | No. | Slightly sunken, small light spot. | Fair color, small light spot. | Says he feels tuning-fork as far as the ear when applied to the hand. |
| 13 | 8 | "Born deaf." | No. | Yes. | No. | Yes. | Obscured by narrow canal. | Obscured by narrow canal. | Well-shaped auricles; has deaf-mute brother. |
| 14 | 15 | "Born deaf." | No. | Vibration. | No. | Vibration. | Sunken, good light spot, red along malleus. | Sunken, vascular along malleus. | Bone conduction feeble on forehead. |
| 15 | 10 | "Born deaf." | ? | ? | ? | ? | Much sunken, no light spot. | Cicatricial, perforation anteriorly. | |
| 16 | 7 | "Born deaf (?)." | No. | No. | No. | No. | Small light spot, sunken. | Sunken, small light spot. | |
| 17 | 8 | "Born deaf (?)." | ? | ? | ? | ? | Sunken, good light spot. | Very sunken, congested above the short process, small light spot. | |
| 18 | 11 | "Born deaf." | No. | Yes. | No. | Yes. | Good light spot, good color. | Good light spot, good color. | |
| 19 | 7 | "Born deaf." | No. | Yes. | No. | Yes. | Short process is prominent, good light spot. | Uncertain. | Feels the tuning-fork on hand. |

*Examination of Deaf-mutes with the Tuning-fork and Aural Speculum* (Continued).

| No. | Age in years. | Cause stated by parents or guardians, and age at which they say deafness appeared. | Right aërial conduction. | Right bone conduction. | Left aërial conduction. | Left bone conduction. | Right membrana tympani. | Left membrana tympani. | Remarks. |
|---|---|---|---|---|---|---|---|---|---|
| 20 | 10 | "Born deaf." | ? | Yes. | No. | Yes. | Opaque, no light spot. | Sunken, a dot-like spot. | |
| 21 | 18 | "Born deaf." | No. | Yes. | No. | Yes. | Good color, small light spot. | Obscured by soft wax. | Is very anæmic. |
| 22 | 12 | "Born deaf." | ? | ? | ? | ? | Sunken, no light spot. | No light spot, sunken, opaque. | |
| 23 | 12 | "Born deaf." | No. | Yes. | ? | Yes. | Sunken, good light spot, good color. | Good light spot, fair color. | Four out of six brothers and sisters are deaf. The mother and father are cousins. Feels the vibration of the tuning-fork from hand to shoulder on the left, and from hand to elbow on the right side. |
| 24 | 10 | "Born deaf." | Feeble. 8″. | Yes. 8″. | Feeble. 7″. | Yes. 6″. | Small light spot, opaque. | Small light spot, sunken, opaque in spots. | Feels the tuning-fork as far as her shoulder when it is applied to her knuckles, and says that it feels the same as it does when applied to the mastoid. |
| 25 | 11 | "Born deaf." | ? | ? | ? | ? | Sunken, small light spot, good color. | Sunken, pinkish, poor light spot. | |
| 26 | 11 | "Born deaf." | ? | Yes. | No. | Yes. | Good light spot, good color. | Present, no details. | Has a deaf-mute brother. |
| 27 | 9 | "Born deaf." | ? | ? | ? | ? | Very small light spot. | Cicatricial, much sunken. | Hears through speaking-tube. |
| 28 | 7 | "Born deaf." | No. | Yes. | No. | Yes. | Present, no details discoverable. | Present, no details discoverable. | |

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| 29 | 8 | "Born deaf." | No. | Yes. | No. | Yes. | Good light spot, fair color. | Sunken, small light spot. | |
| 30 | 8 | "Born deaf (?)." | No. | No. | No. | No. | Sunken, no light spot. | Sunken, good color, no light spot. | No perception of tuning-fork on hand. |
| 31 | 7 | "Born deaf." | ? | ? | ? | ? | Obscured by wax. | Cicatricial. | |
| 32 | 8 | "Born deaf." | No. | No. | No. | No. | Good light spot, sunken. | Opaque, sunken. | Tuning-fork negative on hand. |
| 33 | 19 | "Born deaf." | None. | Feels the tuning-fork almost the same as on hand. | None. | Feels the sound. | Cicatricial, with central perforation. | Sunken, fair light spot. | Never had earache or discharge. |
| 34 | 14 | "Born deaf." | No. | No. | No. | No. | Sunken, good light spot, good color. | Interrupted light spot, sunken, good color. | When tuning-fork is applied to the back of his hand he feels the vibration as far as his shoulder. The same on either side. |
| 35 | 11 | "Born deaf." | No. | Yes. | No. | No. | Very much sunken, small light spot. | Sunken, fair light spot. | One brother of his is a deaf-mute. Tuning-fork applied to hand is felt only as high as middle of forearm. |
| 36 | 14 | "Born deaf." | No. | Yes. | No. | Yes. | Sunken, neoplastic. | Poor light spot, opaque. | Has two sisters and one brother deaf. |
| 37 | 8 | "Born deaf." | ? | ? | ? | ? | Invisible from narrowness of canal. | Obscured by the narrowness of canal. | |
| 38 | 13 | "Born deaf." | No. | Yes. | No. | Yes. | Very much sunken, good light spot. | Good color, light spot, sunken. | Tuning-fork on hand is felt up to the ear on both sides. |
| 39 | 16 | "Born deaf." | No. | Yes. | No. | Yes. | Opaque, calcareous, degeneration, small light spot. | Vascular along malleus, no light spot, sunken. | Can hear some sounds. Feels the fork on hand the same as on mastoid. |

*Examination of Deaf-mutes with the Tuning-fork and Aural Speculum* (Continued).

| No. | Age in years. | Cause stated by parents or guardians, and age at which they say deafness appeared. | Right aërial conduction. | Right bone conduction. | Left aërial conduction. | Left bone conduction. | Right membrana tympani. | Left membrana tympani. | Remarks. |
|---|---|---|---|---|---|---|---|---|---|
| 40 | 16 | "Born deaf." | No. | Yes. | No. | Yes. | Slightly sunken, good light spot. | Present, obscured by wax. | |
| 41 | 13 | "Born deaf." | No. | Yes. | No. | No. | No light spot. | Present, no details discoverable. | Tuning-fork on hand is felt to the shoulder only. Has a brother and a sister deaf. |
| 42 | 11 | "Born deaf." | No. | Yes. | No. | Yes. | Good light spot, good color. | Small light spot. | She is a sister of No. 57. |
| 43 | 8 | "Born deaf." | ? | ? | ? | ? | Obscured by hard wax. | Small light spot, opaque. | |
| 44 | 12 | "Born deaf." | No. | Yes. | Yes. | Yes. | Good light spot, narrow canal. | Good light spot, view obscured. | Tuning-fork applied to hand is felt as far as the head. |
| 45 | 11 | "Cerebro-spinal meningitis at 3 years." | No. | Yes. | No. | Yes. | Opaque, sunken, small light spot. | Opaque, no details. | Corneal opacity in left eye. |
| 46 | 13 | "Spotted fever at 2 years." | No. | Yes. | Slight. 4″. | Yes. 8″. | Opaque, good light spot, sunken. | Good light spot, sunken. | |
| 47 | 10 | "Spotted fever at 1 year." | No. | No. | No. | No. | Sunken, neoplastic. | No light spot. | Hears through a speaking-tube. The tuning-fork negative on hand. |
| 48 | 16 | "Cerebro-spinal meningitis at 5 years." | No. | Yes. | No. | Yes. | Good color, sunken, small light spot. | Good color, sunken, small light spot. | |
| 49 | 11 | "Cerebro-spinal meningitis at 8 months." | Yes. | Yes. | No. | Yes. | Narrow canal, no details. | Opaque, no details by reason of narrowness of canal. | Does not hear through a tube. |

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| 50 | 12 | "Cerebro-spinal meningitis at 10 years." | ? | ? | ? | ? | Opaque, small light spot. | Opaque, no light spot. | Has cataract in the right eye from cerebro-spinal meningitis, with adherent iris, altered color of iris, and a shrivelled lens. Evidently a typical case of middle-ear trouble and choroiditis. |
| 51 | 13 | "Cerebro-spinal meningitis at 2 years." | No. | No. | Slight. 11″. | Feels it. 14″. | Good light spot, good color, sunken. | Good light spot, good color, sunken. | Says he feels the tuning-fork when applied to his hands the same as on the mastoid. |
| 52 | 12 | "Cerebro-spinal meningitis at 8 months." | ? | ? | ? | ? | Sunken, very small light spot. | Good color, very small light spot. | It is observed that none of the persons examined have hard wax in their ears. |
| 53 | 10 | "Cerebro-spinal meningitis at 8 years." | No. | Yes. | No. | Yes. | Sunken, opaque, no light spot. | Sunken, fair light spot. | |
| 54 | 16 | "Cerebro-spinal meningitis at 2 years." | No. | No. | No. | Yes. | Good light spot, vascular along malleus. | Good light spot, not vascular. | Feels tuning-fork on both hands as well as on left mastoid. He imitates it by saying "B" with a buzzing sound. |
| 55 | 15 | "Cerebro-spinal meningitis at 3½ years." | None. | Like piano. | None. | Yes. | Somewhat opaque, small light spot. | Sunken, opaque, good light spot. | |
| 56 | 13 | "Cerebro-spinal meningitis at 2 years." | No. | No. | No. | Little. | Opaque at periphery, good color, somewhat sunken. | Sunken, good light spot. | She says that she cannot make a noise like that noise the tuning-fork makes on her hand. Says it is the same noise as she hears in her ear. |

*Examination of Deaf-mutes with the Tuning-fork and Aurae Speculum* (Continued).

| No. | Age in years. | Cause stated by parents or guardians, and age at which they say deafness appeared. | Right aërial conduction. | Right bone conduction. | Left aërial conduction. | Left bone conduction. | Right membrana tympani. | Left membrana tympani. | Remarks. |
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| 57 | 16 | "Cerebro-spinal meningitis at 4 years." | No. | Feels something. | No. | Feels something. | Opaque, small light spot. | Cicatricial. | No perception of tuning-fork on forehead. |
| 58 | 13 | "Cerebro-spinal meningitis at 2 years." | No. | Yes. | No. | Yes. | Good light spot, somewhat sunken. | Poor light spot, sunken. | |
| 59 | 15 | "Cerebro-spinal meningitis at 4 years." | No. | Feeble. | No. | Feeble. | Opaque, good light spot. | Good light spot, sunken, fair color. | Feels tuning-fork better on the hand than on mastoid process. |
| 60 | 11 | "Spotted fever at 8 years and 8 mos." | No. | Yes. | No. | Yes. | Opaque, probably neoplastic. | Large opacity, neoplastic. | Does not remember that he could ever hear. Used to go to school, and now his speech is no better than that of those who never heard. |
| 61 | 15 | "Spotted fever at 3 years." | ? | Yes. | ? | Yes. | Sunken, good color, good light spot. | Sunken, good color, good light spot. | Hears through speaking-tube. |
| 62 | 10 | "Cerebro-spinal meningitis at 7 years." | ? | ? | ? | ? | Obscured by wax. | Opaque, no light spot. | |
| 63 | 20 | "Spotted fever at 8 years. Discharge from ears." | Yes. 3″. | Yes. Louder. 7″. | Yes. 6″. | Yes. 5″. | Cicatricial, perforation below. | Cicatricial, perforation above. | Hears better in a quiet place, and better some days than others. Hears words spoken in left ear, except sound of "Ch." Feels the tuning-fork on the hand more distinctly than over the mastoid process. |

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| 64 | 14 | "Spotted fever at 3 years." | No. | Yes. | No. | Yes. | Two excellent light spots, neoplastic? | Sunken, no light spot. | Has convergent, concomitant squint. |
| 65 | 11 | "Cerebro-spinal fever at 8 years." | No. | Yes. | No. | Yes. | Sunken, opaque, poor light spot. | Sunken, reddish in color. | |
| 66 | 16 | "Spotted fever at 3 years." | No. | Yes. | No. | Yes. | Cicatricial. | Opaque, three light spots. | Tuning-fork felt as far as shoulder when applied to hand. |
| 67 | 14 | "Cerebro-spinal meningitis at 2½ years." | No. | Yes. | No. | Yes. | Fair light spot, somewhat sunken, good color. | Smaller light spot, sunken. | Effect of fork is the same on hand as on mastoid. |
| 68 | 14½ | "Cerebro-spinal meningitis at 3 years." | ? | ? | No. | Yes. | Sunken, no light spot. | Sunken, no light spot. | |
| 69 | 12 | "Spotted fever at 1 year and 5 mos." | No. | Yes. | No. | Yes. | Sunken, opaque in spots, small light spot. | Sunken, opaque in spots, a second light spot above. | Tuning-fork applied to left hand is said to be felt in ear, not so in the right. |
| 70 | 8 | "Cerebro-spinal meningitis at 6 years." | No. | No. | No. | No. | Good light spot, somewhat sunken. | Obscured by soft wax. | Negative to tuning-fork. |
| 71 | 15 | "Spotted fever at 3 yrs. 6 mos." | No. | No. | No. | Yes. Like a whistle. | Sunken, small light spot. | Sunken, small light spot. | |
| 72 | 13 | "Scarlet fever at 4 years." | No. | No. | No. | No. | Absent. | Opaque, cicatricial. | Feels tuning-fork on hand up to elbow, although he says he does not feel it on mastoid. |
| 73 | 13 | "Scarlet fever at 2 years." | ? | ? | ? | ? | Sunken, opaque, small light spot. | Sunken, opaque, small light spot. | |
| 74 | 10 | "Scarlet fever at 3 years." | No. | Yes. | Yes. | Yes. | Sunken, small light spot. | Sunken, small light spot. | |
| 75 | 14 | "Scarlet fever at 8 years." | No. | Yes. Like a bee. | Yes. 4″. | Yes. 9″. | Perforated, discharge. | Granulations. | |
| 76 | 14 | "Scarlet fever at 3 years." | No. | Yes. | No. | Yes. | Suppurating tympanic cavity. | Suppurating tympanic cavity. | |

*Examination of Deaf-mutes with the Tuning-fork and Aural Speculum* (Continued).

| No. | Age in years. | Cause stated by parents or guardians, and age at which they say deafness appeared. | Right aërial conduction. | Right bone conduction. | Left aërial conduction. | Left bone conduction. | Right membrana tympani. | Left membrana tympani. | Remarks. |
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| 77 | 11 | "Scarlet fever at 1 year and 4 mos." | ? | ? | ? | ? | Sunken. | Congested along handle and upper border of malleus. | |
| 78 | 7 | "Scarlet fever at 4 years." | No. | Yes. | No. | Yes. | Absent, granulations in tympanic cavity. | Absent, granulations in tympanic cavity. | Constant offensive discharge from both ears. Eczematous eruption in both auricles. |
| 79 | 9 | "Scarlet fever at 3 years." | No. | Yes. | No. | Yes. | Opaque, no light spot. | Opaque, no light spot. | Has convergent concomitant squint. |
| 80 | 13 | "Scarlet fever at 4 years." | No. | Yes. | No. | Yes. | Absent, slight discharge from tympanic cavity. | Cicatricial. | |
| 81 | 15 | "Scarlet fever at 5 years." | No. | Yes. | No. | Yes. 8″. | Absent, tympanic cavity granular. | Cicatricial. | Bone conduction on forehead. |
| 82 | 7 | "Scarlet fever at 3 years." | No. | No. | No. | No. | Opaque, no light spot. | Opaque, no light spot. | Tuning-fork negative on hand. |
| 83 | 9 | "Scarlet fever at 2 years and 3 mos." | No. | Yes. | No. | Yes. | Ulcerated. | Cicatricial. | |
| 84 | 14 | "Scarlet fever at 3 years." | No. | Yes. | Yes. 3″. | Yes. 9″. | Sunken, a point-like light spot. | Sunken, a point-like light spot. | |
| 85 | 12 | "Scarlet fever at 6 years." | No. | Yes. | No. | Yes. | Neoplastic, perforated. | Neoplastic, red in centre. | Remembers that at one time he could hear. |
| 86 | 7 | "Scarlet fever at 4½ years." | No. | No. | No. | No. | Very thin, neoplastic. | Neoplastic. | Says "No" as to tuning-fork on hand. |
| 87 | 9 | "Scarlet fever at 3 years." | No. | No. | No. | No. | Obscured by epidermis. | Perforation, no discharge. | Says "No," in answer to question regarding perception of tuning-fork on hand. |

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| 88 | 10 | "Brain fever at 6 years." | ? | ? | ? | ? | Sunken, opaque, double light spot. | Cicatricial. | The interrogation point (?) is used when the answers are contradictory and unreliable, the fork being used sometimes while not vibrating as a test. |
| 89 | 13 | "Brain fever at 1 year." | No. | Yes. | No. | Yes. | Small light spot, sunken, good color. | Sunken, good light spot, good color. | From left hand feels vibration up to elbow; from right up to shoulder. This pupil has a brother and a sister who are deaf-mutes from "brain fever" at one year. |
| 90 | 13 | "Brain fever at 1 year." | No. | Yes. | No. | Yes. | Opaque, linear light spot. | Obscured by hard wax. | Feels tuning-fork to a point between wrist and elbow. |
| 91 | 11 | "Brain fever at 8 years." | ? | . | ? | ? | Sunken, opaque. | Sunken, opaque, small light spot. | Very prominent auricles. |
| 92 | 8 | "Brain fever at 4 years." | ? | ? | ? | ? | Soft wax. | Sunken, no light spot. | |
| 93 | 13 | "Brain fever at 2 years." | Slight. | Feeble. | Slight. | Feeble. | Cicatricial. | Obscured by wax. | Can hear some sounds spoken through speaking-tube into right ear. |
| 94 | 16 | "Brain fever at 5 years." | No. | No. | Yes. | Yes. | Neoplastic. | Fair light spot, sunken. | Has had a discharge from the right ear. |
| 95 | 12 | "Brain fever at 6." | Faint. Something like a bell. | Marked. Like a bell. | Faint. Singing. (?) | Like a bell. Duration 6". | Sunken, poor light spot. | Sunken, poor light spot. | |
| 96 | 16 | "Inflammation of brain at 1 year and 7 months." | No. | Feels it. | No. | Feels it. | Sunken, good color, small light spot. | Sunken, good color, good light spot. | Three of his family became deaf at one year of age. |
| 97 | 12 | "Inflammation of brain at 9 mos." | No. | Yes. | Yes. | Yes. | Pus in tympanic cavity. | Pus in tympanic cavity. | |

*Examination of Deaf-mutes with the Tuning-fork and Aural Speculum* (Continued).

| No. | Age in years. | Cause stated by parents or guardians, and age at which they say deafness appeared. | Right aërial conduction. | Right bone conduction. | Left aërial conduction. | Left bone conduction. | Right membrana tympani. | Left membrana tympani. | Remarks. |
|---|---|---|---|---|---|---|---|---|---|
| 98 | 12 | "Inflammation of brain at 1 year and 7 months." | No. | Yes. | No. | Yes. | Somewhat opaque, small light spot. | Sunken, opaque, small light spot. | Tuning-fork said to be felt in ear when applied to hand. Same on both sides. |
| 99 | 12 | "Inflammation of brain at 8 mos." | No. | Yes. | No. | Yes. | Good light spot, good color, not sunken. Normal. | Somewhat sunken, obscured by epidermis. | |
| 100 | 11 | "Congestion of brain at 1 year and 2 months." | No. | Yes. | Yes. | Yes. | Sunken, good color, good light spot. | Sunken, good color, small light spot. | |
| 101 | 9 | "Unknown." | No. | Yes. | No. | Yes. | Opaque, sunken, good light spot. | Opaque, sunken, fair light spot. | Large auricles. |
| 102 | 9 | ? | ? | Yes. | ? | Yes. | No details observable. | Opaque, no details. | |
| 103 | 13 | ? | No. | Yes. | No. | Yes. | Sunken, small light spot. | Sunken, small light spot. | Tuning-fork is felt from hand (to which it is applied) only to the wrist. |
| 104 | 15½ | ? | None. | Yes. | None. | Yes. | Good color, fair light spot. | Small light spot. | Says the tuning-fork on mastoid feels "more" and "like music" more than on the hand. |
| 105 | 8 | "Unknown." | No. | Yes. | No. | Yes. | Opaque, sunken, interrupted light spot. | Opaque, sunken, small light spot. | |
| 106 | 17 | ? | ? | ? | ? | ? | Sunken, small light spot. | Sunken, small light spot. | Rejected because of contradictory replies. Hears through speaking-tube. |

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| 107 | 19 | ? | None. | A noise. | Slight. Duration 4″. | Noise and vibration. 5″. | Good light spot, slightly sunken, good color. | Good light spot, opaque. | Says she hears better with left ear. Hears one note better than any other. |
| 108 | 13 | "Measles at 1½ year." | ? | ? | ? | ? | Sunken, no light spot. | No light spot. | Hears through speaking-tube. |
| 109 | 15 | "Measles at 1 year." | ? | ? | ? | ? | Obscured by wax. | Opaque, good light spot. | Has a feeble-minded brother. |
| 110 | 14 | "Measles at 10 months." | ? | ? | ? | ? | Good light spot, sunken. | No light spot, much sunken. | Hears the voice through the speaking-tube. |
| 111 | 14 | "Measles at 1 year and 9 months." | No. | Yes. | Yes. 10″. | Yes. 8″. Louder. | Obscured by hard wax. | Sunken, one light spot above the short process and two below. | Hears through speaking-tube. |
| 112 | 18 | "Measles at 10 months." | None. | Feels it. | None. | Feels it. | Sunken, congested, narrow canal. | Obscured by soft wax, canal narrow. | Feels the tuning-fork over mastoid the same as he feels it on back of hand. Totally deaf. Had a harsh voice, which has become softer and more agreeable through education in directing his own voice to his ear through a speaking-tube. |
| 113 | 16 | "Measles at 6 months." | No. | Yes. | No. | Yes. | Obscured by wax. | Obscured by wax. | Has a deaf-mute sister. The tuning-fork on mastoid seems to make very little impression, as shown in his face. Says it feels the same on hand as on mastoid. But as usual *when one says he feels it, it is recorded as bone conduction.* |

*Examination of Deaf-mutes with the Tuning-fork and Aural Speculum* (Continued).

| No. | Age in years. | Cause stated by parents or guardians, and age at which they say deafness appeared. | Right aërial conduction. | Right bone conduction. | Left aërial conduction. | Left bone conduction. | Right membrana tympani. | Left membrana tympani. | Remarks. |
|---|---|---|---|---|---|---|---|---|---|
| 114 | 13 | "Measles at 2 years." | No. | Yes. | No. | No. | Sunken, no light spot. | Sunken, no light spot. | Hears through speaking-tube. |
| 115 | 15 | "A fall at 5 years." | Yes. 6″ or 7″. | Louder. 7″. | No. | Yes. | Present, no details. | Present, no details. | Says that effect (vibration) of tuning-fork applied to hands extends up to the ear. |
| 116 | 11 | "Fall at 11 months." | ? | ? | ? | ? | Sunken, opaque on periphery, fair light spot. | Sunken, opaque on periphery, no light spot. | |
| 117 | 16 | "Fall on head at 11 months." | No. | Yes. Like wire. | No. | Yes. Like wire. | Good light spot, sunken, fair color. | Sunken, pinkish, good light spot. | |
| 118 | 14 | "Fall on head at 3 years." | No. | Yes. | No. | Yes. | Obscured by wax. | Opaque, sunken, no light spot. | |
| 119 | 8 | "Fall on head at 5 months." | ? | ? | ? | ? | Obscured by wax. | Obscured by wax. | |
| 120 | 12 | "Fall on head at 2 years and 6 mos." | No. | Yes. | No. | No. | Good light spot. | Small light spot. | Tuning-fork "heard" on hands. |
| 121 | 13 | "Fall on head at 5 years." | No. | No. | No. | Yes. | Sunken, small light spot, good color. | Sunken, small light spot, good color. | |
| 122 | 7 | "Meningitis at 6 years." | ? | ? | ? | ? | Sunken, double light spot. | Cicatricial, some discharge. | He lost the power of speech at six years of age, very quickly after deafness came on; lost the memory of words that he had previously known. |
| 123 | 7 | "Meningitis at 4 years." | No. | Yes. | No. | Yes. | Cicatricial. | Opaque, sunken, small light spot. | |

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|---|---|---|---|---|---|---|---|---|---|
| 124 | 13 | "Spinal meningitis at 2½ years." | No. | No (?). | No. | Yes. Feeble. | Obscured by hard wax. | Obscured by hard wax. | He says the tuning-fork is "heard" on the back of his hand (when it is applied thereto), and he makes a gesture to indicate that the vibration passes up the arm. The same gesture is made by many others. |
| 125 | 12 | "Spinal trouble at 5 years." | No. | Yes. | No. | Yes. | Sunken, good light spot, opaque, especially around periphery. | Opaque, neoplastic. | Tuning-fork felt as far as the ear when applied to the hand. |
| 126 | 10 | "Spinal meningitis at 6½ years." | No. | Yes. | No. | Yes. | Sunken, no light spot. | Sunken, no light spot. | |
| 127 | 13 | "Convulsions from eating raisins at 8 months." | No. | Marked. Like telegr'ph pole. | No. | Yes. Like telegr'ph pole. | Opaque on margin, small light spot, good color. | Opaque on margin, small light spot, good color. | Tuning-fork was felt longer on hand. He described the effect of the tuning-fork by uttering a musical note whether the fork was applied to the hand or to the mastoid. He uttered the same note given by the tuning-fork when it was applied to the mastoid, and a lower note when it was applied to the hand. |
| 128 | 14 | "Convulsions at 1 year and 4 mos." | No. | Yes. | Yes. | Yes. | Opaque, sunken, good light spot. | Opaque, sunken, good light spot. | Hears words spoken through a tube in both ears with difficulty. Left ear the better one. |

*Examination of Deaf-mutes with the Tuning-fork and Aural Speculum* (Continued).

| No. | Age in years. | Cause stated by parents or guardians, and age at which they say deafness appeared. | Right aërial conduction. | Right bone conduction. | Left aërial conduction. | Left bone conduction. | Right membrana tympani. | Left membrana tympani. | Remarks. |
|---|---|---|---|---|---|---|---|---|---|
| 129 | 11 | "Convulsions at 1 year." | No. | Yes. | No. | Yes. | Opaque, no light spot. | Opaque, sunken, small light spot. | |
| 130 | 13 | "Convulsions at 1½ years." | No. | Yes. | No. | Yes. | Opaque, especially around periphery. | Opaque, no light spot. | Tuning-fork felt only to elbow when applied to hand. |
| 131 | 12 | "Hydrocephalus." | No. | Yes. | No. | Yes. | Obscured by wax. | Sunken, perhaps perforated, obscured by wax. | |
| 132 | 12 | "Hydrocephalus at 1 year and 7 mos." | No. | Feeble. | No. | Feeble. | Sunken, small light spot. | Sunken, no light spot. | |
| 133 | 12 | "Hydrocephalus at 2 months." | ? | ? | ? | ? | Opaque, no light spot. | Opaque, no light spot. | |
| 134 | 9 | "Fever at 5 years." | Yes (?). | Yes. | Yes (?). | Yes. | Exceedingly prominent short process with a light spot above and below it. | Very prominent short process with a light spot above and below it. | |
| 135 | 15 | "Fever at 9 mos." | No. | Yes. | No. | Yes. | Sunken, small light spot. | Sunken, a dot-like light spot. Cicatricial. | Tuning-fork heard from hand up to ear. |
| 136 | 17 | "Fever at 5 years." | No. | Like a spring when pressed and then let go. | No. | Like a spring when pressed and then let go. | Opaque, feeble light spot at end of malleus and two at handle. | | Remembers that he could hear once. Bone conduction feeble on forehead. |
| 137 | 12 | "Pneumonia at 1 year and 9 mos." | No. | Yes. | No. | Yes. | Sunken, small light spot. | Obscured by wax. | Has lost one leg through being run over by the cars. |
| 138 | 10 | "Pneumonia at 8 months." | ? | ? | ? | ? | Opaque, sunken, no light spot. | Opaque, sunken, small light spot. | |

| | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| 139 | 12 | "Whooping-cough in infancy." | ? | ? | ? | ? | Good light spot, sunken, opaque. | Opaque, small light spot. | A sister of hers is a deaf-mute in the same institution. |
| 140 | 14 | "Whooping-cough and intermittent fever at 2 years and 9 months." | Slight. 3″. | Louder. 8″. | Slight. 4″. | Louder. 4″. | Sunken, good color, interrupted light spot, opaque on margin. | Sunken, red along malleus, opaque on margin, interrupted light spot. | |
| 141 | 13 | "Mumps at 6 yrs." | ? | ? | ? | ? | Opaque, small light spot. | Fair light spot, good color, sunken. | |
| 142 | 9 | "Mumps when a few months old." | ? | ? | ? | ? | Cicatricial. | Cicatricial. | |
| 143 | 14 | "Syphilis (?)." | No. | Yes. | No. | Yes. | Much sunken, no light spot. | Slightly sunken, medium-sized light spot. | Syphilitic history; syphilitic teeth, and has had interstitial keratitis. |
| 144 | 12 | "Cholera infantum at 1 year." | No. | Yes. | No. | Yes. | Much sunken, no light spot. | Sunken, no light spot. | Vibrations of fork when applied to either hand are said to extend to the ear of that side. Says she feels the tuning-fork when it is applied to the bones of the head, and as usual this is set down as "bone conduction." |
| 145 | 15 | "Gastric fever at 2 years and 8 mos." | Yes. | Yes. Feeble. | No. | Yes. Feeble. | Sunken, opaque, small light spot. | Sunken, good color, small light spot. | |
| 146 | 14 | "Intermittent fever and spasm at 2 years." | No. | Yes. | No. | Yes. | Small light spot. | Small light spot. | Vibrations of fork extend from hand to ear. |
| 147 | 12 | "Varioloid at 1 year and 4 months." | No. | Yes. | Slight. 6″. | Louder. 7″. | Obscured by soft wax. | Good color, good light spot, sunken. | |

The following table shows the statistics of deaf-mutes in this country in 1880:

| | |
|---|---|
| Total | 33,878 |
| Males | 18,567 |
| Females | 15,311 |
| Native | 30,507 |
| Foreign | 3,371 |
| White | 30,661 |
| Colored | 3,217 |

Total population of the United States:

| | |
|---|---|
| Native | 43,475,840 |
| Foreign | 6,679,943 |
| | 50,155,783 |

In the year 1867, in conjunction with the late Dr. George M. Beard, I examined 296 deaf-mutes with a view of contributing something to our knowledge of the causes of deaf-muteism. The results of these examinations were meagre, and they were made to appear even less complete than they were in reality, because the editor of the journal in which they were published[1] could not give us the space to publish the tables upon which our conclusions were founded, and because the tables were lost so that they could not be published elsewhere. Since the use of the tuning-fork has come to play such an important part in aural diagnosis, it has been made available also in the examination of deaf-mutes. De Rossi,[2] of Rome, has made the most complete examinations of which I know, as to the hearing power of deaf-mutes. He examined seventy individuals with the speaking-tube and tuning-fork. Twenty-seven heard the voice, four the watch, thirty-nine the tuning-fork vibrating in the air. Nearly all of the seventy perceived the vibrations through the bones, eleven only had no perception by bone-conduction, and De Rossi found only three cases of what he termed total deafness. These examinations of De Rossi seem to me to furnish more reliable data than the cases of Toynbee and Kramer, and chiefly because the examination by the tuning-fork and speaking-tube was not made by them. Accordingly, I have imitated the examinations of De Rossi in those I have made. The imitation was an unconscious one, however, for it was not until I had nearly finished my examinations, that I found from a scanty reference in Hart-

[1] American Journal of the Medical Sciences, vol. liii., p. 399.

[2] Relazione sopra l' Ospizio dei Sordi-Muti de Roma. Quoted by Hartmann. "Deaf-Mutism." Translation, p. 84.

mann's book on deaf-muteism, that De Rossi had preceded me in these tests.

The tuning-fork seems to me a very important means of determining the seat of the lesion, in cases of impairment of the hearing in which muteism does not result. I was desirous to know what it would indicate in those who are dumb as well as deaf. I found in the institution for the improved instruction of deaf-mutes in this city, the most ample opportunities for examinations. Every facility was afforded me by the principal, Mr. Greenberger, and I desire to thank him not only for the advantages he so liberally afforded me, but also for his valuable assistance given in a truly scientific spirit. I was also assisted by Dr. J. B. Emerson and Dr. George J. Bull, without whose aid I should not have been able to accomplish the work of examining so many pupils. I used a "$C^2$" tuning-fork in the examination as to the aërial and bone-conduction. The tests by speaking-tube were made by Mr. Greenberger, and I have relied wholly upon his statements as to that point.

TABLE I.—*One Hundred and Forty-seven Cases of Deaf-Muteism* (*causes stated by parent or guardian*).

| | No. | | No. |
|---|---|---|---|
| Born deaf | 44 | Whooping-cough | 2 |
| Cerebro-spinal meningitis | 27 | Spinal trouble | 1 |
| Scarlet fever | 16 | Mumps | 2 |
| Brain fever | 13 | Pneumonia | 2 |
| Meningitis | 4 | Gastric fever | 1 |
| Measles | 7 | Cholera infantum | 1 |
| Fall on head | 7 | Intermittent fever | 1 |
| Unknown | 7 | Syphilis | 1 |
| Convulsions | 4 | Varioloid | 1 |
| Hydrocephalus | 3 | | |
| Fever | 3 | | 147 |

In regard to this table, I can only say that it is as reliable as any that it seems possibl to get from any institution. As far as the statements as to scarlet fever, measles, cerebro-spinal meningitis, meningitis, mumps, and syphilis go, I think it may be considered trustworthy. When we enter the domain of congenital deafness, or such causes as "spinal trouble," "fall on head," "convulsions," there is great uncertainty as to the actual cause. Yet these causes are taken from blanks carefully filled out by the parents or guardians, many of them very intelligent people of the higher walks of life, who send their children to be under Mr. Greenberger's care. The causes are more accurately

given, than in the other institutions in which I have made examinations. It will be seen there were only fifty-one cases, adding together the congenital and "unknown," or a little more than thirty per cent., which may, with much probability, be considered congenital cases. In our tables of 1867, we classified sixty-one per cent. as congenital cases. Hartmann's tables[1] show that of 8404 deaf-mutes 5546, or more than sixty-five per cent., were considered as congenital cases. His statistics are apparently made up largely of official and not personal examinations; for in the examinations made in Berlin by Hartmann himself, one hundred and eighty-five in number, only forty-five are classified as congenital cases; and those made by Cohn, in Breslau, show about the same proportion—that is, of one hundred and thirty deaf-mutes, fifty-seven are said to have been born deaf, while in other parts of Germany, and in Ireland, the proportion of congenital cases is much larger. I regard the official tables of all countries as valueless, except as to the total number of deaf-mutes. Those who collect them, are usually entirely incompetent for the sifting of evidence necessary to get even approximate truth upon this point.

TABLE II.—*Results of the Examination with the Tuning-fork* $C^2$ *of One Hundred and Forty-seven Deaf-Mutes.*

| | |
|---|---|
| There was no aërial conduction on either side, while bone conduction existed in | 74 |
| Bone conduction on one side, both bone and aërial on the other, in | 1 |
| No bone or aërial conduction on one side, bone conduction on the other | 10 |
| Bone and aërial conduction, both sides | 7 |
| Bone and aërial conduction on one side, bone on the other | 13 |
| Neither bone nor aërial conduction on either side | 12 |
| No bone or aërial conduction on one side, both bone and aërial on the other | 1 |
| | 118 |

In twenty-nine cases the subjects were too young or were otherwise incapacitated for intelligent answers: hence no conclusions could be formed, except that the large majority of them probably heard the tuning-fork by bone conduction.

I will now present a series of tables made in consonance with the supposed cause of the deafness.

[1] Loc. cit., p. 64.

TABLE III.—*Scarlet Fever being Cause of Deafness, Condition of Membrana Tympani* (16 *cases*, 32 *ears*).

| | |
|---|---|
| Absent | 1 |
| Opaque and cicatricial | 4 |
| Sunken, opaque, small or no light spot | 11 |
| Perforate and ulcerating | 9 |
| Congested | 2 |
| Neoplastic and perforate | 1 |
| Neoplastic | 2 |
| Not well seen | 1 |
| Perforate, no discharge | 1 |
| | 32 |

*Tuning-Fork Test.*

| | |
|---|---|
| No aërial conduction but bone conduction | 17 |
| Bone and aërial conduction | 3 |
| No bone or aërial conduction | 8 |
| Unreliable | 4 |
| | 32 |

Age of patients at time of becoming deaf:

| | |
|---|---|
| From 2 to 3 years | 2 |
| " 3 " 4 " | 8 |
| " 4 " 5 " | 3 |
| " 5 " 6 " | 1 |
| " 6 " 7 " | 1 |
| " 8 " 9 " | 1 |
| | 16 |

There is in these scarlet fever cases a large proportion—8, or one in 4—where disease of the nerve certainly existed. It will also be remarked that there is a large proportion of cases of ulcerative disease. That an ulcerative disease of the tympanum may more readily involve the internal ear than a plastic or catarrhal inflammation, is probably true. Yet the starting-point of otitis in scarlet fever is usually the middle ear.

TABLE IV.—*Measles Cause of Deafness, Condition of Membrana Tympani* (7 *cases*, 14 *ears*).

| | |
|---|---|
| Sunken, no light spot, opaque | 5 |
| Congested | 1 |
| Sunken light spot | 1 |
| Not well seen | 5 |
| Opaque, but good light spot | 2 |
| | 14 |

*Tuning-Fork Test.*

| | |
|---|---|
| Bone conduction but no aërial conduction | 6 |
| Bone and aërial conduction | 1 |
| No bone or aërial conduction | 1 |
| Unreliable | 6 |
| | 14 |

It will be noted that only one case occurs here of those of whom a reliable test could be made, in which it is possible that disease of the nerve alone exists—that is, the case in which there was neither bone nor aërial conduction.

Age at which deafness occurred:

| | |
|---|---|
| Under 1 year | 3 |
| From 1 to 2 years | 3 |
| " 2 " 3 " | 1 |
| | 7 |

TABLE V.—*Cerebro-Spinal Meningitis Cause of Deafness, Condition of Membrana Tympani* (27 *cases*, 54 *ears*).

| | |
|---|---|
| Cicatricial | 6 |
| Opaque | 6 |
| Sunken, fair light spot | 10 |
| " good color | 8 |
| " small or no light spot | 16 |
| Not well seen | 3 |
| Opaque, good light spot | 1 |
| Cicatricial and perforate | 2 |
| Congested and sunken | 1 |
| Congested | 1 |
| | 54 |

*Tuning-Fork Test.*

| | |
|---|---|
| Bone conduction only, no aërial conduction | 34 |
| Bone and aërial conduction | 5 |
| Neither bone nor aërial conduction | 8 |
| | 47 |
| Unreliable | 7 |

Here the proportion of cases in which it may be conjectured that the nerve alone is involved, was not as large even as in scarlet fever. There were only eight ears of a total of fifty-four, or about one in seven. It is in this disease, that an affection of the nerve has been often assumed to be the most frequent cause of the deafness.

My clinical experience has been against this view, and I believe that the few post-mortem examinations that have been made of persons with aural disease in cerebro-spinal meningitis, go to support the view of that experience, which is that a lesion beginning in the middle ear, is in a large percentage of cases the cause of the deafness.

TABLE VI.—*Deafness said to be Congential, Condition of Membrana Tympani* (44 *cases*, 88 *ears*).

| | |
|---|---|
| Normal color and light spot | 11 |
| Sunken, opaque, or no light spot | 34 |
| Obscured by wax | 10 |
| Opaque, large light spot | 1 |
| Sunken, opaque, but good light spot | 14 |
| Congested, sunken, and small light spot | 5 |
| Obscured by narrow canal | 6 |
| Cicatricial and perforate | 3 |
| Opaque, calcareous | 1 |
| | 88 |

*Tuning-Fork Test.*

| | |
|---|---|
| Bone conduction, but no aërial | 48 |
| Bone and aërial | 8 |
| Neither aërial nor bone | 14 |
| Unreliable | 18 |
| | 88 |

Here the proportion of cases of apparent nerve or central disease is quite high—fourteen to forty-eight, or a little more than one to three.

TABLE VII.—"*Brain fever*," "*Inflammation of Brain*," "*Meningitis*," *and* "*Congestion of Brain*" *said to be the Cause of Deafness, Condition of Membrana Tympani* (15 *cases*, 30 *ears*).

| | |
|---|---|
| Sunken, opaque, small, or no, or double light spot | 12 |
| Normal | 1 |
| Sunken, good color, good light spot | 7 |
| Cicatricial | 4 |
| Not well seen | 3 |
| Perforate and ulcerating | 3 |
| | 30 |

*Tuning-Fork Test.*

| | |
|---|---|
| Bone conduction only | 18 |
| Aërial and bone | 4 |
| Uncertain | 8 |
| | 30 |

Age of patients when deafness occurred:

| | |
|---|---|
| Less than 1 year | 2 |
| From 1 to 2 years | 5 |
| " 2 " 3 " | 1 |
| " 4 " 5 " | 2 |
| " 5 " 6 " | 1 |
| " 6 " 7 " | 3 |
| " 8 " 9 " | 1 |
| | 15 |

TABLE VIII.—*Fall on Head Cause of Deafness, Condition of Membrana Tympani* (*7 cases,* 14 *ears*).

| | |
|---|---|
| Not well seen | 5 |
| Sunken, opaque, fair or good light spot | 2 |
| Sunken, no light spot | 2 |
| Good light spot but sunken | 2 |
| Sunken, congested | 1 |
| Good light spot | 1 |
| Small " " | 1 |
| | 14 |

*Tuning-Fork Test.*

| | |
|---|---|
| Bone conduction only | 8 |
| Neither bone nor aërial | 1 |
| Bone and aërial conduction | 1 |
| Unreliable | 4 |
| | 14 |

TABLE IX.—*Cause Unknown* (*7 cases,* 14 *ears*).

| | |
|---|---|
| Opaque, sunken, good light spot | 4 |
| Not well seen | 1 |
| Opaque | 1 |
| Good color, fair light spot | 1 |
| Small light spot | 1 |
| Opaque and sunken | 2 |
| Sunken, small light spot | 2 |
| " good light spot | 1 |
| Opaque, good light spot | 1 |
| | 14 |

*Tuning-Fork Test.*

| | |
|---|---|
| Bone conduction only | 10 |
| Uncertain | 4 |
| | 14 |

TABLE X.—*Convulsions Cause of Deafness, Condition of Membrana Tympani* (4 *cases*, 8 *ears*).

| | |
|---|---|
| Opaque, small light spot, good color | 2 |
| " sunken, good light spot | 2 |
| Opaque | 2 |
| " small light spot | 2 |
| | 8 |

*Tuning-Fork Test.*

| | |
|---|---|
| Bone conduction only | 5 |
| Aërial and bone conduction | 3 |
| | 8 |

Age at which deafness occurred:

| | |
|---|---|
| Less than 1 year | 1 |
| From 1 to 2 years | 3 |
| | 4 |

TABLE XI.—*Syphilis Cause of Deafness, Condition of Membrana Tympani* (1 *case*, 2 *ears*).

Right much sunken, no light spot; left slightly sunken, medium-sized light spot.

*Tuning-Fork Test.*

Right, no aërial conduction, but bone conduction; left, same.

In this case, the only one found, there was a syphilitic history; notched teeth; the subject has had interstitial keratitis. The disease seems to be confined to the middle ear.

TABLE XII.—*Hydrocephalus Cause of Deafness, Condition of Membrana Tympani* (3 *cases*, 6 *ears*).

| | |
|---|---|
| Not well seen | 1 |
| Sunken, perhaps perforate | 1 |
| " small light spot | 2 |
| Opaque, no light spot | 2 |
| | 6 |

*Tuning-Fork Test.*

| | |
|---|---|
| Bone conduction only | 6 |

Age:

| | |
|---|---|
| Less than 1 year | 1 |
| From 1 to 2 years | 1 |
| Unknown | 1 |
| | 3 |

TABLE XIII.—*Spinal Meningitis Cause of Deafness, Condition of Membrana Tympani* (3 *cases*, 6 *ears*).

| | |
|---|---|
| Not well seen | 2 |
| Sunken, opaque, good light spot | 1 |
| Opaque and cicatricial | 1 |
| Sunken, no light spot | 2 |
| | 6 |

*Tuning-Fork Test.*

| | |
|---|---|
| Bone conduction only | 6 |
| Age: | |
| From 2 to 3 years | 1 |
| " 5 " 6 " | 1 |
| " 6 " 7 " | 1 |
| | 3 |

TABLE XIV.—*Varioloid Cause of Deafness, Condition of Membrana Tympani* (1 *case*, 2 *ears*).

| | |
|---|---|
| Not well seen | 1 |
| Good color, good light spot, sunken | 1 |
| | 2 |

*Tuning-Fork Test.*

| | |
|---|---|
| Aërial and bone conduction | 1 |
| Bone conduction only | 1 |
| | 2 |

Age at which deafness occurred: one year and four months.

TABLE XV.—*Pneumonia Cause of Deafness, Condition of Membrana Tympani* (2 *cases*, 4 *ears*).

| | |
|---|---|
| Sunken, small light spot | 1 |
| Not well seen | 1 |
| Opaque, sunken, no light spot | 2 |
| | 4 |

*Tuning-Fork Test.*

| | |
|---|---|
| Bone conduction only | 2 |
| Uncertain | 2 |
| | 4 |
| Age: | |
| Less than 1 year | 1 |
| From 1 to 2 years | 1 |
| | 2 |

TABLE XVI.—*Whooping-Cough Cause of Deafness, Condition of Membrana Tympani* (2 *cases*, 4 *ears*).

| | |
|---|---|
| Good light spot, sunken, opaque | 1 |
| Opaque, small light spot | 1 |
| Sunken, good color | 1 |
| Sunken and congested | 1 |
| | 4 |

*Tuning-Fork Test.*

| | |
|---|---|
| Uncertain | 1 |
| Both aërial and bone conduction | 1 |
| | 2 |

Age:

| | |
|---|---|
| "In infancy" | 1 |
| Whooping-cough, intermittent fever at two years and nine months | 1 |
| | 2 |

TABLE XVII.—*Cholera Infantum Cause of Deafness, Condition of Membrana Tympani* (1 *case*, 2 *ears*).

| | |
|---|---|
| Sunken, no light spot | 11 |

*Tuning-Fork Test.*

| | |
|---|---|
| Bone conduction only | 2 |

Age one year.

TABLE XVIII.—*Gastric Fever Cause of Deafness, Condition of Membrana Tympani* (1 *case*, 2 *ears*).

| | |
|---|---|
| Sunken, opaque, small light spot | 1 |
| Sunken, good color, small light spot | 1 |
| | 2 |

*Tuning-Fork Test.*

| | |
|---|---|
| Bone conduction only, and that feeble | 2 |

Diseases at two years and eight months.

TABLE XIX.—*Intermittent Fever Cause of Deafness, Condition of Membrana Tympani* (1 *case*, 2 *ears*).

| | |
|---|---|
| Small light spot | 2 |

*Tuning-Fork Test.*

| | |
|---|---|
| Bone conduction only | 2 |

Intermittent fever and spasms at two years.

TABLE XX.—*Mumps Cause of Deafness, Condition of Membrama Tympani* (2 *cases*, 4 *ears*).

| | |
|---|---|
| Right opaque, small light spot; left fair light spot, good color, sunken | 2 |
| Right and left cicatricial | 2 |
| | 4 |

*Tuning-Fork Test, Unreliable.*

| | |
|---|---|
| Age: | |
| A few months old | 1 |
| Six years | 1 |
| | 2 |

TABLE XXI.—*Fever Cause of Deafness, Condition of Membrana Tympani* (3 *cases*, 6 *ears*).

| | |
|---|---|
| Sunken, two light spots | 2 |
| Sunken, small light spot | 2 |
| Opaque, small " " | 1 |
| Cicatricial | 1 |
| | 6 |

*Tuning-Fork Test.*

| | |
|---|---|
| Both aërial and bone conduction | 2 |
| Bone conduction only | 4 |
| | 6 |
| Age: | |
| Nine months | 1 |
| Five years | 2 |
| | 3 |

TABLE XXII.—*Cases in which Words or Letters could be Heard through a Speaking-tube placed in the Ear;*[1] *Condition of Membrana Tympani* (16 *cases*, 32 *ears*).

| | |
|---|---|
| Opaque | 6 |
| Sunken | 15 |
| Good color | 4 |
| Good light spots | 8 |
| Small " " | 6 |
| No " " | 6 |
| Two light spots | 1 |
| Cicatricial | 5 |
| Calcareous | 1 |
| Vascular | 1 |
| Perforated | 2 |
| Not well seen | 3 |

[1] In this table the various appearances of the membrana tympani are noted without regard to the number of ears.

*Tuning-Fork Test.*

| | |
|---|---|
| Both aërial and bone conduction | 4 |
| Bone only | 2 |
| Bone both sides, aërial on one side | 3 |
| Bone and aërial on one side, neither on the other | 1 |
| Neither bone nor aërial on either side | 2 |
| Unreliable | 4 |
| | 16 |

*Disease Causing Deafness.*

| | |
|---|---|
| Born deaf | 5 |
| Measles | 4 |
| Cerebro-spinal meningitis | 3 |
| Brain fever | 1 |
| Convulsions | 1 |
| Scarlet fever | 1 |
| Unknown | 1 |
| | 16 |

To this last table, the words of Mr. Greenberger should be added:

"The speaking-tube is used in these cases to assist the scholars to speak better after they have learned to pronounce them from the lips. There is not a pupil in the school who could be taught to speak a word from hearing it through the tube alone, but they will recognize words with which they have become familiar through lip-reading."

A study of these tables, especially with reference to the conduction of sounds to the ears or auditory centres through bone, indicates to me that a large percentage of these deaf-mutes lost their hearing from disease of the middle ear, and that the acoustic nerve was still capable of appreciating sound. It will be observed that in the column of the table in which the answer as to the perception of the sound of the tuning-fork through bone is given, it is stated in many instances that the subject of examination states that he or she "*feels*" it. I have endeavored to make the tables a mirror of what actually occurred in the examinations. It may be stated that to *feel* the vibrations of the tuning-fork is not to *hear* them, but I am inclined to think that in most instances, if not all, this perception is actually a perception of sound. A little thought as to what sound is will, I think, substantiate this view. We found, as will be seen, a small contingent who did not respond in any way to the vibrations of the fork. In this small contingent the functions of

the nerve were probably destroyed. It is natural to suppose that about the same proportion of infants and very young children would suffer a lesion of the middle rather than the internal ear, in case the organ is attacked by disease, as would be the case in adults, and this seems to be indicated by these tables.

The deaf-mutes from whom these tables are made up, are, so to speak, selected cases, for all or nearly all of them have good intellects and are capable of being taught. There do not appear among them, therefore, any cases in which there is a lack of ordinary cerebral development. In classifying unselected deaf-mutes, or those taken from the whole number to be found in a district or county, the number of those deaf from disease of the central apparatus would, of course, be increased.

It is interesting to notice that a larger number of the cases are attributed to cerebro-spinal meningitis than to any one cause. There were 27 cases of this kind to 16 of scarlet fever. "Brain fever" or meningitis plays an important part in the etiology, for there were 17 cases among the total number of 147. I cannot but hope that the careful instruction of the public and the profession, as to the necessity for the treatment of suppuration of the ear, has borne fruit, in the prevention of many cases of destruction of the ears by the means used to stop the inflammation. In the examinations made by Dr. Beard and myself some eighteen years ago, there was a larger percentage of cases caused by scarlet fever and producing suppuration in the middle ear. We seem as yet without means of successfully treating an inflammation of the ear, when it occurs in the course of cerebro-spinal meningitis. If there be an inflammation of the membranous labyrinth, which is mistaken for this disease, it is as yet not at all recognized by the profession at large.

The observations of Mr. Lawson Tait[1] upon the congenital deafness of white cats have an interesting bearing upon the situation of the lesion in deaf-mutes. Mr. Tait says of a cat that lived in his house for eleven years, that he was deaf to impressions conveyed through the air, "but his intelligence could be reached by impressions conveyed through solid media." When he was wanted, he would respond to a peculiar stamp on the floor. After this interesting statement, Mr. Tait passes, as it seems to me, out of the region of facts, to state that "human deaf-mutes are those in whom deafness is cochlear as well as tympanic." From this premise he concludes that cats are not mutes because their deafness has a tympanic origin. But human mutes emit sounds of various kinds as well as animals who are deaf. The origin of the muteness is to be found in the non-ability of hearing, and not in the situation of the lesion that causes the deafness. The post-mortem investigation of Mr. Tait's cat was most interesting. It was made by Drs. Cumberbatch and Dr. Gibbs. *All the structures in the*

[1] Nature, December 13, 1883, and January 10, 1884.

*ear were found to be normal, save the tympanic membranes,* "in which there were triangular gaps extending from the roof to just below the centre, the bases of the gaps being directed upward, and the anterior sides being formed by the handle of the mallei. The gaps appeared to be congenital and were quite symmetrical." All the other parts of the ear were normal. *The auditory nerves were of normal size and structure.*

## MECHANICAL APPARATUS FOR ASSISTING THE HEARING.

The hearing-trumpet remains as yet the best means, in the greater number of cases, of increasing the hearing power. The audiphone invented by Mr. Rhodes, of Chicago, is of equal value in some cases, and is preferred by those who are able to use it. It is more easily held, and less conspicuous. I think no one is benefited by a hearing-trumpet or audiphone, unless the loss of

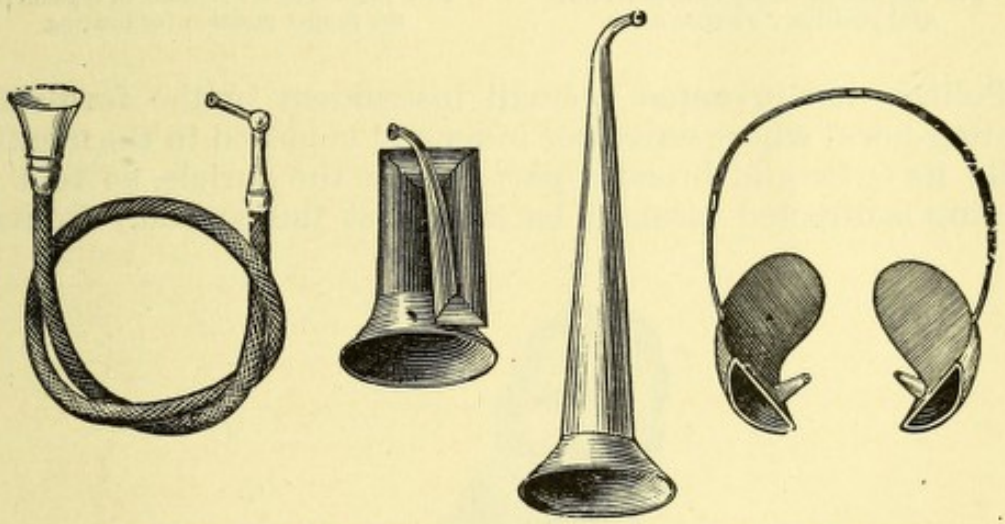


FIG. 136.—Hearing-Trumpets.



FIG. 137.—Auricles.

hearing be due to disease of the middle ear, or to a want of power over the tympanic muscles occurring in old age, which I would style *presbykousis.* As yet, hearing-trumpets and the audiphones must be carefully tested by the patient himself before it can be certainly known that he will be materially assisted by them. I have lately seen a case of watering of the eyes, that seemed to be caused by the use of the audiphone. The patient stated that great lachrymation occurred whenever she used the instrument for a long period, which lasted for some time. If she did not use it for a few hours, the watering would lessen or disappear. Many patients speak of the fatigue of listening with a hearing-trumpet, while others never seem to experience any such sensation.

The accompanying figures give a fair idea of the general form of the most useful hearing-trumpets, and of the audiphone and its use, as well as of the so-called auricles. The latter are unsightly but of some value.

FIG. 138.—The Audiphone in its natural position; used as a fan.

FIG. 139.—The Audiphone in tension; the proper position for hearing.

Politzer has invented a small instrument in the form of a hunting-horn, whose narrower inner end is placed in the meatus, while its outer and broader part lies on the auricle, so that its opening is directed straight back against the concha. Politzer

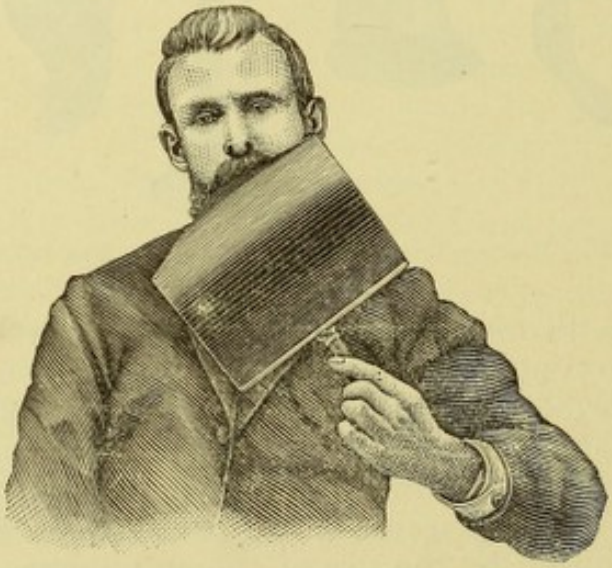


FIG. 140.—Method of Using the Audiphone.

states that the principle of his instrument is based on the physiological fact that sound acting on the ear is heard more loudly when the surface of the tragus is enlarged posteriorly by placing a small solid plate upon it. I have not yet seen any marked benefit to the hearing from Politzer's instrument.

One of my patients, Rev. Richard Walsh, has lately invented a hearing-tube, with a mouth-piece lined with cork, which seems to have some advantages over the ordinary hearing-trumpets. Cork is an excellent conductor of sound. Walsh's ear-trumpet has been patented, and is now in the market.

I am not without hope, as I have already said in this work, that we shall yet make an apparatus which will improve the hearing of such persons as are deaf from disease of the middle ear, and who hear well in a noise, as well as for those who are presbykousic. Those deaf from disease of the nerve, must remain without aid, just as those who suffer from disease of the optic nerve or retina cannot find lenses that will enable them to see.

# 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.[1]—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 toward 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.

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 tym-

[1] The cases here described were treated by Drs. C. J. Blake and H. L. Shaw, of Boston.

pani, 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, followed by 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 inward, 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 dis-

charge 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.

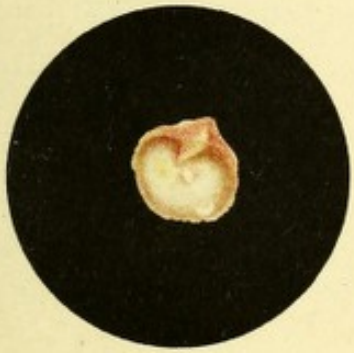
Nº 1.

Nº 2.

Nº 3.

Nº 4.

Nº 5.



Nº 6.

Nº 7.

Nº 8.

H. P. QUINCY, M.D. AD NAT. DEL.

H. BENCKE, LITH. N.Y.

# DISEASES OF THE EAR.

D. B. ST. JOHN ROOSA.

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