

Manual of diseases of the ear : including those of the nose and throat in relation to the ear : for the use of students and practitioners of medicine / by Thomas Barr and J. Stoddart Barr.

Contributors

Barr, Thomas, 1846-1916.

Barr, John Stoddart.

University of Glasgow. Library

Publication/Creation

Glasgow : James MacLehose & Sons, 1909.

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DISEASES OF THE EAR

THOMAS BARR, M.D.

J. STODDART BARR, M.B.

MacLehose 238

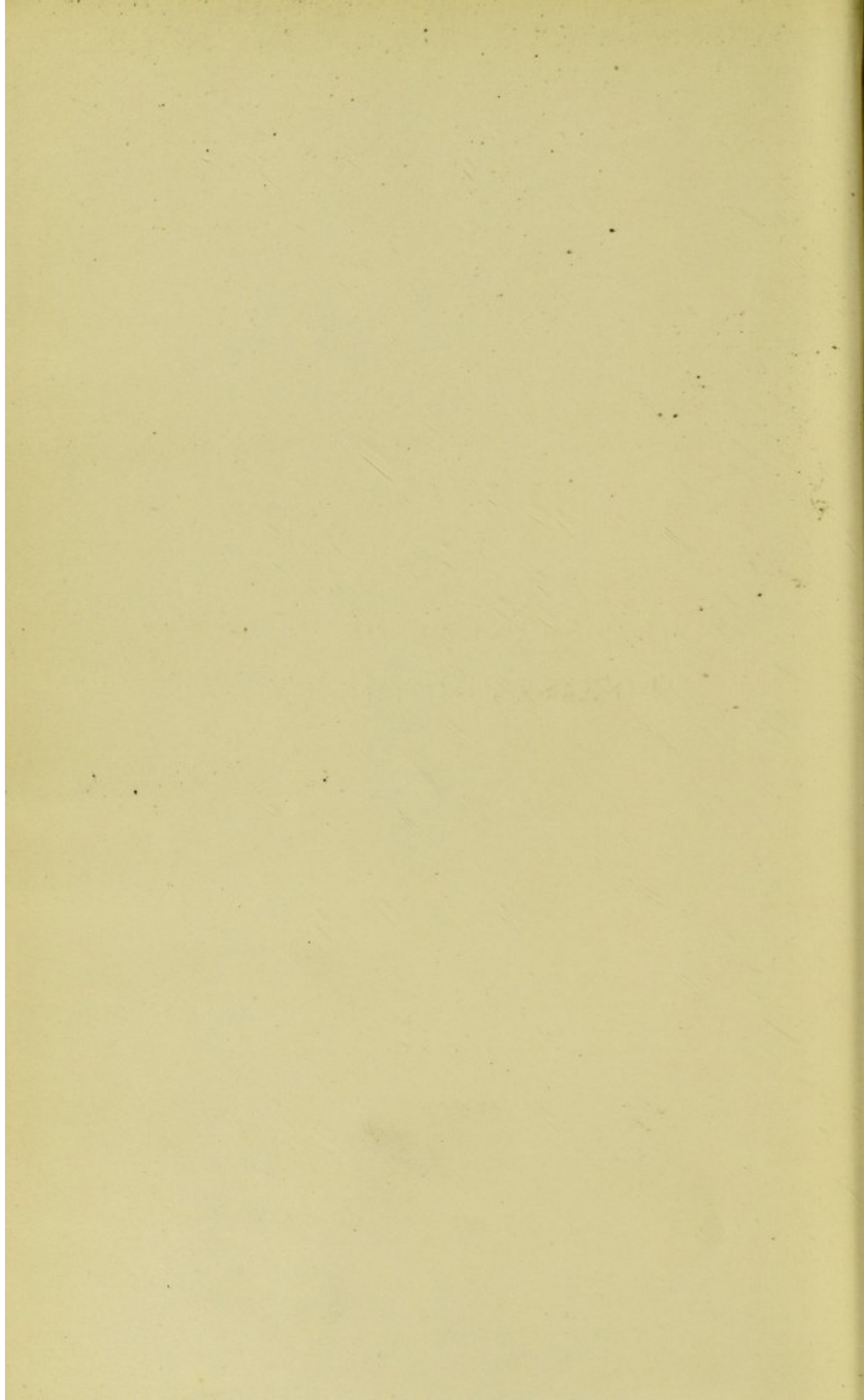
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MANUAL OF
DISEASES OF THE EAR

PUBLISHED BY
JAMES MACLEHOSE AND SONS, GLASGOW,
Publishers to the University.

MACMILLAN AND CO., LTD., LONDON.
New York, - - The Macmillan Co.
Toronto, - - - The Macmillan Co. of Canada.
London, - - - Simpkin, Hamilton and Co.
Cambridge, - - Bowes and Bowes.
Edinburgh, - - Douglas and Foulis.
Sydney, - - - Angus and Robertson.

MCMIX.

MANUAL OF DISEASES OF THE EAR

INCLUDING THOSE OF THE NOSE AND THROAT IN
RELATION TO THE EAR

*FOR THE USE OF
STUDENTS AND PRACTITIONERS OF MEDICINE*

BY

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FOURTH EDITION
ENTIRELY REVISED AND LARGELY RE-WRITTEN

WITH THREE COLOURED PLATES AND 215 ILLUSTRATIONS

GLASGOW
JAMES MACLEHOSE AND SONS

PUBLISHERS TO THE UNIVERSITY

1909

MANUAL

OF THE BAR

IN THE CITY OF GLASGOW

BY THE BARRISTERS AT LAW

IN THE CITY OF GLASGOW

AND THE BARRISTERS AT LAW

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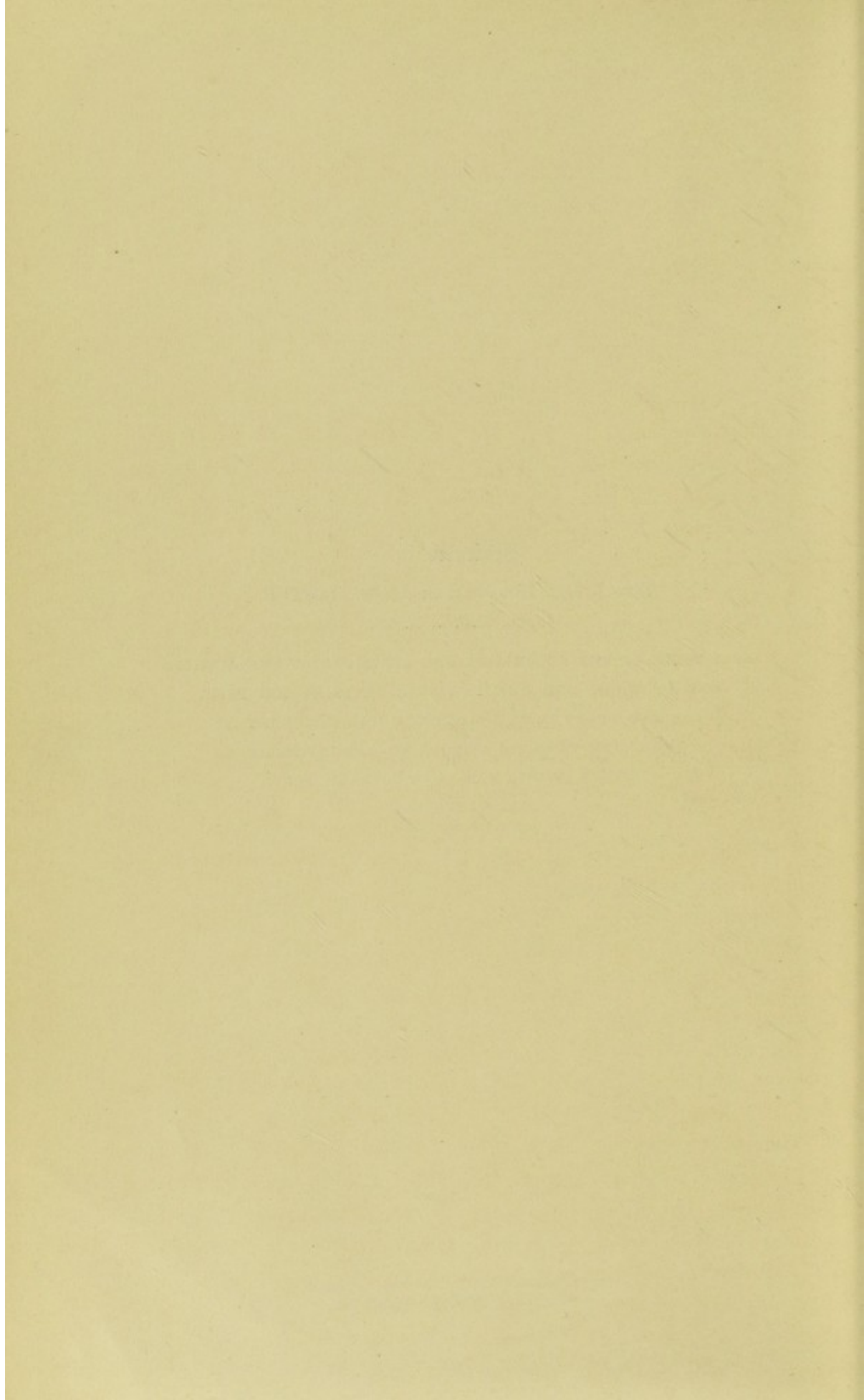
AND THE BARRISTERS AT LAW

AND THE BARRISTERS AT LAW

AND THE BARRISTERS AT LAW

Dedicated to
THE RIGHT HONOURABLE LORD LISTER
LL.D., D.C.L., F.R.S.

AS A TOKEN OF THE ADMIRATION AND GRATITUDE OF THE AUTHORS
ONE OF WHOM HAD THE PRIVILEGE OF BEING HIS PUPIL
FOR TWO YEARS IN THE GLASGOW ROYAL INFIRMARY AT
THE TIME WHEN HE INTRODUCED HIS ANTISEPTIC
SYSTEM WHICH HAS DONE SO MUCH FOR
AURAL SURGERY



PREFACE.

THE third edition of this "Manual," published in 1901, having been exhausted for several years, a fourth edition is now issued.

In its preparation Dr. Thomas Barr has had the active co-operation of his son, Dr. Stoddart Barr, and this edition is the result of their joint labour.

Every effort has been made to bring the present work up to date, and to include in it the advances which have been made in this department since the third edition was published. In this endeavour the authors have kept in view the intention expressed in the Preface to the first edition "to present the main facts of aural surgery in a form sufficiently concise and methodical to meet the wants of general practitioners and students of medicine."

The whole of the previous edition has undergone thorough revision, which has involved the re-writing of large portions as well as very many additions and alterations.

Notwithstanding considerable pruning down in certain parts, and the exercise of every care to avoid undue enlargement, it has been found necessary to increase the size of the volume to the extent of about 50 pages.

An additional chapter is devoted to the operative treatment of the ear, and the description of mastoid operations in this chapter has been entirely re-written by Dr. Thomas Barr.

The two chapters on the nose and throat have also been re-written by Dr. Stoddart Barr, who has treated the rhinological part with the fulness befitting its important bearing upon the ear.

The two chapters on "the intra-cranial and vascular complications of purulent inflammation of the middle ear" have been very considerably enlarged so as to embrace a fuller account of the symptoma-

tology and the present methods of operating. Such problems as are involved in the evacuation of intra-cranial abscesses, the opening of the lateral sinus, and the ligaturing of the internal jugular vein are discussed in the light of the present practice of otologists and surgeons.

The good work done of late years in connection with the labyrinth has necessitated fuller treatment of this part of the subject, and special attention is given to labyrinthine suppuration and operations upon the labyrinth.

Otosclerosis, which, in the third edition, was included under interstitial inflammation of the middle ear, is now, in the light of improved knowledge of its pathology, treated separately.

A special section is devoted to general and local anæsthesia, in operations upon the ear, nose and throat; the part on general anæsthesia has been written by Dr. R. Home Henderson, of Glasgow, to whom the authors are much indebted.

A new feature of the present edition is the introduction of coloured plates, which will be found at the beginning. They include 45 figures, embracing several varieties of the normal tympanic membrane, and all the more common pathological conditions exhibited by the tympanic membrane and tympanum. It is to be hoped that the coloured illustrations will aid the student and practitioner in the recognition of these when examining with the mirror and speculum. The figures were drawn and coloured from the authors' cases by Mr. A. K. Maxwell, of Glasgow, whose medical illustrations, both in colour and in black and white, are already very favourably known to the profession. They have been reproduced by Messrs. André & Sleight by the four-colour process.

Partly on account of the introduction of these coloured plates, 79 of the black and white illustrations, which appeared in the third edition, have been omitted, while 58 fresh illustrations (exclusive of the coloured plates) have been added. These consist of photographic reproductions and drawings of anatomico-pathological specimens, tympanic appearances, methods of examination and treatment, and additional figures of instruments. The borrowed illustrations, of which there is a considerable number, are duly acknowledged.

The Formulæ at the end of the work have also been carefully revised with the kind help of Mr. George Sinclair, pharmaceutical

chemist; and 44 of the old Formulæ have been omitted, while 32 new ones have been added.

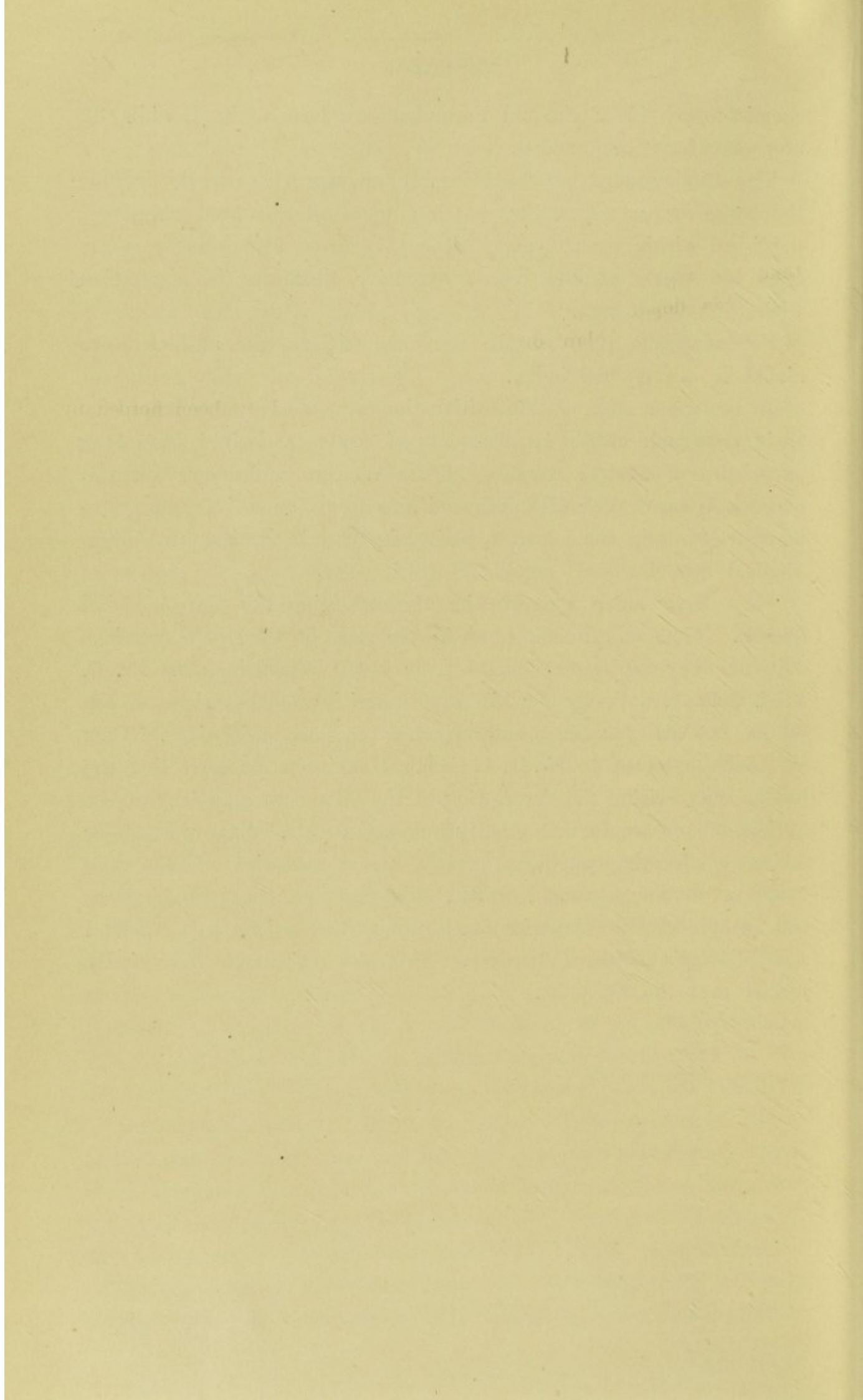
The Bibliography has been largely augmented, so as to include the more important works, bearing upon otology and rhinology, published within recent years, without, however, attempting to overtake the whole of the recent extensive literature in connection with this department.

Following the plan of the previous editions, the authors have aimed at a very full index.

In the preparation of this edition the authors have been helped by their knowledge of the requirements of students, derived from long experience of clinical teaching in the Western Infirmary, Glasgow, and the Glasgow Ear Hospital, and also from the delivery of systematic lectures in the Glasgow University and in Anderson's College Medical School.

They have much pleasure in acknowledging the help of kind friends. First and foremost, as in the case of the three previous editions, they desire to express their great indebtedness to Dr. C. Fred. Pollock, not only for his careful revision of the whole of the proofs, but also for many and valuable practical suggestions. They are much indebted to Dr. J. Goodwin Tomkinson for correcting the proofs and revising the description of the cutaneous affections of the auricle. They are further greatly indebted to Mr. Bertrand Seymour Jones, of Birmingham, who revised the manuscript of the two chapters on the nose and throat. To Professor Cleland's kindness the authors owe the introduction of some illustrations from Cleland and Mackay's *Human Anatomy*. Professor Stockman has kindly looked over the Formulæ.

13 WOODSIDE PLACE,
GLASGOW, *February*, 1909.



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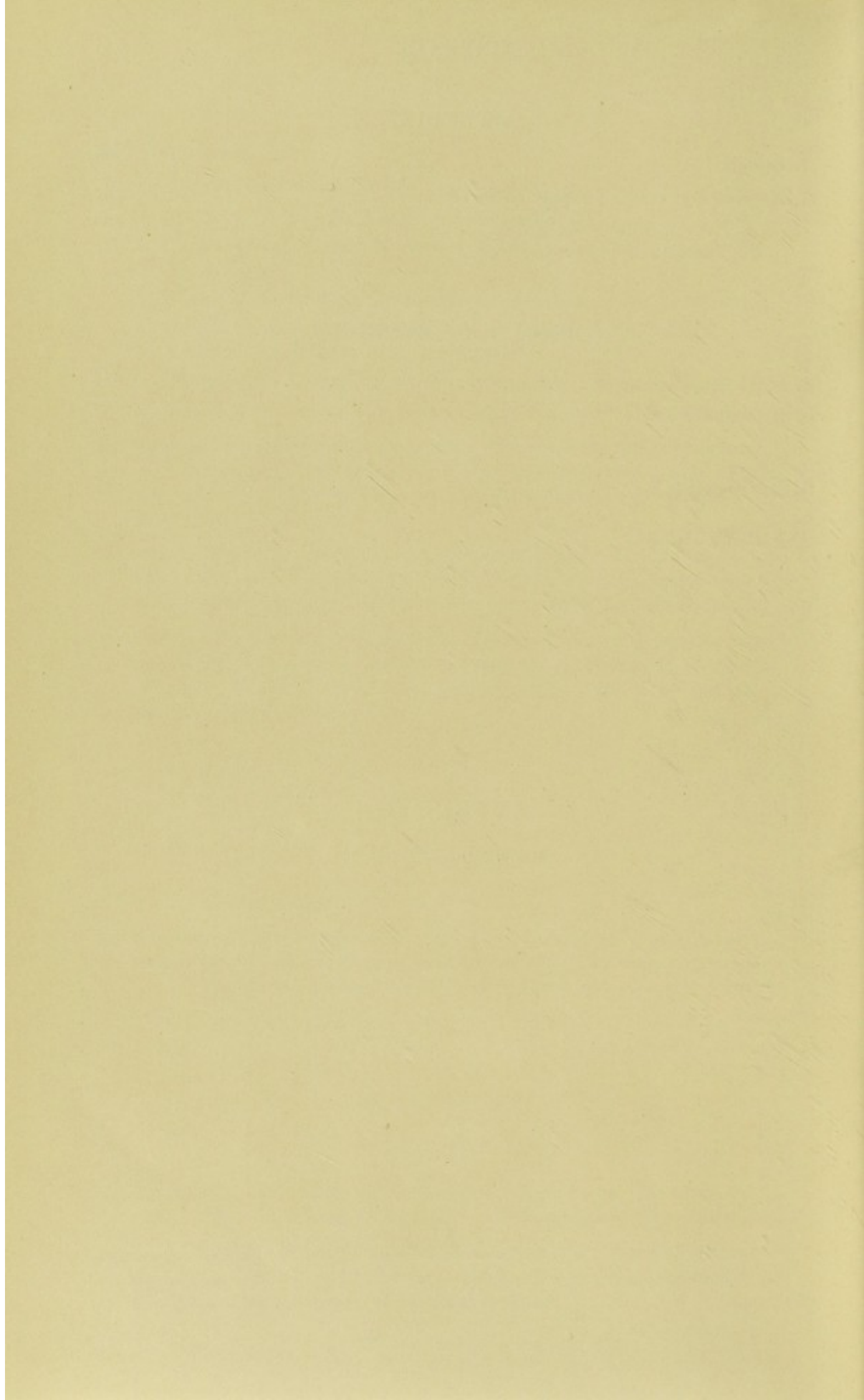
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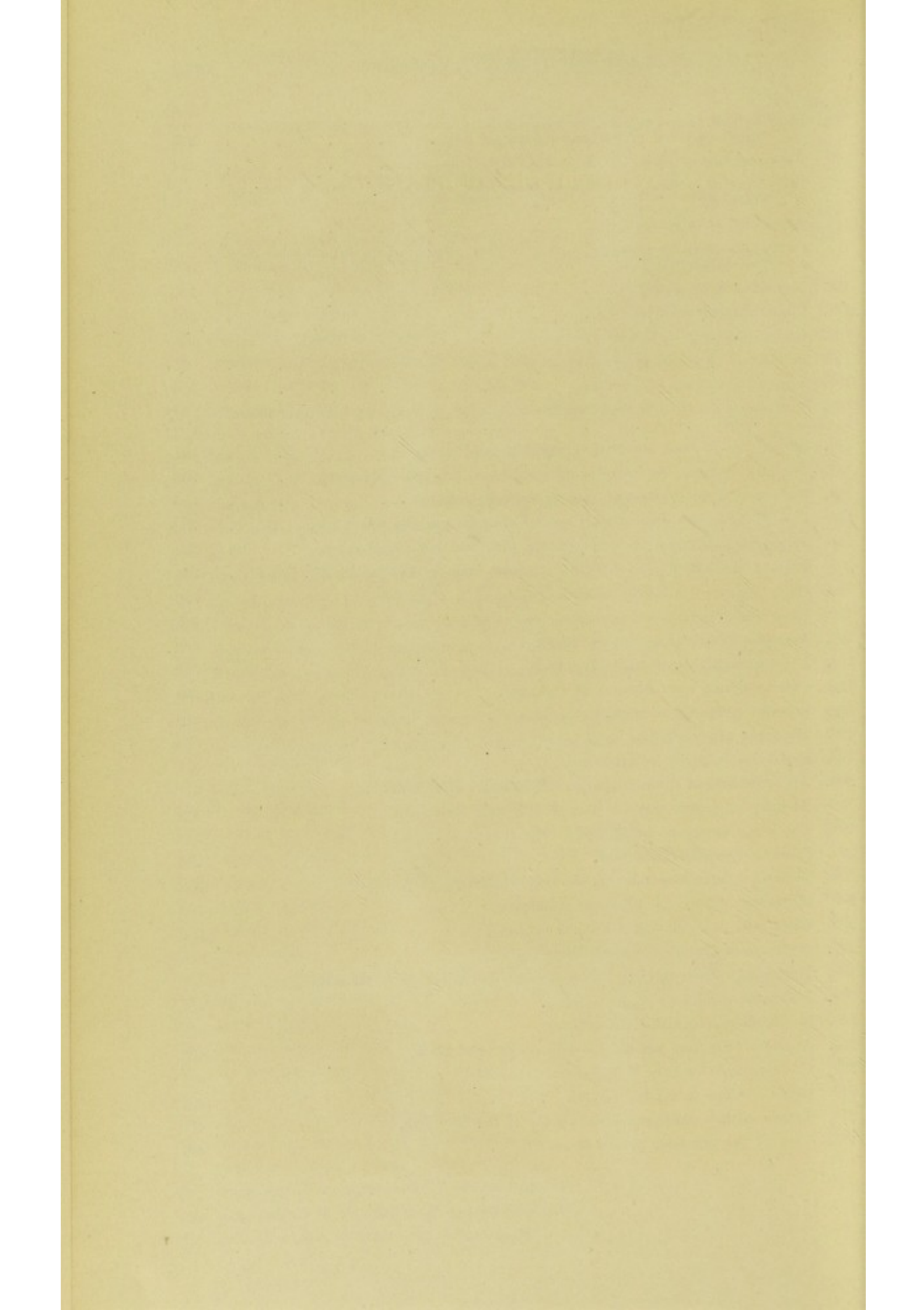
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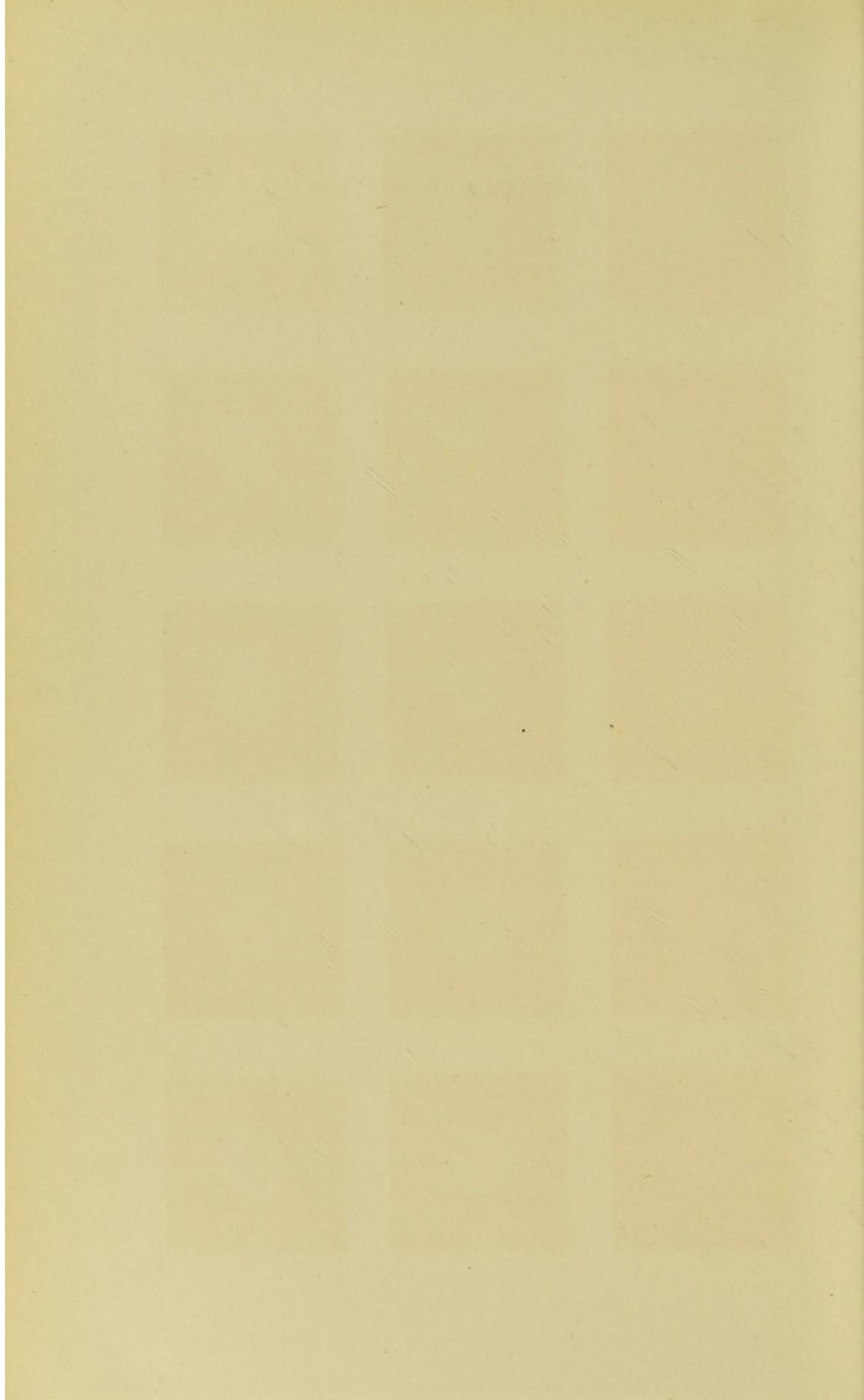
DESCRIPTION OF PLATE I.

DESCRIPTION OF PLATE I.

- No. 1. Right normal tympanic membrane, showing manubrium, short process, umbo, cone of light, membrana flaccida. (See p. 10.)
- No. 2. Left normal tympanic membrane, more transparent than No. 1, showing through the membrane, postero-superiorly, the junction of the incus and stapes, and, postero-inferiorly, the entrance to the fenestra rotunda as a somewhat darker semilunar area. (See p. 11.)
- No. 3. Indrawn right tympanic membrane, showing foreshortened manubrium and more tense posterior fold—from lad aged 17, who had been dull of hearing for a year from exudative catarrh of middle ear. (See p. 370.)
- No. 4. Left normal tympanic membrane, showing also long process of incus above and behind, seen through the membrane. (See p. 11.)
- No. 5. Right normal tympanic membrane, showing long process of incus above and behind and also, below and behind, the darker semilunar area indicating the entrance to fenestra rotunda; the membrane has a pinkish colour reflected from inner tympanic wall. (See p. 11.)
- No. 6. Indrawn right tympanic membrane from boy with post-nasal adenoids and enlarged tonsils; defective hearing for 2 years; membrane opaque, but over the enlarged posterior fold it is congested; case of muco-serous catarrh with obstruction of Eustachian tube. (See p. 370.)
- No. 7. Circular opacity of right tympanic membrane, from woman aged 52 years; hearing very defective for 20 years owing to chronic "dry" catarrh of middle ear. (See p. 384.)
- No. 8. Left tympanic membrane, opacity with bluish tint; deaf for several years owing to adhesive catarrh of middle ear; from woman 42 years of age. (See p. 384.)
- No. 9. Cicatricial right tympanic membrane, showing adhesion to promontory and fenestra rotunda; head of stapes, visible above promontory, projecting through adhering membrane; small calcareous patch antero-inferiorly. Result of a past suppuration in girl aged 15. (See p. 262.)
- No. 10. Right tympanic membrane, with oval cicatrix behind the handle of the malleus; handle and membrana flaccida injected; from man 40 years of age, with very defective hearing and indications of labyrinthine trouble. (See p. 256.)
- No. 11. Left tympanic membrane, with crescentic calcareous patch in front and below the handle of the malleus; from girl 21 years of age with moderate deafness, who had otorrhœa in childhood; dry for some time. (See p. 256.)
- No. 12. Left tympanic membrane showing rosy tint behind umbo due to reflection through the membrane from the congested promontory; otherwise normal looking; from patient with otosclerosis complaining of marked and increasing deafness and tinnitus. (See p. 396.)
- No. 13. Left tympanic membrane, presenting a saccular bulging postero-inferiorly, concealing the greater part of the handle of the malleus; from woman 22 years of age suffering from acute otitis media. (See p. 251.)
- No. 14. Large exostotic growth coming from the postero-inferior meatal wall of right ear; very small one above and in front, behind this short process of malleus visible; narrow portion of tympanic membrane seen above and in front of the large tumour. (See p. 206.)
- No. 15. Exostosis springing from roof of external meatus; sickle-shaped portion of tympanic membrane visible. (See p. 206.)

PLATE I.



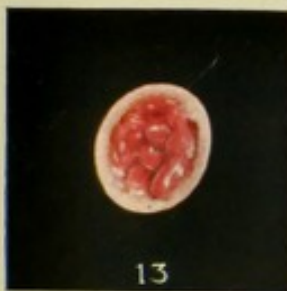
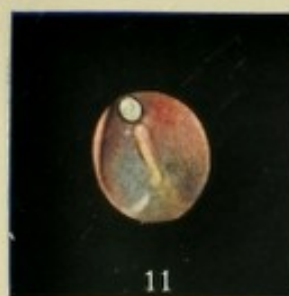
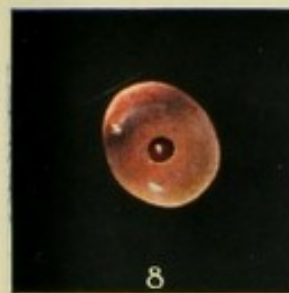
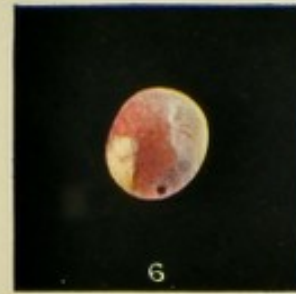
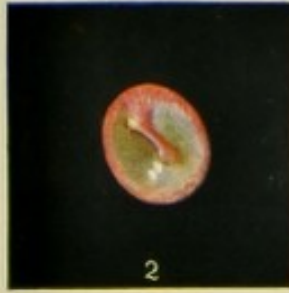


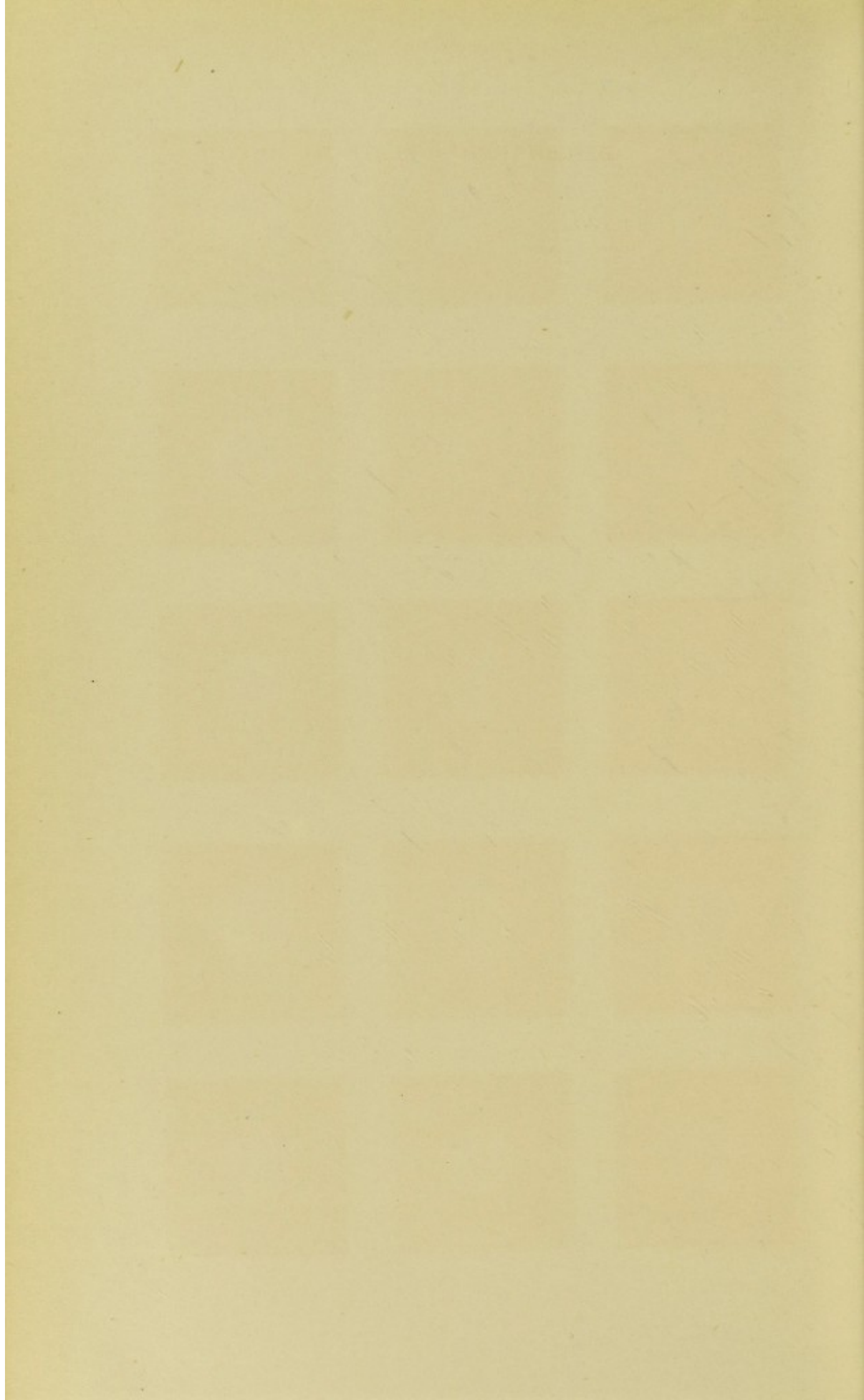
DESCRIPTION OF PLATE II.

DESCRIPTION OF PLATE II.

- No. 1. Indrawn tympanic membrane (left); serous exudation in tympanic cavity; boy aged 14 years; dull of hearing for 3 months, from exudative middle ear catarrh; greatly improved by inflation. (See p. 371.)
- No. 2. Hyperæmia of left tympanic membrane at manubrium, membrana flaccida and periphery (after syringing); membrane otherwise bluish grey; from woman aged 18 years, with long-standing defective hearing from chronic "dry" catarrh. (See pp. 194 and 384.)
- No. 3. Left tympanic membrane, with radiating vessels from case of acute otitis media at the stage when the inflammation is passing off. (See p. 366.)
- No. 4. Reddish yellow bulging above and behind right tympanic membrane; from man 35 years of age, 24 hours after the beginning of an acute otitis media. (See p. 251.)
- No. 5. Left tympanic membrane from man recovering from acute purulent otitis media of 5 weeks' duration; usual landmarks obliterated; injected vessels; short process seen antero-superiorly; behind and below white spot indicating seat of recent perforation. (See p. 253.)
- No. 6. Right tympanic membrane from man aged 30, suffering from acute purulent otitis media; membrane congested, with small perforation at lower part near periphery; normal landmarks of membrane gone; sodden whitish epithelium postero-inferiorly and antero-superiorly; considerable mucopurulent discharge for 5 days. (See page 253.)
- No. 7. Right nipple-shaped perforation springing from postero-superior part of membrane; drop of pus at apex of nipple; antero-inferior part of meatal wall seen; acute purulent otitis media (influenzal) of 2 months' duration in man 60 years of age; ultimately complicated with mastoid empyema which had to be operated upon. (See pp. 253 and 280.)
- No. 8. Left tympanic membrane with round perforation in centre; from woman 40 years of age suffering from acute purulent otitis media of 3 weeks' duration. (See p. 253.)
- No. 9. Large perforation of right tympanic membrane; a few vessels on inner wall of tympanum, the latter being pink and moist; remnant of membrane greyish white; lower part of shortened manubrium projecting into upper edge of perforation; discharge for 7 years from man 30 years of age. (See p. 254.)
- No. 10. Almost total destruction of tympanic membrane (left), narrow rim remaining; inner wall of tympanum pink; greyish white cholesteatomatous material coming down from attic above; otorrhœa from childhood; girl aged 19. (See p. 301.)
- No. 11. Small perforation in left membrana flaccida, above short process; cholesteatoma seen in perforation; man aged 28 years, with otorrhœa for 10 years; other ear similarly affected. (See pp. 254 and 301.)
- No. 12. Greater part of left tympanic membrane destroyed; only manubrium and part in front of it remaining; articulation of incus and stapes shown at postero-superior quadrant; promontory and entrance to fenestra rotunda seen; boy 16 years of age who had otorrhœa for many years; now dry; condition suitable for "artificial drum." (See pp. 255 and 284.)
- No. 13. Exuberant granulation tissue occupying the inner half of meatus; the meatal wall seen at circumference. Man 33 years of age, suffering from otorrhœa for 15 years. (See p. 258.)
- No. 14. Oval cicatrix in front of and involving umbo; lower end of handle gone; from man aged 36 years who had otorrhœa in boyhood. (See p. 256.)
- No. 15. Opacity of the whole of the right tympanic membrane, with bluish tinge (right); handle slightly hyperæmic but not indrawn; chronic "dry" catarrh of 5 years' duration in man 30 years of age. (See p. 384.)

PLATE II.





DESCRIPTION OF PLATE III.

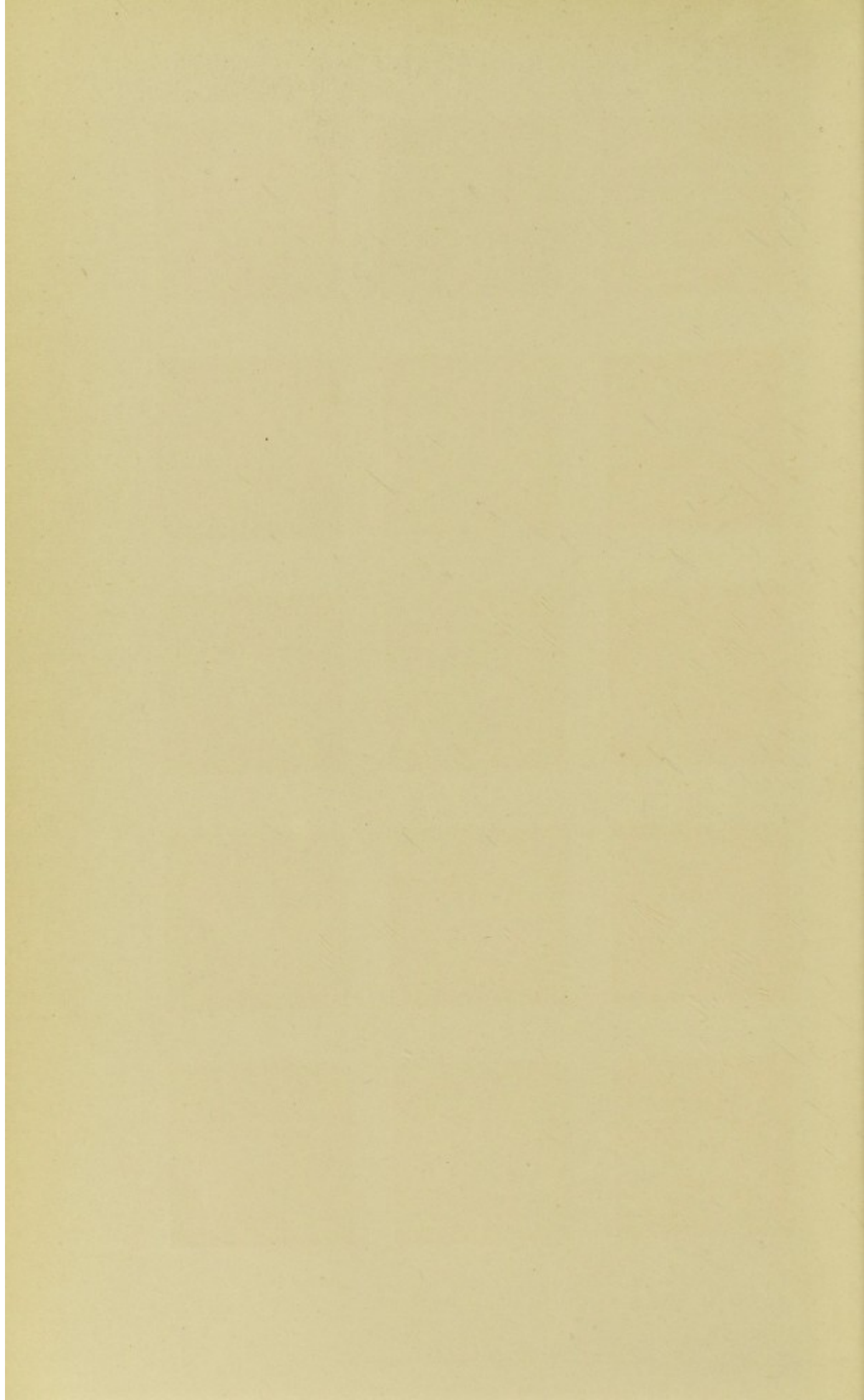
DESCRIPTION OF PLATE III.

- No. 1. Right tympanic membrane, with pin-point perforation in front of and below handle; semilunar calcareous deposit behind, with small ecchymotic spot in centre; recovering from acute purulent otitis media. (See pp. 253 and 256.)
- No. 2. Oblong perforation in left tympanic membrane, in front of faintly defined manubrium; membrane greyish with pink patches; chronic purulent otitis media in man aged 49. (See p. 253.)
- No. 3. Oval perforation in front of manubrium (left); two opaque spots posteriorly; perforation pink in colour and yielding secretion; from girl aged 13, with otorrhœa for some months. (See p. 253.)
- No. 4. Right kidney-shaped perforation; inner wall of tympanum (promontory) pink in colour; remnant of tympanic membrane congested; handle and short process faintly defined; antero-inferior wall of meatus seen; man aged 44, with otorrhœa for 7 months (See p. 254.)
- No. 5. Right tympanic membrane, with round perforation below the umbo; elongated calcareous deposits in front of and behind the perforation; inner tympanic wall at perforation pink; man aged 34, with otorrhœa for 6 years. (See pp. 253 and 254.)
- No. 6. Globular mass of granulation tissue protruding out of large perforation in left tympanic membrane; short process and upper part of handle seen above and in front of the mass; antero-inferior meatal wall seen; man aged 29, with otorrhœa from childhood, following scarlet fever. (See p. 258.)
- No. 7. Two polypoid growths sprouting from posterior part of right tympanic cavity through large perforation; short process of malleus remains; below that anterior part of perforation seen; lad aged 18 years, with otorrhœa for several years. (See p. 258.)
- No. 8. Large perforation in left membrana flaccida, with dark brown secretion on inner wall; lower end of handle congested; woman aged 49, with otorrhœa from childhood. (See p. 254.)
- No. 9. Destruction of left tympanic membrane; only narrow rim left with stump of manubrium and short process; head of stapes visible; inner wall of tympanum pale yellow, and postero-inferiorly is seen the entrance to fenestra rotunda. (See pp. 254 and 255).
- No. 10. Large dry perforation in posterior half of right tympanic membrane; lower edge adhering to inner tympanic wall; entrance to fenestra rotunda seen behind with bulging promontory in front of it; two calcareous deposits front of manubrium; man aged 21, result of chronic otorrhœa, now dry. (See pp. 254 and 256.)
- No. 11. Right kidney-shaped perforation; inner wall of tympanum pale yellow and dry; calcareous deposit in front of manubrium; hyperæmia behind and above handle; man aged 20 years, with a past otorrhœa; ear dry for several years. (See pp. 254 and 256.)
- No. 12. Large destruction of right tympanic membrane; inner tympanic wall yellowish, showing entrance to fenestra rotunda behind; with the bulging promontory in front of it; only upper part of manubrium remains, with greyish remnant of membrane behind it; narrow rim of membrane round periphery; postero-superior meatal wall seen (congested). (See p. 254.)
- No. 13. Left tympanic membrane converted into cicatricial tissue partially adherent to inner tympanic wall; part in front of manubrium whitish; above and behind there is head of stapes with stapedius tendon; result of old purulent disease, in man aged 45 years. (See p. 262.)
- No. 14. Large transparent cicatricial or atrophied collapsed part of left tympanic membrane behind manubrium; through this can be seen long process of incus and stapedius tendon, also promontory below; remnant of tympanic membrane pinkish; from boy aged 12, with otorrhœa for 2 years, ear dry for considerable time. (See pp. 256 and 372.)
- No. 15. Same tympanum as No. 14, after inflation by Politzer's method, showing thin atrophied or cicatricial tissue blown out like a bladder; soon afterwards it became collapsed as before. (See pp. 256 and 372.)

PLATE III.



A. K. Maxwell, delt.



MANUAL OF DISEASES OF THE EAR.

INTRODUCTORY NOTE.

MAIN ANATOMICAL AND PHYSIOLOGICAL DIVISIONS.

IN the organ of hearing the physiologist recognizes—1st, the peripheral part, for the conduction of sound; and, 2nd, the central part, more immediately connected with the perception of sound.

The part for the conduction of sound is divided by the anatomist into the external and the middle ear. The external ear is subdivided into the auricle and the external auditory canal; the middle ear into the tympanum, the Eustachian tube, and the mastoid cells.

The part for the perception of sound is called the internal ear. This includes the labyrinth and the auditory nerve; the labyrinth being divided into the vestibule, the semicircular canals, and the cochlea. These contain the labyrinthine fluid and certain membranous structures, which support the terminal ramifications of the auditory nerve.

The external is separated from the middle ear by the tympanic membrane, while the internal is separated from the middle ear by the membrane of the fenestra ovalis and the membrane of the fenestra rotunda.

A short anatomical and physiological account will be given in connection with each of the divisions of the ear by way of introduction to the description of their diseases. It is not, however, intended to treat the anatomical and physiological aspects of the subject exhaustively, but rather to draw attention to those points which

have special bearings upon injuries and diseased processes. This plan, it is thought, will better serve the practical scope of the work than a complete anatomical and physiological description of the organ introduced as a separate section.

In order to avoid undue increase in the size of the volume, the anatomical and physiological descriptions are printed in smaller type.

CHAPTER I.

METHODS OF EXAMINATION.

THESE may be conveniently divided as follows :

- I. Examination of the superficial or visible parts of the ear.
- II. Examination of the tympanum through the external meatus.
- III. Examination of the middle ear through the Eustachian tube.
- IV. Examination of the pharynx, nasal passages, and naso-pharynx.
- V. Methods of testing the hearing and localizing the seat of a defect.
- VI. The order of examining a patient.

I. EXAMINATION OF THE SUPERFICIAL OR VISIBLE PARTS OF THE EAR.

As the chief and most important parts of the organ of hearing lie concealed from view in the interior of the temporal bone, we have, in the examination of these deeply seated structures, to employ certain instrumental aids. While these are essential to the due investigation of the ear, we must not neglect the examination of the outer or superficial parts with the unaided senses, for in this way we may derive important information.

Auricle and External Meatus. The various conditions of the auricle may be thus readily recognized, such as the presence of cutaneous affections, morbid growths, congenital malformations, haematomata, injuries, and displacements. If the auricle be pulled backwards and the tragus pressed forwards we may, with the aid of good direct light, see well into the external meatus; and, in the case of a wide canal, we may even secure a glimpse of the tympanic membrane. Purulent secretion or granulation tissue may be seen, or even a polypus (Fig. 1) protruding from the external orifice; and these usually point to a purulent affection of the deep parts. Such conditions as excess of cerumen, exostosis, eczema, thickening of the walls of the

canal, and furunculi, may also be discovered by simple inspection, and the existence of the last would necessitate great caution in introducing a speculum lest pain or injury be caused. Even a plug of cotton wool in the orifice may yield information by the presence and odour of secretion upon it.

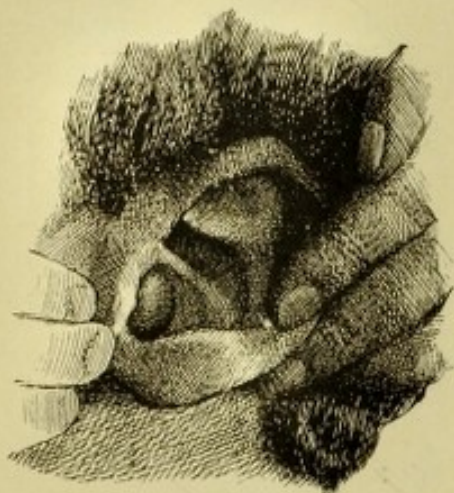


FIG. 1.—Polypus protruding from external meatus.

Mastoid Region. Much valuable information may be gained by simple inspection and palpation of the mastoid region, especially in middle ear suppurations. A red painful swelling, with or without fluctuation, causing displacement outwards and forwards of the auricle, would denote mastoid periostitis, or a sub-periosteal escape of pus from the interior of the cells.

A hard brawny swelling lower down would point to the escape of pus from the cells at the apex into the digastric groove—Bezold's mastoiditis. Pain on pressure, without redness or swelling, especially in front of the lower part of the mastoid, along with acute profuse purulent discharge from the ear, would probably mean a mastoid empyema. In similar circumstances, pain on pressure behind the mastoid, especially with fulness, would raise the suspicion of lateral sinus involvement. A discharging sinus behind the auricle points to caries or necrosis in the mastoid cortex, while a depressed bony cicatrix indicates the seat of an old sinus or of an operation cavity.

Glandular Structures. The glandular structures are often tender and swollen in purulent ear disease, especially the glands behind the ramus of the jaw and lower down in the neck. There may be simply inflammatory swelling, or an abscess, or tubercular mischief. The mastoid glands and those over the parotid, as well as the parotid itself, may also be involved—pain and swelling of the mastoid glands are sometimes mistaken for mastoid periostitis. Involvement of the glandular structures in the neighbourhood of the ear calls for careful examination through the meatus, when a perforation with purulent discharge will often be found to be the real source of the glandular mischief.



FIG. 2.—Facial aspect in deafness associated with post-nasal growths.

Facial Aspect. The facial aspect may yield information, especially if there be post-nasal adenoids, when the open mouth, the compressed nostrils, and the dull expression are characteristic (Fig. 2). Facial paralysis, generally unilateral, is not infrequently observed, and is generally associated with purulent ear disease, especially in children. In persons who are very deaf, the keen watchful eye, while striving to read the face of the speaker, is often noticeable.

II. EXAMINATION OF THE TYMPANUM THROUGH THE EXTERNAL MEATUS.

In order to survey in all their detail the deep parts of the external meatus, the tympanic membrane and the interior of the tympanum, we require, first, to remove or turn aside any obstructions in the canal of the ear; second, to straighten the curve of the canal; and third, to reflect light into the interior.

During examination the patient should be seated on a revolving arm-chair of simple design, constructed of some plain polished wood, and having a straight back to which an adjustable sliding head rest can be attached. Such a chair is equally well suited for nose and throat work.

Removal of Obstructions in the Meatus. The view of the deep parts of the ear is very frequently obstructed by hairs, particles of

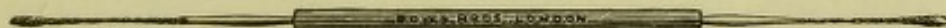


FIG. 3.—Cotton holder.

cerumen, epidermic scales, purulent secretion, etc. The aural speculum suffices to push aside the hairs. The cotton holder (Fig. 3) is the safest instrument to employ in removing other substances. It consists of a piece of iron or steel wire, both ends of which are wrought into the form of a fine screw, round which, before use, a piece of cotton

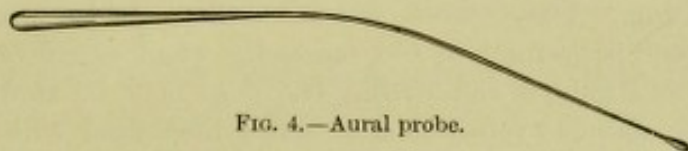


FIG. 4.—Aural probe.

wool is firmly wound into a cylindrical shape. Metallic instruments, such as forceps or a probe, may be required to remove scales or particles of cerumen. The cautious use of the probe (Fig. 4) often yields valuable information as to the presence of granulation tissue, polypi, or furunculi. Such instruments should only be used when the inside of the ear is properly illuminated, so that the eye may guide the hand. A permanent difficulty is presented by an unusually prominent antero-inferior meatal wall, which in certain cases

may admit of only the postero-superior quadrant of the tympanic membrane being seen. For the removal of purulent secretion or an excess of cerumen syringing the ear is usually required in order to see the deep structures.

Syringing the Ear. A piston syringe (Fig. 5) is generally the most efficient. *It should be furnished with a fixed ledge, or other contrivance to prevent the slipping of the index and middle fingers when the piston is being pressed down.* The



FIG. 5.—Mode of syringing the ear.

nozzle should not exceed an inch and a half in length, should be slender, and should not have a knob-shaped extremity. If the nozzle is too thick, or if it has a bulbous end, the canal of the ear is liable to be stopped up by it, and the injected fluid, having difficulty in passing out again, may produce dangerous pressure on the deep parts. A vessel (Fig. 5) of a suitable size and shape is required to receive the fluid as it issues from the ear. The comfort of the patient is not unworthy of our attention, and the drenching which patients sometimes undergo, not to mention the trickling of water down the neck and under the collar, must be avoided when syringing the ear. The point of the nozzle of the syringe

should be placed in contact with the roof of the canal, just within the external orifice. At the same time the auricle should be pulled upwards and backwards with the left hand, so as to remove the curve of the canal. When the object of syringing is to remove pus or other inflammatory products, the syringe should be used efficiently but gently, and with interruptions. A powerful stream of fluid propelled against the softened or perforated tympanic membrane may easily do injury. After syringing, the fluid which remains in the auditory canal should be allowed to drain out, and then the passage is to be dried with absorbent cotton fixed on a cotton-holder (Fig. 3). A plug of cotton wool should be worn in the meatus for a few hours after syringing. In some persons syringing the ear, even when it is done with caution, excites giddiness, and more rarely, nausea and vomiting. These effects are more likely to be produced when the tympanic membrane is perforated, and especially when excessive force has been used, and when *cold* fluid is employed. The fluid may be simple water, as in the removal of ceruminous collections, or water medicated with some antiseptic substance, and it should always be pleasantly warm, say at a temperature of about 100° F.

Aural Specula. The curve of the canal may be straightened more or less by pulling the auricle upwards and backwards, and by the introduction of an aural speculum. The aural speculum is a funnel-shaped tube, about an inch and a half in length, composed of either silver (Fig. 6) or vulcanite (Fig. 7). The metallic ones are the most suitable, especially those known as Gruber's, which have an oval lumen

at the inner end. Four sizes are necessary in order to fit the various widths of the external meatus in different persons and at different ages. Grünfeld has, by connecting an oval mirror to the outer opening of a speculum with a hinged joint, constructed a demonstration

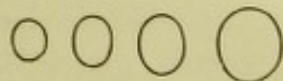
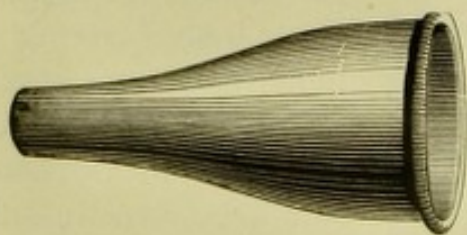


FIG. 6.—Gruber's speculum.

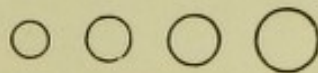


FIG. 7.—Poltzer's vulcanite speculum.

speculum, so that an observer looking at the mirror may see the reversed image of the tympanic membrane. Long narrow specula are to be avoided, unless in practised hands, as they are apt to cause pain by being introduced too far.

Reflecting Mirror. The best method of illuminating the interior of the ear is by reflecting light from a concave mirror. This should have a diameter of about two and a half inches, be perforated by a small hole in the centre, and have a focal distance of from three to five

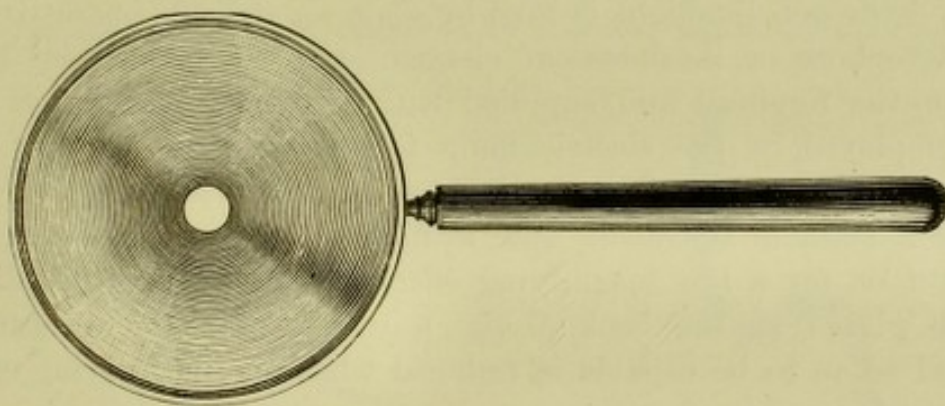


FIG. 8.—Concave perforated mirror with handle.

inches. It is used either with a handle (Fig. 8) screwed on to the metallic back, or, if the right hand requires to be free, as is usually the case, it is attached to a head-band by means of a ball and socket joint, or to a metallic head spring, or a spectacle frame, and is thus supported in front of the eye of the operator (Fig. 9). For persons with faulty refraction a proper lens may be fitted behind the perforation in the mirror, or suitable spectacles may be worn.

Source of Light. Bright diffuse daylight, especially the light reflected from white clouds or a white wall, affords the best illumination. The direct rays of the sun show very minute changes on the membrane and may partially illumine the interior of the tympanum.

It is usually necessary, however, especially in this country, to employ artificial light, which, it is to be noted, imparts a reddish-yellow tint to the parts. Either lamp-light or gas-light will serve the purpose, and, in the latter case, an Argand burner, or preferably an incandescent

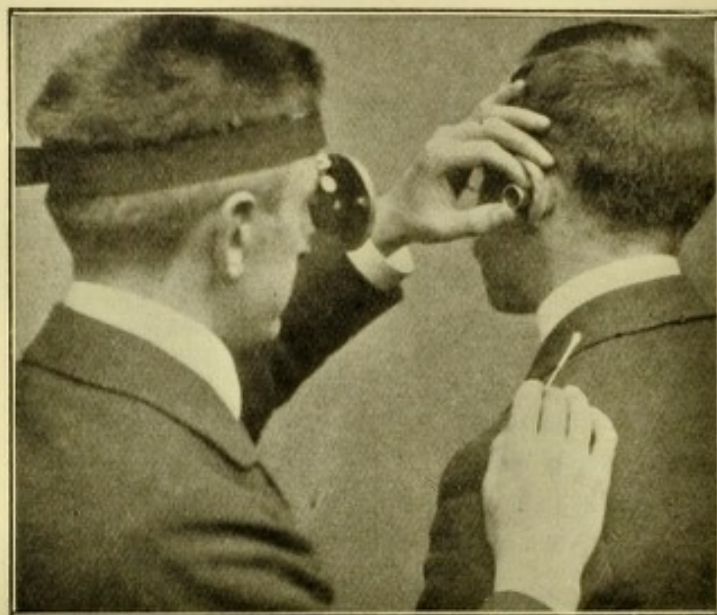


FIG. 9.—Examination of the ear with forehead mirror and speculum.

gas burner, having a long glass tube covering the light, and supported by a suitable wall bracket or table standard, is most suitable. An incandescent electric lamp, with frosted glass, 32 candle power, or the still more powerful Nernst lamp, affords excellent illumination, used along with a reflecting mirror; it has the advantage over gas or oil of being cooler, and therefore more comfortable to the patient.

A portable oil lamp or Baber's spirit lamp is useful for the bedside. The oxy-hydrogen limelight is used by some for delicate operative work. The Photophore or incandescent electric lamp, introduced by Trouvé, fixed on the forehead and supplied with a storage battery, is sometimes employed, or the electric lamp may be attached to the front of the mirror. It is sometimes desirable to magnify the parts. For this purpose a suitable bi-convex lens is fixed to the wide opening of the speculum, or, for a less magnifying effect, one of longer focal distance may be placed at the back of the mirror, behind its aperture, but arranged so as to be capable of removal when the magnifying effect is not desired.

Mode of using the Mirror and Speculum (Fig. 9). The examiner, having the mirror adjusted in front of the right eye, moves his head sufficiently near to the patient's ear (which should be in shadow), manipulating the mirror so as to direct the reflecting surface towards the light, which is reflected into the meatus. The auricle is now held between the left index finger in the concha, and the middle finger behind the auricle, and gently pulled upwards and backwards in order to straighten the canal, while the right thumb presses the tragus forward. In this way, without a speculum, we may see well into the meatus, and even as far as the tympanic membrane. We may thus detect excess of cerumen, pus or mucus, granulation tissue or a polypus, eczema or a furunculus, or stenosis. It is important to inspect the

meatus in this way before introducing the speculum, which might readily conceal such a condition as eczema of the orifice, or excite great pain if there should be a furunculus. The auricle being held backwards in the way described, the speculum (which should be as wide as possible and warmed) is held by its outer edge with the right hand and passed carefully in with a slight rotatory movement, until the membrane is clearly exposed by the light projected into the speculum. The speculum is moved about between the left thumb at its lower edge and the index finger in the concha, so that the examiner may observe the different parts of the meatus and the tympanic membrane (Fig. 10).



FIG. 10.—Position of fingers in using the speculum.

Brunton's Speculum. This consists of a metallic tube, furnished with a bi-convex eye-piece at one end and an ear speculum at the other (Fig. 11). Light is admitted through a wide funnel-shaped opening at the side and falls upon a perforated mirror, set at an angle, from which it is reflected into the ear, passing back through the perforation in the mirror to the eye of the observer. By means of Voltolini's modification the column of air in the external meatus may be condensed and rarefied as with Siegle's speculum. This instrument is now but little used, being inferior in simplicity and efficiency to the speculum and mirror. Owing to its magnifying power it may be employed, in practised hands, for showing minute changes.

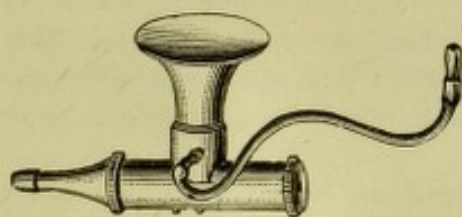


FIG. 11.—Brunton's speculum with suction tube.



FIG. 12.—Siegle's pneumatic speculum.

Siegle's Pneumatic Speculum (Fig. 12) consists of a vulcanite speculum screwed on to one end of a vulcanite cylinder, closed at the other end by a plate of glass placed obliquely, or, if we wish to magnify the parts, by a convex lens. The side of the cylinder has an

aperture, over which a perforated peg is fixed. To this peg is affixed an india-rubber tube, furnished at its other end with a mouth-piece, or with an india-rubber ball or a pump. The speculum is fitted air-tight into the external meatus, and, while we illuminate the interior by means of the forehead mirror, we alternately rarefy and condense the air in the canal either with the mouth, or by compressing and relaxing the ball, or by Delstanche's suction apparatus (Fig. 13). It is necessary to cover the end of the speculum with a short piece of india-rubber tubing, in order to make it fit the external meatus exactly. During rarefaction the tympanic membrane is seen to move outwards, especially above and behind. A cicatrix or atrophied portion will bulge outwards. If there is rigidity of the membrane or adhesion to the inner tympanic wall, no movement or only a slight one will be perceived. A small perforation may be located by observing aspirated secretion at a point in the membrane. Used with an electro-motor, this instrument is now much used in treatment (see p. 86).

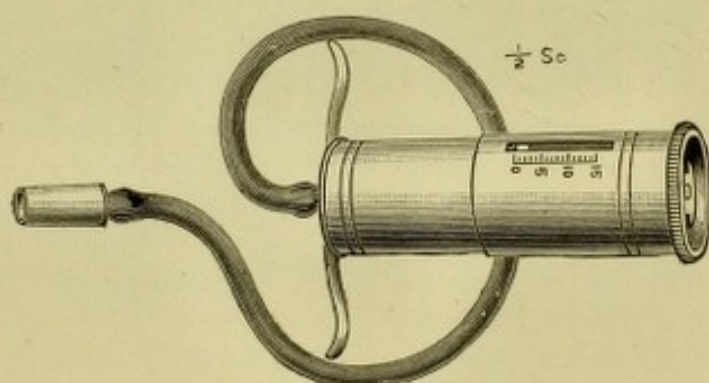


FIG. 13.—Delstanche's suction apparatus.

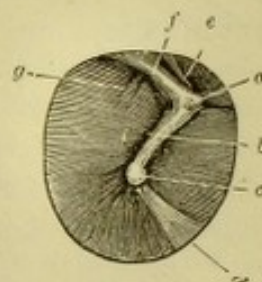


FIG. 14.—Outer aspect of right tympanic membrane—double the natural size; *a*, short process; *b*, middle of manubrium; *c*, umbo; *d*, cone of light; *e*, membrana flaccida; *f*, posterior fold; *g*, long process of incus shining through the membrane.

Conditions revealed by Speculum and Mirror. We note the condition of the *external canal*, such as its curvature and width, the colour of its lining, the injection of its vessels, and the quantity and character of the cerumen. We must note also if any of the following conditions exist: purulent or mucous secretion, epidermic material, granulation tissue, polypi, hyperostosis or exostosis, cutaneous thickening or swelling, or furunculi.

Appearance of the Normal Tympanic Membrane (Fig. 14, also Coloured Plate I., Fig. 1). In health this structure presents by daylight a pearl-grey shining surface, darker in front of the handle of the malleus, with a general concavity outwards, and such an obliquity that the upper and back part is nearer the eye of the observer and more easily seen than the lower and front part. Its most prominent feature is the *handle of the malleus* or *manubrium*, a bony ridge, varying in size in different persons, but broader at the upper end, extending from the antero-superior pole of the membrane downwards, backwards and slightly inwards to a point somewhat below the middle, where it ends in a grey spade-like expansion—the *umbo*. From the obliquity of the membrane the posterior side only of the handle is seen, the anterior being concealed and in shadow. The upper end of the handle appears as a small rounded white knob, the *short process*. Extending from the lower end of the handle, downwards and forwards, there is usually a bright reflection termed the *cone of light*, with the apex at the umbo. This varies in

different persons, and is often broken up into several parts or reduced to one little spot; these varieties have but little significance. From the short process a narrow, more or less distinct fold, passes backwards—the posterior fold—and a less distinct one in front, the anterior fold. The small area above the short process and these two folds is known as the *membrana flaccida*, or *Shrapnell's membrane*, which occupies the Rivinian segment, and varies in size. When the tympanic membrane is specially transparent (Coloured Plate I., Fig. 2), we may see the long process of the incus through it as a whitish streak, slightly behind and parallel with the upper part of the handle, and from its lower end the posterior crus of the stapes may be observed passing backwards, forming with the incus an elbow-shaped appearance; even the tendon of the stapedius may in some cases be discernible. Occasionally there is also visible below and behind a dark semilunar area—the depression of the fenestra rotunda on the inner tympanic wall; while, behind the umbo, a yellowish-grey colour may be reflected from the promontory.

Abnormal Tympanic Membrane without Perforation (see Coloured Plates). We note the colour, polish and transparency of the drum-head. We may observe one or other of the following changes—hyperaemia, especially along the manubrium or on the *membrana flaccida*—a yellowish-green moist appearance indicating secretion in the tympanum—local or general opacities or calcareous deposits—a dark depressed area indicating a cicatrix—bulgings which may be reddish, bluish or yellowish, frequently above and behind,—a foreshortening of the handle of the malleus, with increased prominence of the short process and folds, indicating the indrawn membrane—the incus, stapes or promontory seen through an atrophied or transparent membrane—an abnormally prominent and large manubrium or a thin atrophied one.

Abnormal Tympanic Membrane with Perforation (see Coloured Plates). If a perforation exists we should note its size, shape and situation; the presence or absence of secretion; the state of the mucous membrane on the inner tympanic wall, whether it is pale and dry, or secreting, congested and swollen, or the seat of granulations or polypi. Observe if the handle of the malleus is shortened, absent or adherent to the inner tympanic wall; if the incus or stapes is exposed by the perforation above and behind; if we can see the bulging promontory or the niche of the fenestra rotunda. We should observe the appearance of the remnant of the membrane. Is it greyish, white or congested; thickened, opaque or the seat of a calcareous deposit; or does it adhere to intra-tympanic structures?

III. EXAMINATION OF THE MIDDLE EAR THROUGH THE EUSTACHIAN TUBE.

This consists mainly in observing the effects produced when compressed air is forced into the pharyngeal mouth of the Eustachian tube, termed inflation of the middle ear. We shall consider, first, the methods of inflating the middle ear; and, second, the information derived from these methods. The therapeutic value of inflation will be considered elsewhere (see p. 76).

There are three methods of inflation usually practised:

- (A) Catheterization.
- (B) Politzer's method.
- (C) Valsalva's method.

(A) CATHETERIZATION OF THE EUSTACHIAN TUBE.

A suitably formed tube—the Eustachian catheter—is passed through the inferior meatus of the nose into the pharyngeal opening

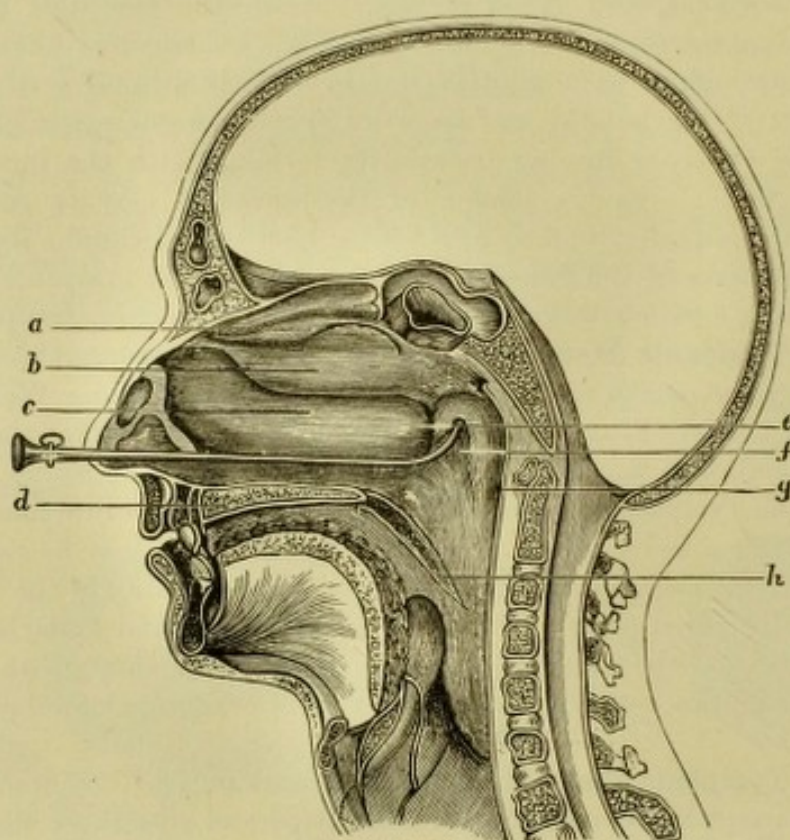


FIG. 15.—Vertical section of head, showing catheter introduced into the mouth of the Eustachian tube (after Politzer); *a*, superior spongy bone; *b*, middle spongy bone; *c*, inferior spongy bone; *d*, hard palate; *e*, posterior end of inferior spongy bone; *f*, mouth of Eustachian tube, with bulging above and behind; *g*, Rosenmüller's fossa; *h*, soft palate.

of the Eustachian tube (Fig. 15), and then a current of air is forced through the catheter.

Eustachian Catheter (Fig. 16). This is a tube about six inches in length, made of either silver or vulcanite, curved at one end. The outer end is widened for receiving the mouth-piece of an india-rubber



FIG. 16.—Vulcanite Eustachian catheter.

bag, while the inner end is narrower for insertion into the mouth of the Eustachian tube. In order to suit the varieties in the capacity and form of the inferior meatus and of the naso-pharynx, it is necessary to have a number of catheters differing in thickness, and in the length and degree of curvature of the beak. The most efficient catheter is one which is fairly wide, and has a strongly curved beak. A ring is attached to that side of the outer end of the catheter which

corresponds with the concavity of the beak, so that, when the catheter is introduced, the situation of the ring informs the operator of the position of the beak. Vulcanite catheters possess several advantages over those made of silver. They are not injured by fluids injected through them; they are less unpleasant to the patient; and by their elasticity the operator can more easily evade obstructions which may exist in the nasal passages.

Precautions before using the Catheter. Before using a catheter it is well to inspect the nasal passages by means of a mirror and speculum (Fig. 17), in order to ascertain if any obstruction exists to

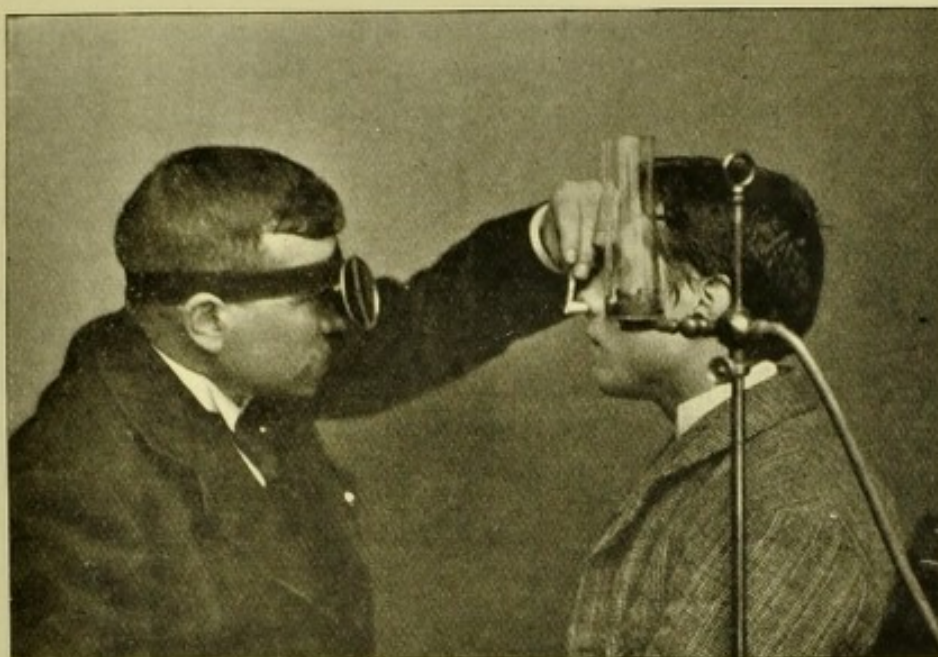


FIG. 17.—Anterior rhinoscopy.

the passage of the catheter, and the nature of it. The application to the mucous membrane of the nose of a 10 per cent. solution of cocaine on cotton wool diminishes the sensitiveness and widens the nasal passage. A current of air should also be forced through the catheter to test its permeability. Both patient and operator should be seated, the face of the former being well exposed to the light. As most patients tend to move the head backwards, while the catheter is being introduced, the back of the head should rest against some firm support.

First Stage of Catheterization. The first stage of the operation consists in passing the instrument through the inferior meatus of the nose, till the point of the beak is felt to be in contact with the posterior wall of the naso-pharynx. The four fingers of the surgeon's left hand rest on the patient's forehead and bridge of nose, while the thumb gently presses up the tip of the nose. The catheter is held like a pen between the thumb and first two fingers of the right hand, and

the point of its beak is placed lightly within the nostril in contact with the floor of the nasal passage, which, it is to be remembered, is under the level of the inferior edge of the nasal entrance. The instrument should now be pushed carefully, but not too slowly, along the inferior meatus, with the point of the beak *kept in contact with the floor* until it touches the hard posterior wall of the naso-pharynx. When introduced properly, the outer part of the catheter forms a right angle with the face. If it has slipped into the middle meatus—the most common mishap of the beginner—it will form an obtuse angle with the upper part of the face, and while in this position pain is apt to be excited.

Second Stage of Catheterization. This consists in moving the point of the catheter from the posterior wall of the pharynx to the mouth of the Eustachian tube. This may be done in several ways. *Politzer* turns the point of the catheter outwards into the fossa of Rosenmüller, and then, keeping the point in contact with the mucous membrane, he withdraws the catheter, until its point is felt to pass over the usually well-marked rounded projection forming the postero-superior border of the mouth of the Eustachian tube. *Löwenberg's* plan consists in turning the point of the catheter inwards towards the opposite side, and then withdrawing it until the beak hooks round the posterior edge of the nasal septum. The catheter (held between the thumb and index finger of the left hand while the other three fingers rest on the bridge of the nose and the forehead) is now rotated downwards and outwards, so as to describe a half circle, when the point is usually at the mouth of the tube. These methods possess the advantage of having well-marked and fixed anatomical guides, namely, the cartilaginous projection behind the mouth of the Eustachian tube, and the posterior edge of the nasal septum, respectively. Another method consists in withdrawing the catheter till the beak is opposed by the soft palate. The point is then turned outwards. The distance between the posterior wall of the pharynx and the edge of the soft palate presents great varieties during the movements of the palate, so that this method is uncertain. When the point of the beak is in the mouth of the tube, the ring should be directed towards the auricle of the same side.

Difficulties in the First Stage. These are due to obstructions encroaching upon or even obliterating the free space between the outer and the inner wall of the nasal passage. The most common of these are deflections or spurs on the septum or an enlarged inferior turbinal, or, still worse, both combined. By a little manipulation the surgeon is generally able to overcome the difficulties, or a thinner catheter and one having a smaller curve may be tried. The use of cocaine is of great service by shrinking the mucous membrane and widening the

passage. Occasionally it may be necessary to introduce the catheter through the opposite nostril. In this case an instrument is used having a very long beak and a pretty strong curve; it is passed in the way already described, and the point is then turned inwards and withdrawn till the beak is felt to be in contact with the posterior edge of the septum, when the point will be near to, or in the mouth of, the Eustachian tube of the opposite side, that is, the side upon which we wish to operate.

Difficulties in the Second Stage. In regard to this stage, there is sometimes difficulty in turning the beak of the catheter. This may be due to the catheter having slipped into the middle meatus or to the space between the posterior edge of the nasal septum and the mouth of the tube being unusually small, or the free space of the nasopharynx may be diminished by swelling of the mucous membrane or by post-nasal growths. We can overcome these difficulties by keeping the point of the catheter on the floor of the inferior meatus or by using a catheter having a short and slightly curved beak. Spasmodic contractions of the pharyngeal muscles may hinder the turning of the catheter; these pass off when the patient breathes deeply a few times through the nose. The contact of the catheter with the mucous membrane of the nose or pharynx sometimes excites coughing, sneezing, or retching, but it is sufficient simply to let go the catheter until these pass off. There is occasionally slight bleeding, but rarely more than a stain of blood on the beak of the catheter is seen.

Third Stage of Catheterization. This consists in inflating air, by means of an air-bag, through the catheter into the middle ear. During inflation the catheter is retained *in situ* most conveniently by being held between the thumb and index finger of the left hand, while the hand is steadied by resting the other three fingers on the forehead and bridge of the nose (Fig. 18).

The air-bag (Fig. 19) is a pear-shaped india-rubber balloon, of a size capable of containing eight or ten ounces of fluid, furnished with a tubular mouth-piece, somewhat conical in shape, so as to fit accurately into the outer opening of the catheter. While the catheter is being introduced, the air-bag may be conveniently held in the left arm-pit of the surgeon.

The mouth-piece is placed in the outer opening of the catheter (Fig. 18), and the bag is then firmly compressed *laterally* between the four fingers and thumb, so as to force the air into the catheter. Before relaxing the hand, the mouth-piece of the bag should be withdrawn from the catheter, and then the bag allowed to fill with air. Three or four compressions of the bag are generally sufficient. If the patient swallows during compression of the bag, the air usually passes in more

freely, owing to the contraction of the *tensor palati* muscle. The surgeon must be careful not to push the catheter inwards while compressing the bag, which must at first be done *gently*, till he is convinced by the amount of resistance that the point of the catheter is really in the mouth of the tube, and not pressing on the mucous membrane. If, during compression of the air-bag, the point of the catheter is forced through the mucous membrane, the air may pass



FIG. 18.—Catheterization.

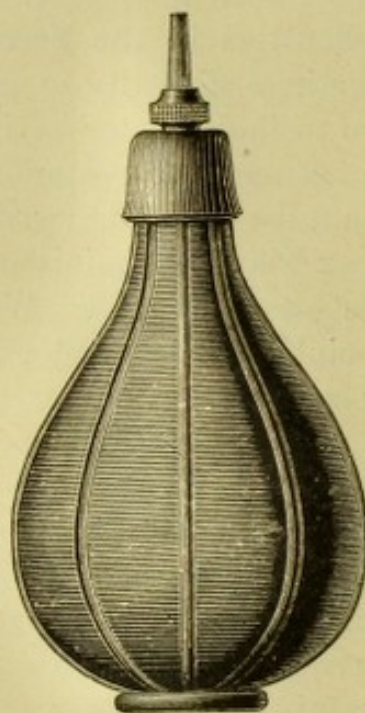


FIG. 19.—Catheter inflating bag.

under the mucous membrane and produce emphysema of the neighbouring parts, such as the soft palate, uvula, cheek, or neck. If the hand meet with great resistance, while attempting to compress the bag, we should not persist, but rather re-adjust the catheter, as the point is probably not engaging the mouth of the Eustachian tube. With this precaution, emphysema will be an extremely rare accident and can never prove a serious complication.

After use, the catheter must be cleansed by syringing with very hot water and then placed in a 5 per cent. solution of carbolic acid in water till again required, when it is syringed with very hot water before use. Metallic catheters can be sterilized by boiling. In syphilitic cases it is imperative that the patient have a special catheter reserved for his use.

Eustachian Bougies. When catheterization fails in opening the tube sufficiently to allow of a stream of air passing into the tympanic cavity, the *experienced* surgeon is justified in attempting gradual mechanical dilatation by means of thin gum bougies with olive-shaped, conical or cylindrical points which, before use, may be dipped in liquid vaseline or other medicated substance. A series is required ranging from a half to one millimetre in diameter. An

olive-shaped one is the most useful in overcoming a stricture. Bougies are introduced through a catheter, which is better to be short and to have an acutely curved beak. The point of the bougie should be introduced as far as the tympanic end of the Eustachian tube, the length of which is an inch and a half. The length of the catheter should be marked off with ink on the bougie, so that when the latter is passed into the catheter (properly introduced into the Eustachian tube) we may know from the ink-mark when the point of the bougie has reached the inner end of the catheter. A second mark is made an inch and a half from the other, visible when the bougie is introduced, which informs the operator how far into the Eustachian tube the point of the bougie has at any moment reached. The bougie should remain in position for from five to ten minutes. It should be cautiously and slowly introduced. Difficulty in passing a bougie may not be due to constriction but to folds of the mucous membrane. Several efforts at different times may be necessary before its complete introduction is possible. Air afterwards enters the tympanic cavity by the catheter more fully and freely, and there is often relief to the deafness and subjective sounds. If its action prove favourable the bougie may be introduced twice a week for several weeks.

(B) *POLITZER'S METHOD OF INFLATING THE MIDDLE EAR.*

We pass now to the very important method of inflating the middle ear (Fig. 20), named after its discoverer, Professor Adam Politzer, of Vienna.

Description of Politzer's Method. After the patient has taken a small quantity of water into his mouth, the beak-shaped nasal piece of a tube connected with an air-bag is placed about one-third part of an inch into the outer angle of one nostril close to the floor, the nasal passages being then completely closed in front by compressing the nostrils firmly with the thumb and index finger of the left hand. The air-bag is then grasped by the right hand; the patient is told to swallow, and immediately after the bag is forcibly compressed, and suddenly emptied into the closed nasal cavity; the bag must not be allowed to fill with air till the nose-piece is removed from the nostril. The closure of the nasal cavity posteriorly is effected in the act of swallowing by the elevation of the soft palate and its apposition to the posterior wall of the pharynx, while the sudden increase of density in the air contained in the shut nasal cavity, produced by emptying the air-bag, overcomes the resistance in the Eustachian tubes, and air passes freely into the tympana. In the act



FIG. 20.—Poltzer's method of inflating the middle ear.

of swallowing, also, the contraction of the muscles of the Eustachian tubes facilitates the passage of air into the tympana. If there is



FIG. 21.—Poltzer's nasal piece and tube.



FIG. 22.—Soft nasal piece.

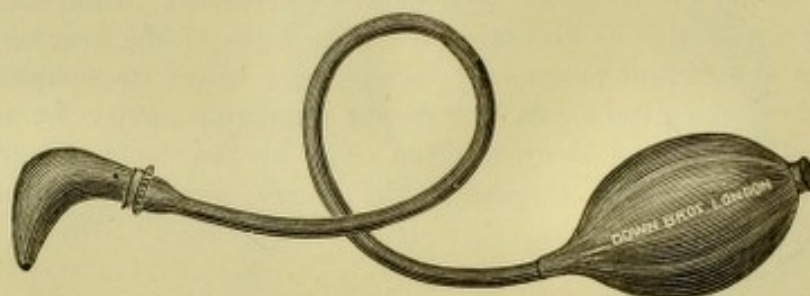


FIG. 23.—Gardiner Brown's inflating apparatus.

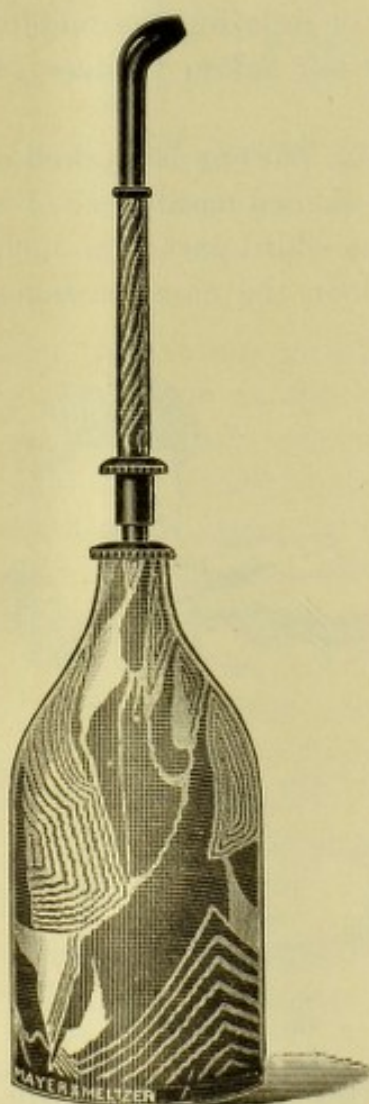


FIG. 24.—Bottle-shaped inflating bag.

difficulty in making the inflation synchronize with the act of swallowing, it is a good plan to observe the larynx and compress the bag when the larynx begins to rise in swallowing.

Modifications of Politzer's Method. The ordinary method of swallowing may not yield a successful result, or it may be impracticable, as in young children. In such cases the vigorous sounding of "ah" or the pronouncing of "hook," with prolonged emphasis on the "k," or the act of crying in the case of a child, will often prove successful. Blowing out the cheeks during inflation, as recommended by Holt, often proves a good substitute for the swallowing of water. In most cases, however, the swallowing of water seems to be more effectual, owing to the assistance gained by the contraction of the tensor palati in swallowing. If we desire a greater effect to be exercised upon one ear, we may close the opposite ear tightly with the finger, and cause the patient to incline his head well to the side on which the least effect of inflation is desired. We can often tell by the sense of resistance to the hand during compression of the bag if the soft palate has closed accurately.

Instruments for Politzer's Method. The bag used may be the same as for catheterization with a suitable nasal tube. Politzer himself used a nasal tube shaped like a catheter, and connected to the mouth-piece of the bag by means of a soft india-rubber tube, two or three inches in length (Fig. 21). The beak-shaped extremity of the hard nasal piece, which may be somewhat flattened, should be covered with soft india-rubber tubing, which renders it less unpleasant, and less likely to hurt the nasal mucous membrane. A fresh piece of tubing should be affixed for each patient. A soft nasal piece (Fig. 22) made of thick india-rubber somewhat flattened at the side is perhaps less disagreeable than the thin nasal piece, and is therefore specially suited for children and sensitive persons; the nasal piece of Gardiner Brown's inflating apparatus is also suitable for children (Fig. 23). Mayer & Meltzer have introduced a convenient bottle-shaped bag with soft nozzle (Fig. 24). When thick olive-shaped nasal pieces are used with the intention of completely closing one nostril, there is apt to be reflux of air rendering the inflation less efficient. An ordinary india-rubber enema-bag of six or eight ounces capacity, with a piece of soft india-rubber tubing covering and projecting from its hard ivory mouth-piece, suits very well. In all cases great care should be taken that the nose-piece is thoroughly cleansed and disinfected after use. An adult patient may practise self-inflation by closing the nostrils firmly over a nose-piece inserted into one nostril, while he himself blows through the tube (Fig. 25).

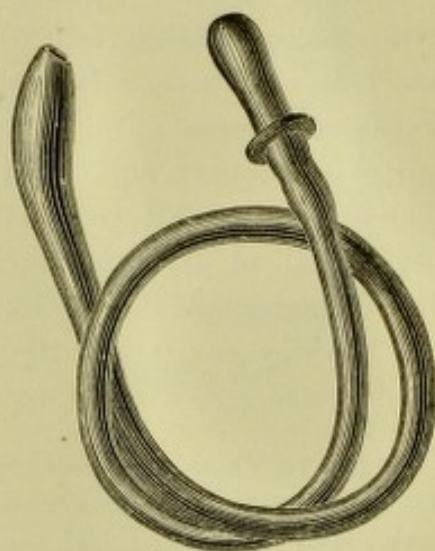


FIG. 25.—Simple inflating tube for children, or for auto-inflation.

Disagreeable Symptoms from Politzerization. Occasionally pain in the stomach is set up, owing to insufficient closure of the pharyngeal cavity, and the consequent passage of air down the œsophagus; but this is immediately relieved by eructation, or by a few full inspirations. Temporary giddiness or tinnitus rarely results. There should only be gentle pressure upon the bag at the first inflation, to prevent fright, while if there is atrophy of the tympanic membrane rupture may result from strong pressure, especially if there is marked Eustachian patency; also in acute tympanic inflammation only slight pressure should be employed. The inflation may be quite successful and yet the patient be unconscious of any sensation in his ear.

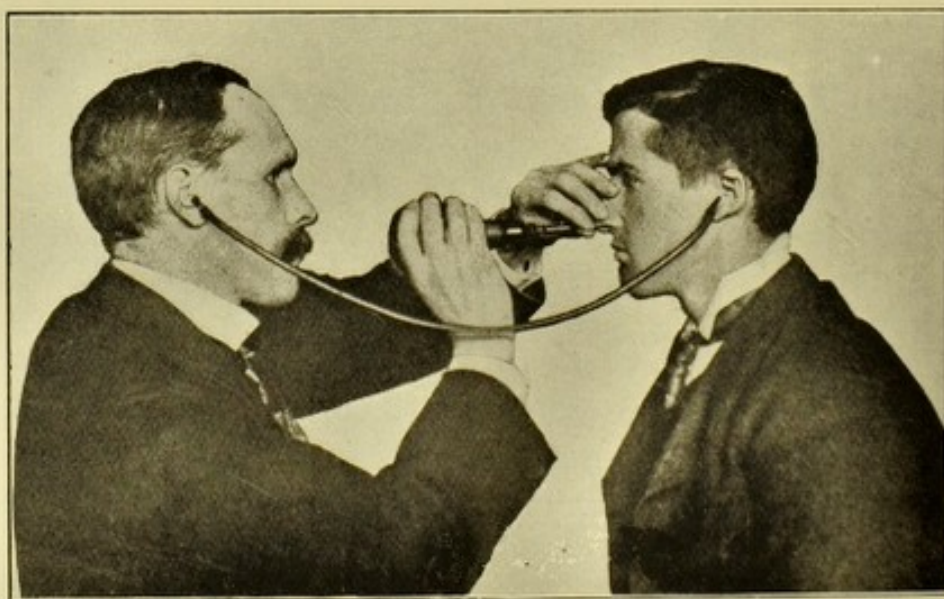
(C) *VALSALVA'S METHOD OF INFLATING THE MIDDLE EAR.*

Valsalva's Method of inflating the middle ear consists in making a forced expiration, with the lips closed and the nostrils firmly compressed with the fingers. In this way, the air contained in the naso-pharyngeal space becomes more or less condensed in proportion to the strength of the expiratory muscles in the given case. Where the resistance offered by the walls of the Eustachian tube or by the tympanic membrane is inconsiderable, the condensed air passes through the Eustachian tube into the tympanic cavity, producing an unpleasant sense of fulness or click in the ear. This method is often, however, quite ineffectual, and, even in a normal condition of the middle ear, many persons fail to inflate in this way. Where the membrane is perforated it is more likely to be successful, in consequence of the diminished resistance. Rarely Valsalva's method succeeds in inflating the middle ear after the catheter and Politzerization have failed; *its frequent repetition is apt to be detrimental to the hearing.*

Negative Valsalva's Method. This consists in swallowing several times, while the mouth and nose are closed. A rarefaction of the air in the naso-pharyngeal cavity is thus produced, and, provided the Eustachian tube is in a normal condition, some of the denser air in the tympanum will pass into the naso-pharyngeal cavity. A sensation of unpleasant pressure is experienced in the ear, which is removed when the patient swallows in the ordinary way.

*INFORMATION DERIVED FROM THE VARIOUS METHODS OF
INFLATING THE MIDDLE EAR.*

This information is mainly derived from auscultation, inspection, and the effects upon the hearing.



* FIG. 26.—Auscultation of the ear during catheterization of the middle ear.

Auscultation of the Ear (Fig. 26). Valuable information is derived from the kind of sound produced by the current of air on the walls and contents of the middle ear. In order to hear these sounds the surgeon must auscultate the ear during the passage of the current, and for this purpose the external meatus of the patient is connected with that of the surgeon by an india-rubber tube, thirty inches long, termed the auscultation tube (Fig. 27). This tube is furnished at each end with an ear-piece, one for the use of the surgeon, and the other for the patient. Different sized ear-pieces should be at hand in order to fit, without holding, the particular meatus, and they should have distinctive colours or shapes, so that one may be reserved for the surgeon. To prevent interfering with the passage of sound from the patient's ear to the surgeon's, nothing should be allowed to touch or press upon the auscultation tube when in use, while we must see that the ear-pieces are not obstructed with any material, such as wax. It is important that the student should familiarize himself with the sounds heard by auscultation, and for this end he should always use the auscultation tube while inflating.

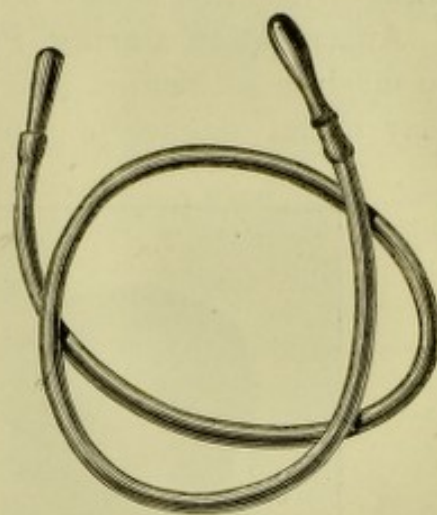


FIG. 27.—Auscultation tube.

Sounds heard during Catheterization. In the normal state the sound has a distinctly blowing character, compared by Politzer to that produced when we place the tongue against the hard palate and make a quick expiration with the lips slightly apart. In undue patency, as in oto-sclerosis, the sound has a fuller, drier, and more frictional character than in the normal. When there is a thin fluid secretion in the tympanum or Eustachian tube, it has a moist crackling or bubbling character. A rough vibrating sound generally indicates that the point of the catheter is not properly inserted in the mouth of the Eustachian tube. If the sound be weak, somewhat distant, or interrupted, there is usually obstruction in the Eustachian tube or tympanic cavity; this is confirmed if it become fuller and stronger when the patient swallows at the moment of the inflation. When the tympanic membrane is indrawn but movable, the sound is usually very distinct, and of a clicking or thudding character. A crepitating sound may be heard just after the inflation, due to the retraction of adhesions, etc., previously stretched. Probably the most characteristic sounds are heard in perforation of the membrane. If the perforation be small, with fluid secretion in the tympanum, there is a loud hissing sound, with perhaps gurgling. When the perforation is large, a loud blowing

sound is heard, sometimes painful to the listener, and conveying a sense of nearness; but, if there is narrowing of the tympanic end of the Eustachian tube, the sound may be of a whistling or squeaking character. Of course, when there is stenosis of the Eustachian tube these perforation sounds are not heard.

Auscultation during Politzerization (Fig. 28) does not yield us so much or so distinct information as by catheterization, because there may be an absence of sound during Politzer's method, or the sound

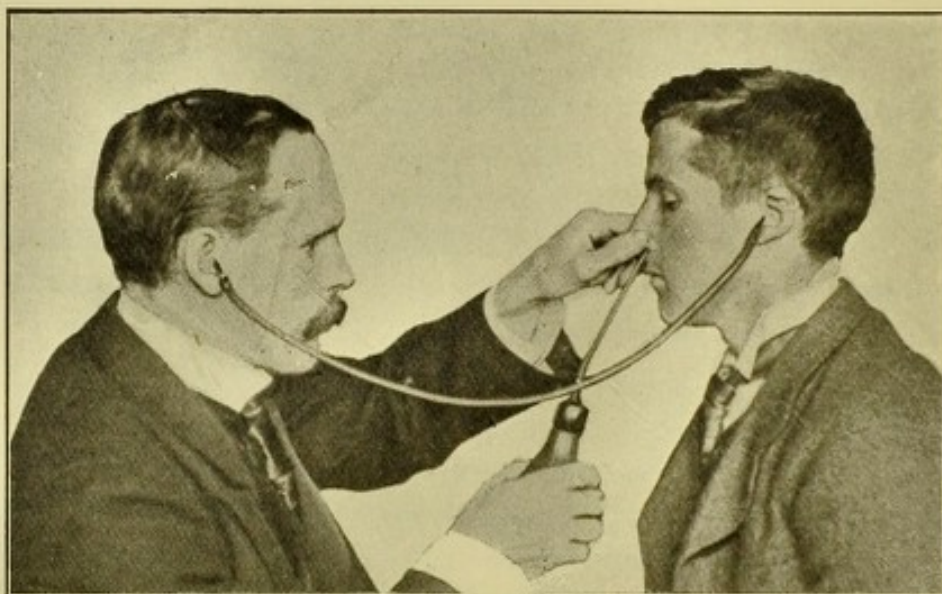


FIG. 28.—Auscultation during Politzerization.

caused by the act of swallowing may muffle the weaker sounds in the ear. The practised surgeon, however, is often able to hear many of the sounds, which have been described as heard during catheterizing, such as the "perforation r  le," the well-marked sound heard when the indrawn tympanic membrane returns to its proper position, or when there is secretion in the tympanum.

Auscultation during Valsalva's Experiment does not yield much information. Its chief value is in diagnosing a perforation by the well-marked hissing sound, caused by the passage of the air through the perforation. During the negative Valsalva's experiment there is occasionally heard a slight crackling sound.

Inspection of the Membrane during Inflation. During Valsalva's method we may get evidence of a perforation by the appearance of secretion at a point in the membrane, or we may observe an outward movement of the membrane, especially at the postero-superior part, while during the negative method it may be seen to recede. More important information is derived from inspecting the membrane during Politzerization or catheterization. By a little practice the examiner is quite able to inflate by Politzer's method and inspect at the same time. We may make out in this way the site of a

perforation by observing air bubbles being projected outwards during inflation, or thick secretion protruding like a ball from the orifice. If secretion is in the tympanic cavity without a perforation, we may see little circles through the membrane after the inflation, or its colour may change owing to the membrane being freed from the inner wall of the tympanum. When the membrane is indrawn and movable, we may see the unfolding outwards of the membrane with change of colour. A cicatrix or an atrophied portion will be seen to bulge out like a bladder; and, if watched, these bulgings will be seen to disappear shortly afterwards. The general mobility of the membrane may also be ascertained by inspection during inflation. These various effects also demonstrate the permeability of the Eustachian tube.

Ear-Manometer. This gives ocular demonstration of the changes in the density of the air in the tympanum produced by inflation. A simple form (Fig. 29) consists of a fine glass tube, having the shape of a horse-shoe. This is fitted air-tight into the external meatus by means of an india-rubber plug. A drop of red ink, or a solution of carmine, is placed in the tube near its outer end. The falling and rising of the coloured solution indicate the fluctuations in the pressure of the air in the tympanum or meatus.



FIG. 29.—Ear-manometer.

Effects of Inflation upon the Hearing. Valuable information is frequently obtained regarding the nature of the disease, from observing these effects. If, for example, in a case of chronic deafness without perforation, successful inflation produces no effect upon the hearing, or sounds in the ear, the prognosis is unfavourable. We have probably to do with intra-tympanic fixations or stiffenings, or labyrinthine trouble. If, on the other hand, distinct improvement is at once manifested, and especially if it continues for several hours or a day or two, we then have probably to do with an exudative middle ear catarrh which justifies a favourable prognosis. If the improvement lasts for only two or three minutes, there are probably adhesions, pseudo-bands, retraction of the tendon of the tensor tympani, or atrophy—the temporary stretching causing a momentary improvement. In purulent disease of the middle ear with perforation, improvement in hearing and mitigation of the sounds in the ear after inflation indicates the probability of permanent improvement. Inflation is sometimes followed by a temporary feeling of increased deafness, probably owing to the excessive tension of the tympanic membranes or to labyrinthine concussion.

Sensations of the Patient during Inflation. The sensations of the patient as to whether the current of air penetrates to the tympanum are not always to be depended upon. A sensation of fulness in the ear is often experienced, continuing, with sometimes a feeling of dulness, for a short time afterwards. In many cases, where by auscultation we know that the air has entered the tympanum, the

patient says that he hears nothing. On the other hand, the patient sometimes says that he feels it in his ear, when we know that it has not penetrated to the tympanum. Many patients, however, have a correct appreciation of the sensation, and can tell when the operation is, and when it is not, successful. The perforation sound is usually sufficiently loud as to startle the patient. In children, we may know that Politzer's method is efficient by the child suddenly raising his hands up to his ears—due to the marked sensation which is often felt during inflation in the middle ear catarrh of childhood.

IV. EXAMINATION OF THE PHARYNX, NASAL PASSAGES AND NASO-PHARYNX.

Light. For a superficial examination of the mouth and throat daylight, either used directly (direct method) or reflected by means of a mirror, suffices; but for a thorough and intimate exploration of the nasal and post-nasal spaces one or other of the more intense forms of illumination already described (p. 7) is essential. A 32 candle-power electric light, furnished with a frosted globe and attached to a wall bracket which allows free movement in all directions, is in common use, and the addition of a hood-reflector with a condensing lens increases the intensity of the light. A Nernst lamp or an oxy-hydrogen flame yields a still more powerful light, especially useful when operating in the deeper recesses of the nose.

Mirror. In examining by reflected light (indirect method), a suitable concave mirror is required to collect the rays of light and reflect them into the desired cavity. This mirror has a larger diameter and a longer focal length than that used solely for aural examination. The writer uses one of 4 inches diameter and 8 inches focal length, serviceable alike for aural and rhino-laryngeal work.

Cleansing of Instruments. The greatest care should be exercised in cleansing all instruments before and after use. Failing a small sterilizer into which to place all soiled instruments, thorough washing under the hot water tap, followed by immersion in carbolic acid or lysol solution, 5 per cent. of the former or 1 per cent. of the latter, is sufficient. A separate set of mirrors having some distinguishing mark, such as a handle of a different colour, should be reserved for specific cases.

Examination of Patient. The patient should be seated erect in a suitable chair (see p. 5), grasping its arms with the hands, whilst the examiner sits facing him at a slightly lower level (his eyes should be on a level with the patient's nose). The position of the light preferred by most examiners is upon the patient's left side, almost on a level with his ear. Some, however, favour placing the light upon the other side as less liable to be obstructed by the operator's hand.

The forehead-mirror, attached to the examiner's head by a band,

spectacle frame or flexible metal hoop, and having the perforation in the centre of the mirror opposite the right eye, is manipulated so as to reflect light on to the patient's face. It is important that the beginner should learn to employ both eyes, and not fall into the error of using only the one uncovered by the mirror. When both eyes are used a better perspective view is obtained, and the orientation of the parts is more effective.

The order of examination adopted by most surgeons is as follows:

- (A) Pharyngoscopy.
- (B) Anterior rhinoscopy.
- (C) Posterior rhinoscopy.

As a preliminary it is desirable to view the general aspect of the patient's head, neck and face, noting the state of the eyes and complexion, the presence or absence of scars, enlarged glands, etc.

(A) PHARYNGOSCOPY.

We should first examine the teeth, if present, and note their condition; the gums, lips and tongue for excoriations, ulcers, etc.; also the alveolar arches for defective development or congenital malformation. The hard palate is best seen when the patient's mouth is well open and his head tilted backwards.

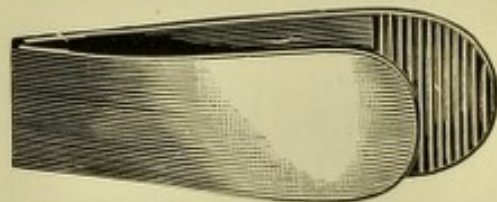


FIG. 30.—Tongue depressor.

Examination of Pharynx. In order to examine the pharynx a tongue-depressor is required in most cases. A serviceable form (Fig. 30) consists of a double spatula hinged together and constructed of vulcanite or metal; the latter is preferable as it facilitates sterilization. The under surfaces of the tips of the two pieces should be corrugated to prevent slipping. Fränkel's tongue-depressor (Fig. 31) is a good one and is widely employed. The thimble depressor of Baber is suitable for children, although perhaps for the very young the fore-finger alone is best. In default of one of the above, recourse may be had to a tea-spoon or dessert-spoon, the handle of which makes an efficient substitute.

Light is reflected by the mirror through the widely opened mouth into the pharyngeal cavity, or direct rays from the sky or lamp are arranged so as to pass into the open mouth. The patient is instructed to breathe quietly through the mouth; and, by means of the tongue-depressor applied flat upon the dorsum of the tongue, gentle but firm downward traction is made. Care must be taken not to insert the instrument too far as heaving or retching is apt to be excited. A better and more complete view of the back of the

pharynx is obtained when the patient sounds "ah," as during its phonation the soft palate is elevated. The introduction of a tongue-

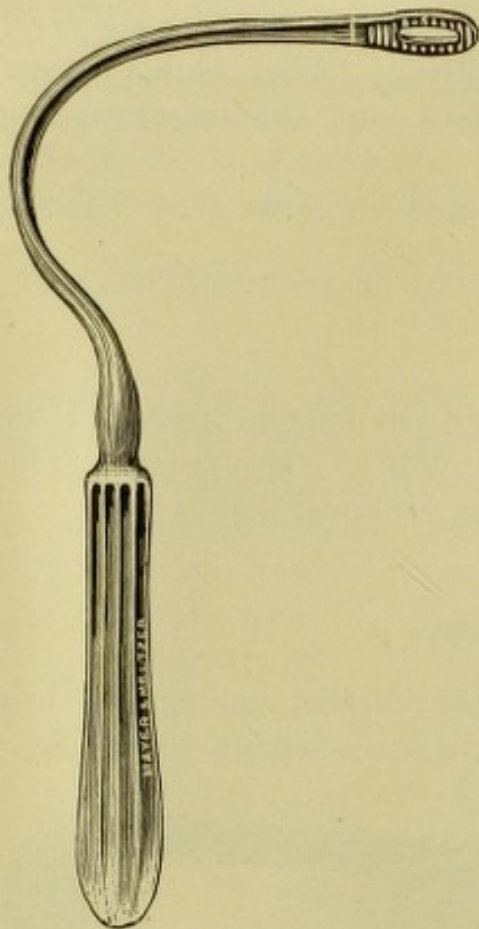


FIG. 31.—Fränkel's tongue depressor.

depressor, no matter how gently, excites in some people violent contraction of the muscles of the pharynx and troublesome retching. In these cases the use of the finger may be more successful. Arching upwards of the tongue is sometimes a hindrance to a satisfactory examination. This is best overcome by exerting firm and constant pressure downwards for 20 or 30 seconds with the tongue-depressor, whereupon the muscles become exhausted, and the tongue subsides into the floor of the mouth. In an unruly child the closure of the nostrils by the fingers ensures a speedy opening of the mouth.

Structures seen by Pharyngoscopy.

The curtain of the soft palate above, with the uvula hanging down from its free edge in the middle line. Diverging from the base of this on either side the anterior and posterior pillars of the fauces with the tonsil lying in the niche between.

Behind is the back wall of the pharynx lined by mucous membrane. Sometimes a view may be obtained of the posterior surface of the tongue, and not infrequently in children strong traction with the tongue-depressor will bring the tip of the epiglottis into view. The normal colour of these parts is a rosy pink; but considerable variations of tint are compatible with a healthy state.

Pathological changes in the Pharynx. Resulting from catarrhal or inflammatory attacks, especially those associated with a gouty or rheumatic diathesis, the mucous membrane of the pharynx may be thickened, swollen, of a raw fleshy appearance, and intolerant to touch. Associated with this the veins coursing over the back wall are not infrequently dilated and may even be thrombosed. In the condition known as granular pharyngitis small, white or pink, raised patches of adenoid tissue are seen studding the rather pale mucous membrane of the posterior pharyngeal wall. Larger, often elongated, flat elevations of similar tissue may result from irritating discharges from the naso-pharynx. The uvula may be elongated, œdematous, puckered or dragged up to one side owing to paralysis or cicatricial contraction; or it may be bifid.

The tonsils, especially in children, are frequently hypertrophied. They may be so enlarged as to meet in the middle line. The tonsillar crypts may be the seat of inflammation giving rise to "the spotted throat" (acute follicular tonsillitis), or they may be filled with white or yellowish white, cheesy looking matter (chronic follicular tonsillitis). Ulcers on the soft palate or tonsils may

be seen. These are most frequently observed in syphilis, diphtheria or scarlet fever; in the two latter they are of course more likely to be observed at the bedside. The fauces may be generally injected and oedematous as in acute pharyngitis, or they may be covered with a membranous exudate as in diphtheria. In peri-tonsillar abscess the soft palate on the affected side is red, tense and much swollen, and protrudes forwards and downwards into the mouth. The soft palate may be cleft, or it may be the seat of scars or adhesions to the pharyngeal wall; or there may be a perforation from old gummatous ulceration. The faucial mucous membrane may be atrophied and dry-looking, and crusts of a dirty green colour may be adherent to the back wall. Pus or mucus is sometimes seen escaping downwards from the naso-pharynx.

(B) ANTERIOR RHINOSCOPY.

By anterior rhinoscopy (Fig. 32) is meant a visual examination of the interior of the nose through the anterior nares. For this purpose an efficient nasal speculum is used to dilate the *alæ nasi*,

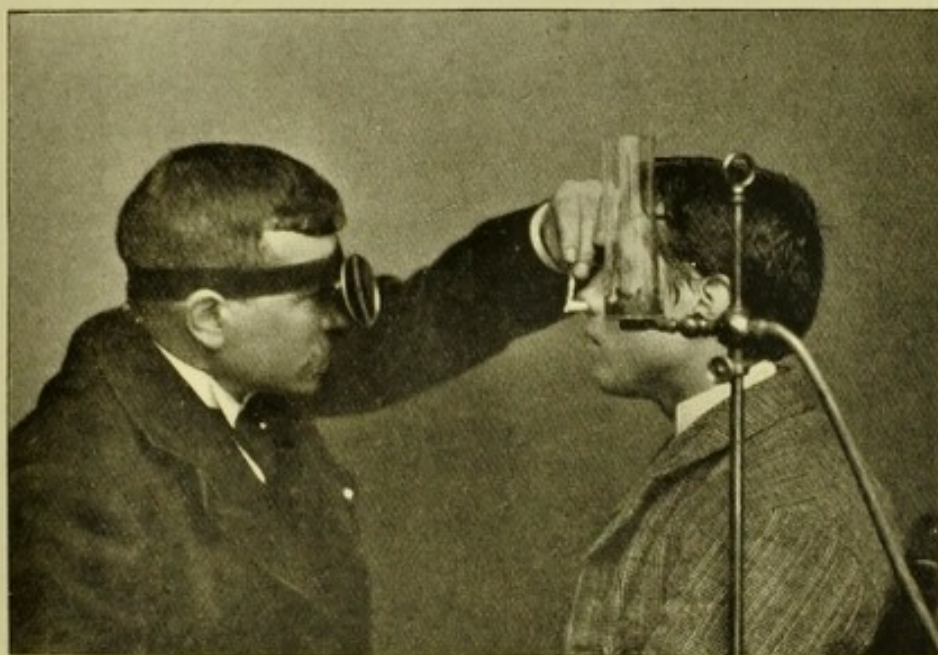


FIG. 32.—Anterior rhinoscopy.

and a more powerful light is required than in pharyngoscopy; furthermore, the room should be darkened so as to exclude all other conflicting sources of light.

Nasal Specula are so numerous and varied that a beginner is at a loss which one to select. The following are a few of the more widely used: (1) the bivalve type, of which Roth's (Fig. 33), Duplay's, Fränkel's, Lennox Browne's, and Krause's, are examples; (2) the self-retaining variety, of which Thudicum's spring nasal speculum (Fig. 34) and Baber's self-retaining nasal speculum are favoured by many. Personally the writer uses a bivalve, either Roth's or Krause's.

Having focused the light on the anterior nares, Roth's speculum, held in the left hand, is introduced with the blades closed and the handles directed upwards (Fig. 32). By slight pressure on the handles, the blades are forced apart as far as is necessary to obtain

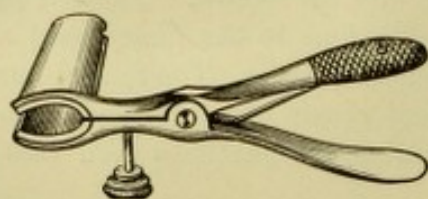


FIG. 33.—Roth's speculum.

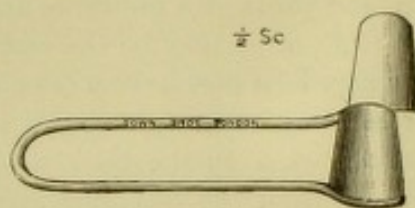


FIG. 34.—Thudicum's spring nasal speculum.

a view of the parts, without causing the patient undue discomfort. This speculum has the great advantage that the hand manipulating it is entirely out of the way. Krause's speculum, with the long handles downwards, admits of a less constrained position, which is no small comfort to the operator during prolonged nasal operations.

Use of Cocaine and Adrenalin. In order to make a thorough examination, it is very often necessary to use a 10 per cent. solution of cocaine, with a few drops of a solution of adrenalin chloride (1-1000) added to it, applied to the nasal mucous membrane either

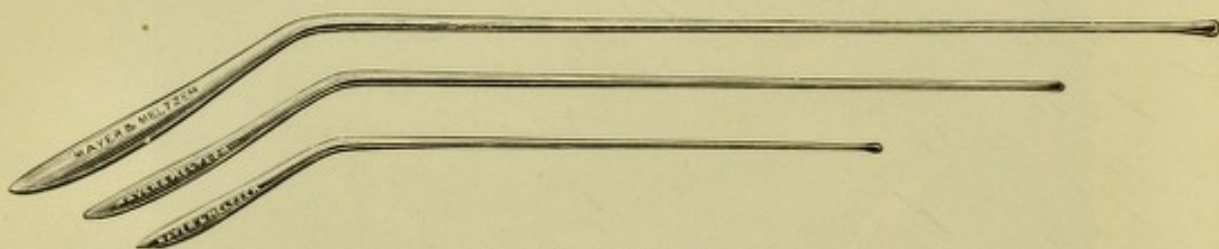


FIG. 35.—Nasal probes.

by means of cotton wool on a cotton holder, or a spray. Cocaine and adrenalin contract and blanch the parts, and at the same time produce local anæsthesia, thereby permitting of free manipulation with a probe. A suitable nasal probe is depicted in Fig. 35. It is Hajek's pattern, constructed of copper nickled over, and can be readily bent to any required angle. It is specially useful in exploring the nasal accessory sinuses; valuable information may also be derived by its use as to the consistence and mobility of growths, such as polypi, localized hypertrophies or bone cysts.

Parts seen by Anterior Rhinoscopy. Generally the most prominent object which first meets our view on looking into the nose is the anterior end of the inferior turbinated body. In the normal condition the colour of its mucous membrane is reddish pink; but considerable variations in tint are compatible with a healthy condition. In many cases ridges, protuberances or concavities are seen upon the septum. Above and behind the anterior end of the inferior turbinal lies the anterior end of the middle turbinal, and between these two

is the middle meatus, a region which merits the closest scrutiny. In the anterior half of the middle meatus, upon the outer wall, is a gutter-like depression, the hiatus semilunaris, curving upwards in front to receive the opening from the frontal sinus (Fig. 36). At its posterior end is the ostium of the antrum of Highmore. Forming the anterior and lower border of the hiatus semilunaris is a crescentic ridge of bone covered with mucous membrane—the processus uncinatus, which varies considerably in size, and may be so hypertrophied as to simulate the middle turbinated body. Constituting part of the

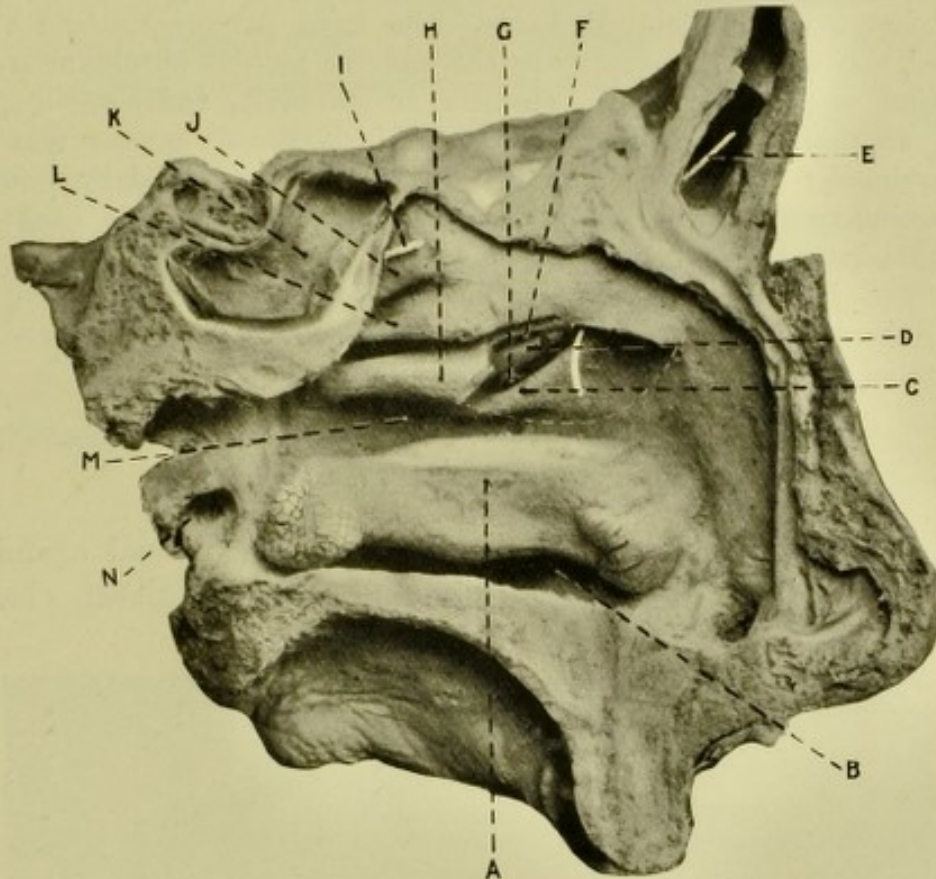


FIG. 36.—The outer wall of the nasal passages. The anterior half of the middle turbinal has been removed in order to expose the contents of the middle meatus. The dotted line indicates the outline of the portion of the middle turbinal which has been removed. A, inferior turbinal, showing hypertrophy of the anterior and posterior ends; B, inferior meatus of the nose; C, processus uncinatus; D, bulla ethmoidalis; E, bristle passed through the ostium frontale into the anterior end of the infundibulum; F, recess between bulla and middle turbinal where the principal opening into anterior ethmoidal cells lies; G, ostium maxillare; H, middle turbinal; I, bristle passed through ostium of sphenoidal sinus of left side; J, supernumerary superior turbinal; K, right sphenoidal sinus, unusually large; L, superior turbinal; M, middle meatus; N, pharyngeal orifice of Eustachian tube.

upper border of the hiatus is the bulla ethmoidalis, a bony expansion of the lowest and largest of the anterior ethmoidal cells. Opening on the bulla, or in the groove between this and the middle turbinal, generally lie the principal orifices of the anterior ethmoidal labyrinth. Below the inferior turbinated body is the inferior meatus of the nose, along which the Eustachian catheter is passed. In a few cases, where the inferior meatus is unusually wide, and in the condition known as atrophic rhinitis, the posterior wall of the naso-pharynx, the ostium of the Eustachian tube and the movements of the levator palati muscle can be observed.

The commoner Pathological Conditions seen by Anterior Rhinoscopy. On separating the blades of the nasal speculum, one not infrequently sees the

anterior end of the inferior turbinal, red and greatly swollen, obstructing entirely our view of the other parts. At other times inspection of the deeper regions is hindered by a large spur or marked deflection of the septum to one side. The anterior end of the middle turbinal may appear as a large pale rounded mass impinging on the septum, or there may be an appearance as if two middle turbinals were present when the processus uncinatus or the bulla ethmoidalis is enlarged. The presence of pus should be carefully noted and its source investigated. Mucous polypi in the nose appear as smooth pendulous pale-blue swellings, freely movable with a probe, and generally accompanied by more or less muco-purulent discharge. The nasal passages, instead of being obstructed, may appear abnormally patent, and the mucous membrane atrophied, dry looking, and covered with greenish or yellowish, badly-smelling crusts (ozæna). In this condition the inferior turbinals usually appear stunted and under-developed; in marked cases they are merely represented by a small low ridge running from before backwards. The middle turbinals, in most cases of ozæna, participate in the general atrophy, as do also the contents of the middle meatus; but in some instances the middle turbinals appear hypertrophied, while in others the bulla ethmoidalis and the processus uncinatus stand out in marked relief from the surrounding atrophic areas.

(C) POSTERIOR RHINOSCOPY.

By posterior rhinoscopy is signified an indirect visual examination of the naso-pharynx and posterior aspect of the nasal chambers.

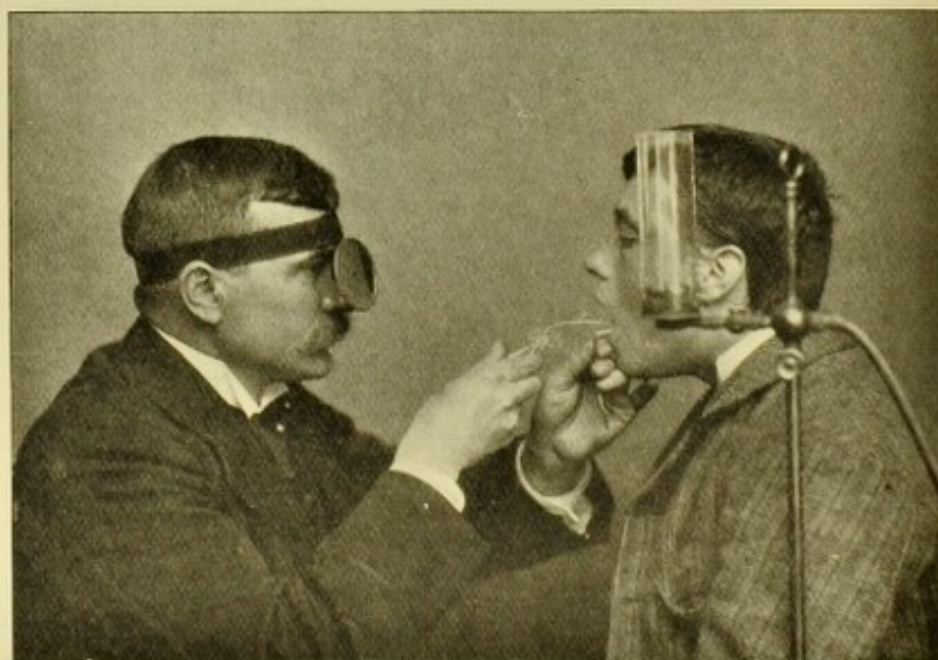


FIG. 37.—Examination by posterior rhinoscopy.

Repeated practice is required in carrying out this method of examination in order to acquire sufficient dexterity, as, even with the most skilful, indifferent success is far from uncommon. In cases of nasal stenosis, it is advisable to cocainize freely the nasal passages before

attempting the examination of the naso-pharynx. The tongue must be well depressed by a tongue-depressor, in order to secure a clear space between the base of this organ and the soft palate. It is a good practice to encourage the patient to make an effort to respire quietly through the nose while the tongue-depressor is in position. Should the soft palate constantly retreat upwards and the attempts to breathe through the nose fail, the patient should be directed to pronounce the French word "on"; this frequently permits of a better view. If, after repeated attempts, only partial success is met with, the throat may be cocainized; this generally permits of a satisfactory examination. If that fails, one or other of the various palate-retractors should be called into requisition.

Method of Conducting Examination (Fig. 37). A forehead reflector is used as in the examination of the pharynx, the tongue is

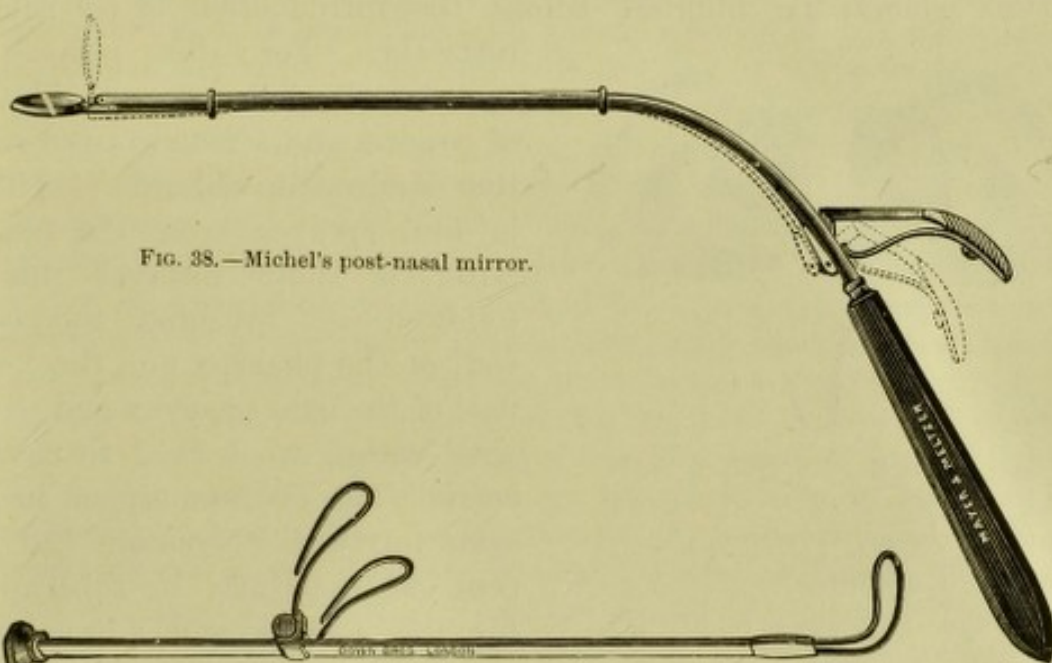


FIG. 38.—Michel's post-nasal mirror.

FIG. 39.—White's self-retaining palate retractor.

depressed by one or other of the instruments already described for that purpose, and a small mirror, the face of which has been previously warmed over a spirit lamp or in hot water, is cautiously introduced into the throat with the reflecting surface upwards. Care must be taken, in introducing the mirror, to avoid touching the soft palate or uvula. Once past these highly sensitive regions the chief difficulty is over, as the back wall of the pharynx is less sensitive to accidental contact. Perhaps the best form of mirror is that known as Michel's (Fig. 38), having a mechanism by means of which the angle made by the small mirror with the shaft may be regulated as desired. A No. 1 or No. 0 laryngeal mirror does very well, and in point of fact is preferred by many.

Palate-retractor. In the event of great difficulty being experienced in the examination, the employment of a palate-retractor may be necessary. A serviceable form is White's self-retaining palate-

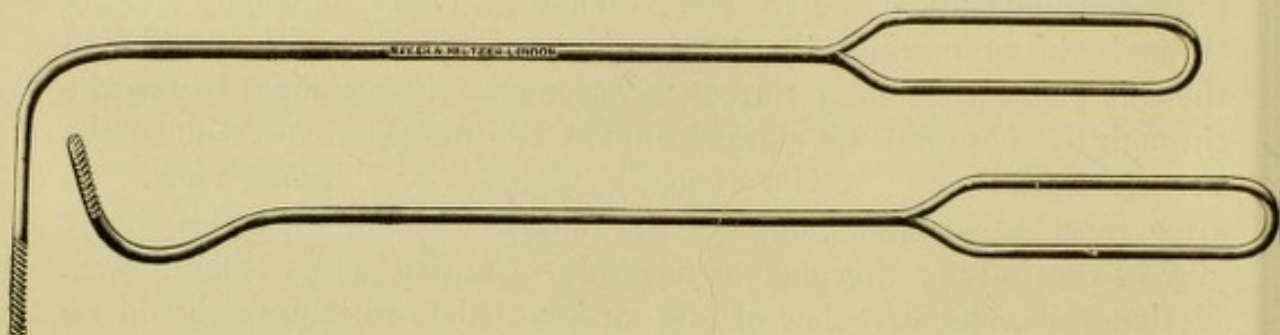


FIG. 40.—Wool carriers for naso-pharynx.

retractor introduced by Baber (Fig. 39). It possesses a movable clip, with which to clamp it over the upper lip. The pharynx and naso-pharynx should be numbed before the introduction of a palate-

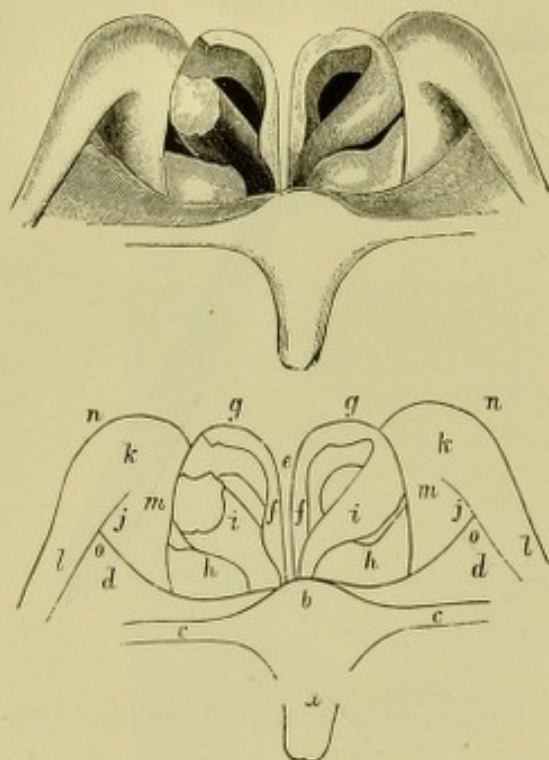


FIG. 41.—Posterior rhinoscopic view, as seen with the mirror in the ordinary position. *a*, Posterior surface of uvula; *b*, uvula cushion; *c*, posterior margin of palate; *d*, levator cushions; *e*, septum nasi; *f*, swellings on the sides of septum; *g*, choane or posterior nares; *h*, inferior turbinated bodies; *i*, middle turbinated bodies; *j*, Eustachian openings, more strictly the depressions leading to them; *k*, Eustachian cushions; *l*, salpingo-pharyngeal folds; *m*, salpingo-palatine folds; *n*, position of upper part of Rosenmüller's fossae; *o*, posterior tubal sulci. (Cresswell Baber.)

retractor. For this purpose a mixture of a 10 per cent. solution of cocaine and a few drops of solution of adrenalin chloride (1-1000) is first sprayed over the fauces. After a short interval this is followed by brushing the back wall of the pharynx and the lower part of the naso-pharynx and uvula with cotton wool fixed to a wool carrier (Fig. 40), and dipped in the same mixture. Novocain (20 per cent. solution) may be substituted for the cocaine and adrenalin—this is said to be less toxic. The hook of the retractor is rapidly passed up behind the soft palate and the clip adjusted over the upper lip, and steady traction exerted on the soft palate. In this way a very complete view of the naso-pharynx may usually be obtained (Fig. 41), as a much larger mirror, such as a No. 4, or even No. 5, can be used.

Image by Posterior Rhinoscopy (Fig. 41). The image seen in the mirror when its surface is directed upwards and forwards includes: (1) the posterior edge of the nasal septum, which may be recognized as paler in colour than the

surrounding parts. On each side of the septum are the posterior nares or choanæ, and projecting inwards from their outer walls are seen the posterior ends of the three turbinal bodies. The middle one of these is generally the most prominent, and appears as an oblong protuberance of a grey or bluish colour. The superior turbinated body is often invisible, and the inferior is generally only seen in its upper part, the rest being concealed by the soft palate. If the mirror be now inclined somewhat laterally, the pharyngeal mouth of the Eustachian tube comes into view, triangular in shape, with its base directed forwards and its apex backwards, situated behind the inferior turbinal on a slightly higher level. Bounding the Eustachian orifice above and behind is a rounded swelling, which varies in prominence in different persons; and behind that again, and between it and the back wall of the naso-pharynx, is a depression called the fossa of Rosenmüller. On altering the inclination of the mirror, so that the reflecting surface is directed upwards, the roof and part of the back wall of the naso-pharynx can be inspected.

Pathological Appearances in the Naso-Pharynx. The most common pathological change is met with in children, although occurring also in adults, namely, hypertrophied adenoid or lymphoid tissue, the so-called adenoid vegetations. These are the result of hyperplasia of a normal layer of adenoid tissue present in the mucous membrane of the back wall and roof of the naso-pharynx, the pharyngeal tonsil. Their appearance varies from a slight fringe to a large corrugated mass, with vertical rugæ, filling the summit of the pharynx and obstructing the view of the upper segment of the septum. In some there is a simple cushion faintly fissured in the middle line. Occasionally the fossæ of Rosenmüller are occupied with these growths. Associated with adenoid growths there may be hyperplasia of the lymphoid tissue in the lip surrounding the Eustachian orifice, giving rise to considerable enlargement of this structure. We may also find swelling or congestion of the mucous membrane, which may be studded with granular projections similar to those observed in the back wall of the pharynx in granular pharyngitis. The posterior ends of the turbinated bodies, especially the inferior, are frequently seen to be swollen or hypertrophied, and polypi may project through the posterior nares; sometimes a fibrous polypus is seen completely blocking the naso-pharynx. Mucous or purulent secretion may be seen in greater or less quantity, and thin streaks of pus may be observed over the posterior end of the inferior turbinal; the presence of pus in the region of the posterior end of the middle turbinal should be noted and its origin investigated. Ulcerations (tubercular or gummatous), cicatrices, and adhesions are less common.

Digital Examination of the Naso-Pharynx. This method is chiefly used in young children where posterior rhinoscopy is impracticable. It is of great value, more especially in the diagnosis of adenoids, as by this means a better idea of their amount is obtained than by the use of the reflecting mirror.

The little patient is seated upon a chair with the head thrown back resting upon the left arm and body of the examiner, who is standing behind. It is advisable to have an assistant to hold the patient's hands and secure the legs. The index finger of the right hand, which has been thoroughly washed, is passed into the mouth as far as the

posterior wall of the pharynx. To prevent injury from the teeth of the patient, the first phalanx and the metacarpo-phalangeal joint of the exploring finger should be protected by thick india-rubber tubing, or the cheek of the patient should be pressed between the separated jaws by the left hand of the examiner.

On reaching the posterior wall of the pharynx the tip of the finger is quickly passed *behind* the uvula. The muscular spasm which takes place usually passes off when the point of the finger is well in the naso-pharyngeal cavity. During the examination the patient should take full and regular inspirations through the nose. By moving the finger in the appropriate directions a very correct impression can be obtained of the condition of the back wall and roof, the upper surface of the soft palate, the posterior edge of the nasal septum, the posterior ends of the inferior turbinals, the mouths of the Eustachian tubes and the fossæ of Rosenmüller. In a normal condition the mucous membrane lining these parts should be firm and smooth. In addition to its use for diagnostic purposes, the introduction of the finger into the naso-pharynx is often necessary in operating, as in curetting for adenoids, or adjusting a snare round the hypertrophied posterior end of an inferior turbinal or a large fibrous polypus.

V. METHODS OF TESTING THE HEARING AND LOCALIZING THE SEAT OF A DEFECT.

We shall consider the tests to be applied, (A) By air-conduction, and (B) By bone-conduction.

(A) TESTS APPLIED BY AIR-CONDUCTION.

In testing by air-conduction (the ordinary mode of hearing) each ear should be tested separately while the opposite ear is closed and the eyes are shut or covered. Obviously the room should be as noiseless as possible.

The tests by air-conduction are (*a*) simple tones, and (*b*) speech.

(*a*) Simple Tones.

The most convenient instruments for testing the capacity for hearing simple tones are the watch, a special acoumeter, Galton's whistle and tuning-forks.

Watch Test. We must employ a watch the tick of which is a clear distinct sound, not a rubbing or shuffling tick, keeping in mind that the tick of a watch is louder after winding, while it is fainter after cleaning and oiling. A stop-watch is the best, as with it we may at any moment stop the ticking, and in this way we are able to check

the veracity of the patient, a precaution specially necessary in the examination of children. As watches differ very much in pitch and intensity of tone, the particular watch used for the purpose should be tried on a number of persons having good hearing. The distance in inches, at which the tick is heard by a person of good hearing power, is termed the *normal* hearing distance, and forms the standard in testing the hearing power of patients. Thus, if the normal hearing distance of a given watch is 36 inches, and the actual hearing distance of a patient is 20, this fact would be expressed by the fraction $\frac{20}{36}$. This is a very convenient and simple way of expressing, in the record of a case, the state of the hearing power. If the tick is not heard even when the watch is pressed on the ear, we express the condition of hearing as $\frac{0}{36}$; if heard on pressure, as $\frac{p}{36}$; while, if the watch is heard on slight contact, as $\frac{c}{36}$. To ensure accuracy we should use a measuring rule, which must not be touched by the watch, while we are testing the hearing. The watch is first held close to the best ear, so that the patient may know the character of the sound, and thus be able to distinguish it from other sounds. The ear which is not being tested should then be carefully closed, and the watch held, parallel with the auricle, beyond the hearing limit, and then brought gradually nearer to the ear until we find the exact hearing distance. It is well to repeat the test, perhaps more than once, as in some patients we get contradictory statements as to the distance at which the tick is heard. While imagination has something to do with this, it is to be remembered that there is, in special forms of labyrinthine deafness, an uncertain zone of hearing.

Politzer's Acoumeter (Fig. 42) consists of a pillar of vulcanite (*a*) rather more than an inch in length, into which are fitted an immovable cylinder of steel (*c*), about an inch in length, and a short distance above this a movable lever about an inch and a half in length, with a longer arm terminating in a small ball (*b*), so as to form a percussion hammer, and a shorter arm (*e*), pressure on which raises the hammer. The vulcanite pillar is held between the index finger and the thumb, and, the shorter arm of the lever being pressed down by the middle finger, the longer arm with the percussion hammer is raised to a fixed height, and, being allowed to fall on the steel cylinder, a sharp click is produced. As the extent of fall and the dimensions of the instrument are the same in all cases, the amount of sound is uniform. In the vulcanite pillar, above the percussion hammer, is a perforation for the insertion, when required, of a metal pin, four centimetres

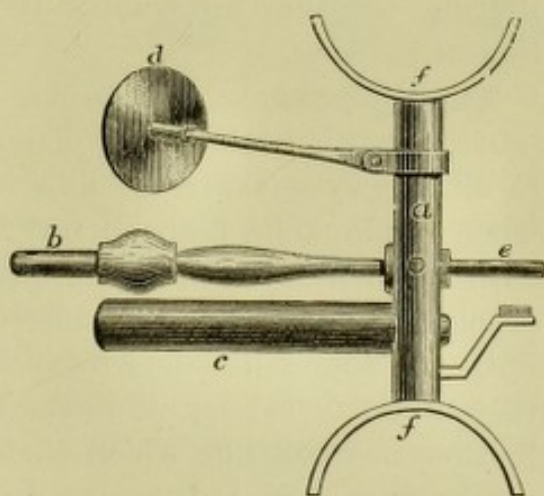


FIG. 42.—Poltzer's acoumeter.

in length, its free extremity terminating in a round metal plate (*d*). This pin is intended to be used, when testing the perception of sound conveyed through the bones of the head, by pressing the metal plate on the temporal bone or the mastoid process. With the greatest care, after excluding all disturbing elements, the normal hearing distance for this instrument has been found to be fifteen metres, about sixteen yards. The intensity of the click of the acoumeter, being so much greater than the ticking of any watch, makes it possible to determine the degree of sharpness of hearing in many cases where the tick of the watch cannot be perceived. Its chief value is to test the hearing in persons whose deafness is so great that the tick of a watch cannot be heard.

Galton-Edelmann's Whistle (Fig. 43) is very useful for testing the patient's power of perceiving the high tones. It has a very fine

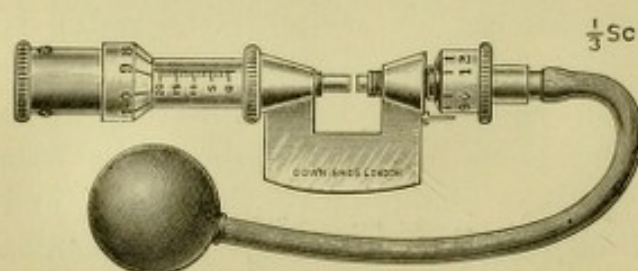


FIG. 43.—Galton-Edelmann's whistle.

bore, furnished with a movable plug by which the tube can be at will shortened or lengthened. A small india-rubber ball is attached, by which the air is blown into the tube. By lengthening the tube the pitch is lowered, by shortening it the pitch is raised. The distance of the

piston from the lower end of the tube is marked with a millimetre scale from 0 to 20 mm., and, by referring to a table which is provided, we can tell the exact number of vibrations of the note. While in normal hearing a tone of over 40,000 vs. may be heard, in labyrinthine mischief (such as is found in boilermakers) the hearing may be reduced to 10,000 vs. Failure to hear the high notes of this whistle is usually associated with nerve or labyrinthine disease.

König's rods may also be used for testing the upper limits of hearing, but they are comparatively seldom employed in the examination of patients.

Tuning-forks. The tuning-fork most suitable for testing the hearing by air conduction (quantitatively) is $C^1 = 256$ vs. It is made to vibrate by striking the knee with the flat of one of the prongs, or when employing a high pitched fork, striking a piece of wood, covered with a thick layer of cloth, *with a uniform strength of stroke*. The prongs are held near the orifice of the ear, but not touching the skin, until the sound has died away, when the fork is quickly removed to the patient's good ear, or to the ear of the examiner, and the difference in time noted during which the sound continues. The tuning-fork is much more useful, however, in determining the patient's power of hearing the *pitch* of notes (qualitatively). For experimental purposes, or for the exhaustive examination of the hearing, an extensive series of tuning-forks is employed, ranging from the lowest to the highest

notes, but for ordinary purposes five tuning-forks are sufficient, extending from $C = 128$ vs. to $C^4 = 2048$ vs. (Fig. 44). Lower forks such as those with vibrational numbers of 64 and 32 are in some cases clinically useful. Useful work, however, may be done with three, one for the lower tones of the scale ($C = 128$ vs.), one for the medium ($C^1 = 256$ vs.), and one for the higher ($C^3 = 1024$ vs.).

In using these the time during which a high-pitched fork is heard should be compared with a low-pitched one—using an equal strength of stroke each time—and the difference noted. It is pretty well established that defective appreciation of the lower tones usually points to a defect in the conducting structures, and that failure to hear the higher notes of the scale generally indicates a defect in the nerve structures. If there be defective perception of both low and high tones, but good perception for medium ones, the likelihood is that both the conducting and the nerve structures are implicated. It may be said that the results are more reliable in cases in which the deafness is very pronounced and one-sided.

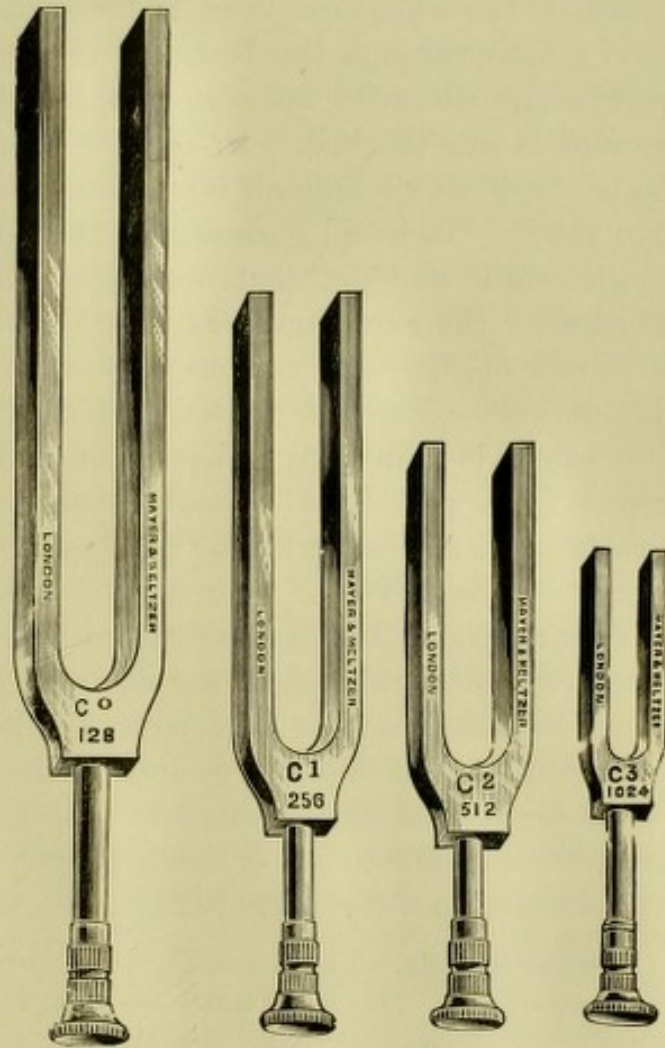


FIG. 44.—Series of tuning-forks.

In considering the significance of defective hearing of high notes, it is important to remember that elderly patients usually hear the high notes badly, and the same holds good with those who work amid noisy surroundings. The value of these tests for the hearing of high and low notes depends a good deal on the intelligence of the patient as well as his musical appreciation, and in any case much patience and time are required.

(b) *Testing by Speech.*

As the power of hearing such a sound as the tick of a watch may be no criterion of the patient's power of hearing speech the testing of

the latter is important. In testing the hearing by means of speech, the ear should be turned towards the examiner, while the opposite ear should be carefully stopped, and the eyes of the patient should be shielded or turned away, so as not to see the face of the speaker.

Whispered Voice. A whisper is more suitable for testing the hearing than loud speaking, not only because we can maintain a greater uniformity at different and distant times, but also because in one-sided deafness, the whispered voice is not so likely to be heard through the good ear, or through the bones of the head, and, further, in whispered speech the disparity between the sound of vowels and that of consonants is less marked. In normal hearing, a whispered word should be heard, if we exclude all other sounds, at about a distance of twenty-five yards. To avoid guessing by the patient, it is well to pronounce single words and not sentences, the patient repeating them word for word after the examiner. It must be remembered, however, that the whispers of different persons may vary very much in loudness and distinctness. For the limited size of a consulting room, it is well to cultivate a low uniform whisper, and make the distance at which it is heard by a person of normal hearing our standard. If this were twelve feet, and a particular patient heard it only at three feet, we would express it $\frac{3}{12}$. We should not repeat the same words on different days, as familiar words are heard by deaf persons at a greater distance than words which are not well known; hence the distance at which words of a foreign tongue are heard is sometimes only $\frac{1}{3}$ th or $\frac{1}{5}$ th that of the mother tongue (Politzer). Friends are also more easily understood than strangers. If the deafness is very great, however, the conversational or loud-spoken voice must be used, and even a conversation tube may have to be utilized.

Vowel Sounds. Vowel sounds, it is well known, are heard much more clearly than consonants. Hence the latter are more frequently mistaken by deaf persons—for example, “marble” may be heard as “gargle,” or “man” as “fan.” Oscar Wolf, of Frankfurt-on-Maine, has investigated very thoroughly the acoustic characters of the different elements of speech. His researches show the relative distance at which the vowel and consonant sounds can be distinguished when loudly sounded. If the vowels and consonants are pronounced as in German, and the distances expressed in paces, the highest and richest in tone is *a* (*ah*), which is heard at a distance of 360 paces; while the lowest and feeblest is *h* aspirate, heard only at 12 paces. Between these extreme limits Wolf found *o*=350, *ei* and *ai*=340, *e*=330, *i*=300, *eu*=290, *au*=285, *u*=280, *sch*=200, *s*=175, *g* and *ch* soft =130, *ch* rough and uvular *r*=90, *f* and *v*=67, *k* and hard *g*=63, *t* and *d*=63, *r* lingual=41, *b* and *p*=18. While too much stress need not be placed on these results, they may be useful as a guide in making up a list of words suitable for testing.

Testing very Deaf Children. When testing a young child in whom almost complete deafness is suspected, we may employ the

sound of a bell, a loud whistle, a tuning-fork, clapping the hands, or a very loud voice, taking care that the child's face is turned away from the source of sound. We must not produce a sound by stamping on the floor or knocking on the wall or door of the room. If a silent tuning-fork be applied to the forehead or near the ear, the child's features will probably remain unaltered, but if applied afterwards, while vibrating, the child's smile or cry of surprise will frequently shew that he hears the note, because there is even in deaf-mutes usually some degree of perception of sound.

Simulated Deafness. The detection of simulated or exaggerated deafness is often difficult, particularly if *total* deafness is simulated. In continental countries, where compulsory military service exists, this form of malingering is much more common than in this country. To make the deception more easy, foreign bodies are even pressed into the ear, or caustic substances applied to the canal. An objective examination should in the first place be carried out to see if there is any cause for deafness. When the person does not feign *total* deafness, the hearing power should be accurately tested and noted while he is blind-folded, and comparisons made at intervals, when the great disparity in the apparent hearing, as stated by the patient, who does not see how far he hears, reveals the true state of matters. When there is feigned *total* deafness, it is more difficult to expose well-planned deception. Such expedients as observing if loud speech awakens the individual out of sleep, if opprobrious statements made in his presence have any effect on his features, or the effect of informing him "to go, as he is unfit for work," etc., may be tried. In a case under the author's care, that of a young woman, the simulation was discovered by observing that one afternoon she sung the identical songs which had been sung by the servant in the forenoon of the same day. When we have to ascertain if total unilateral deafness exists, it is a good plan to cause the supposed malingerer to apply to his ears a double-tube stethoscope, having the tube for his hearing ear plugged. When the cup-shaped end of the stethoscope is spoken into, the person will probably say he hears. If the tube is now removed from the hearing ear, and the latter closed with the finger, he will say that he no longer hears, knowing as he does that the hearing ear is shut, while the tube of the stethoscope is only in the ear in which he pretends to be deaf.

(B) TESTS APPLIED BY BONE-CONDUCTION.

Bone-Conduction of Sound. Supposing the ears were sealed up so that a vibrating tuning-fork could not be heard by air-conduction, if the fork were placed *in contact* with the head, its note would be heard resounding even more loudly than if the ears were open.

Similar exaggeration of the impression of sound may be noted in our own persons, when, in the act of speaking, we close the ears; the vibrations of the vocal apparatus, transmitted by the cranial bones, will then affect our auditory nerves much more strongly. The vibrations of the tuning-fork are communicated to the bones of the head, and are transmitted to the osseous casing of the cavities of the ears, from which they pass to the endings of the auditory nerve in the labyrinth. In testing sound perception through the bones of the head, a tuning-fork yields the most reliable results.

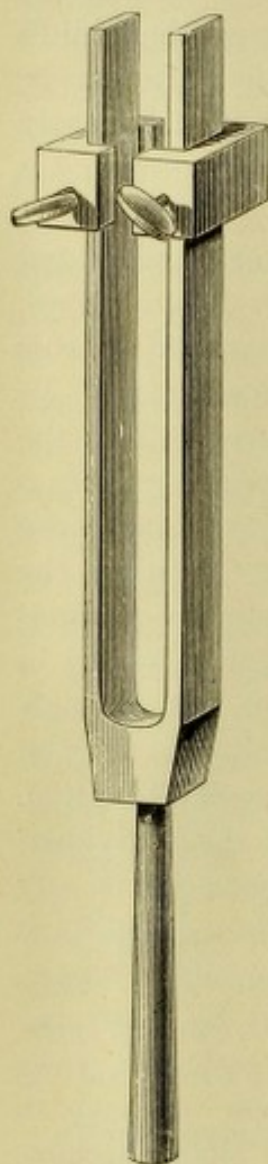


FIG. 45.—Tuning-fork with clamps.

Tuning-Fork Test. The tuning-fork most useful for our purpose should be large-sized, and of the pitch $C = 128$ vs. or $C^1 = 256$ vs. (Fig. 45), with the end of the handle flat, so as to rest on the surface of the head. It yields two simultaneous sounds—the fundamental or deep tone, and the high tones or harmonics. The harmonics are usually appreciated more distinctly when the fork is held some distance from the ear; the fundamental tone predominates when it is held nearer. The harmonics are in great measure destroyed, when the limbs of the tuning-fork are grasped by two brass clamps. When these are attached, only one tone is appreciated, and that one, on account of the number of vibrations per second being diminished, is much lower in the scale. By shifting the clamps towards the handle we render the pitch higher, until, when we reach the lower end of the limbs of the fork, it is raised a complete octave. In this way one tuning-fork, with the addition of these clamps, can produce a variety of notes according to the position of the clamps.

Watch Test. In testing bone-conduction this is a handy test, but not so reliable as the tuning-fork. The watch should be applied first to the temple, and then to the mastoid process. The sound of even a loudly ticking watch may not be heard although the perceptive power of the auditory nerve be unimpaired; but, if a weakly ticking watch is clearly heard in a deaf person, the indication is in favour of a healthy condition of the sentient part.

There are three methods of employing the tuning-fork, namely, Weber's, Rinne's, and Schwabach's.

Weber's Test. Weber's method is based upon the following experiment. If one ear be closed, and the end of a sounding fork placed in

contact with the middle line of the head, such as the bridge of the nose, the forehead, or the vertex, the effect will be striking—the sound heard in the closed ear will be much louder than in the open one; indeed, it will be so intensified on the closed side as to give the impression that no sound is perceived in the open ear at all. Even though the fork, still in contact with the head, be moved close to the unoccluded ear, the sound will still be heard almost exclusively on the closed side. The same effect, which is brought about by this experiment, is produced by the diseases of the sound-conducting apparatus. Pathological obstructions in the external meatus and tympanum, which prevent the entrance of the waves of sound to the labyrinth, also intercept, in their passage outwards, the vibrations which have been conducted to the labyrinth by the bones of the head; and these vibrations, being reflected back on the nerve, intensify the sound of the tuning-fork. Hence, if the sound of the tuning-fork, applied to the middle line of the head, is distinctly referred by the patient to the affected or deafer side (positive effect), the cause of the deafness is probably in the external or middle ear. On the other hand, if it is clearly referred to the normal or less affected side, the mischief is probably in the labyrinth or auditory nerve. In *Weber's test* there is a source of error against which we must be on our guard. The patient being preoccupied by the thought that he *should* hear the tuning-fork better on the good side, and worse on the deaf one, will probably, if not previously cautioned, at first say that he hears it better on the healthy side. In most cases, however, we will, by a little exercise of patience, succeed in getting an accurate account.

The obstructions in the auditory passages leading to excess in bone-conduction may consist simply of foreign substances, such as impacted cerumen in the meatus, or catarrhal exudations in the tympanic cavity. The same effect is produced, however, by any cause which interferes with the vibrating power of the membrana tympani and ossicular chain, such as their increased tension, ankylosis of the ossicles to one another, or of the plate of the stapes to the edge of the fenestra ovalis. In the case of perforation of the membrane, the increased perception of sound conducted by the bones, generally observed, is due to other changes in the tympanum, such as thickening of the mucous membrane, rigidity of the ossicles, or the presence of purulent secretion.

Rinne's Test consists in applying the vibrating tuning-fork, with moderate pressure, to the surface over the base of the mastoid process, and, after holding it in that position until the sound has completely died away, transferring the prongs rapidly opposite and near to the orifice of the ear. If the note of the tuning-fork again becomes audible, the result is said to be positive (+R), the condition in normal hearing and frequently in affections of the labyrinth or nerve. When, on the contrary, the sound of the tuning-fork remains inaudible after the

transference, the result is said to be negative ($-R$), bone-conduction being in excess, as in many cases of disease of the conducting structures. The opposite order may be followed, using the tuning-fork first by air-conduction and transferring it to the mastoid the moment the tone has ceased to be heard. For the sake of accuracy the time in seconds should be observed and noted during which the tuning-fork is heard by bone-conduction after it has ceased by air-conduction, or by air-conduction after it has ceased by bone-conduction. The duration of the air-conduction and the duration of the bone-conduction should be compared with the normal standard.

Schwabach's Test. By this test we compare the patient's appreciation of the tuning-fork applied to the head with that of our own, provided that our nerves of hearing are normal. If we hear the tuning-fork on our mastoid clearly and for some time after the patient has ceased to hear it on his mastoid, we may conclude that there is nerve impairment.

Gellé's experiment consists in applying the tuning-fork to the bones of the head, while the air in the external auditory canal is condensed by means of Siegle's speculum. In the normal state the tone is thus diminished owing to increased labyrinthine pressure due to pushing in of the ossicular chain upon the labyrinthine fluid, if undiminished there is probably fixation of the stapes.

In *Gruber's* test, after the tuning-fork has ceased to be heard by air-conduction, it is applied to the finger closing the ear, when the sound may be again heard.

Modifying Circumstances. It must be remembered, in deciding as to the significance of these tests, that they are not of value in elderly persons, as in them the bone-conduction is usually weak—probably after the age of 55 years. The result may be also obscured by the fact that there may be in the one ear affections of both the conducting and nerve structures. There may be, for example, an undoubted affection of the conducting structures, with a positive Rinne. On inquiring, however, we may find that the person had worked for a long time amid loud sounds, thereby damaging his auditory nerve structures, enfeebling his bone-conduction and so neutralizing the effects on the bone-conduction of the disease in the conducting structures. Or a patient may have clear signs of nerve mischief, and yet there may be a negative Rinne, which, after the removal of a plug of cerumen, may become positive, the plug having so reinforced the bone-conduction that the effects of impaired nerve structures were more than neutralized. We sometimes find that, while Rinne's test gives a positive result, Weber's may refer the sound to the affected ear; in such a case probably the latter is the more reliable. Not infrequently it is found that Rinne's test yields a positive response to a higher pitched tuning-fork, say one of 256 vs.,

and a negative one to a lower, say one of 128 vs.; this is partly explained by the rule that low notes are badly heard by air-conduction in affections of the conducting structures, while higher ones may be well heard. When the higher notes yield a negative result by Rinne's test there is probably very pronounced disease of the conducting structures. In experiments carried out by the writer, in cases of purulent middle ear disease, he found comparatively few in which, by Weber's and Rinne's tests, bone-conduction was not in excess.

VI. THE ORDER OF EXAMINING A PATIENT.

When making an exhaustive examination of a patient suffering from ear disease, the following order and methods are recommended to the student.

Preliminary Enquiries. The patient usually mentions at once the symptom or symptoms for which he has come, such as dulness of hearing, noises in the ear, pain in the ear, discharge from the ear, etc. We should then enquire as to: 1st, the duration and course of his symptoms; 2nd, the previous existence of any ear trouble; 3rd, his own opinion of the cause.

In regard to the *duration* and *course* of the symptoms, we cannot in many cases get definite or reliable information as to the beginning of the trouble, unless it began (1) as an acute inflammation, especially if followed by discharge or dulness of hearing; (2) in connection with a zymotic or other general disease; (3) with a sudden change from good hearing to marked deafness or tinnitus; or (4) with an injury. More frequently, especially in one-sided deafness, the condition has existed for some time—it may be for years—unnoticed by the patient, till he finds, perhaps quite accidentally, that he does not hear the tick of a watch on one side. In other cases, the occurrence of tinnitus first draws attention to an ear where there has probably been defective hearing for a long time, unknown to the person. Again, in others, the hearing defect, slight at first and slowly progressive, is not observed or admitted by the patient till it becomes so noticeable as to attract attention and compel admission. We should enquire if the beginning has been sudden or gradual, limited to one ear or involving both, and if the course has been steadily progressive or interrupted. Marked variations in the hearing power are of favourable import, as compared with a steady and continuous deafness. Short duration of the symptoms is usually a favourable point, although we often find that the objective condition of the ear points to a much longer duration of the disease than the patient's account indicates. The *previous existence* of any ear trouble is important and should be enquired

into, such as earaches in childhood, discharge from the ear, temporary attacks of deafness. The patient will usually be able to inform us as to these.

The *cause* is frequently attributed by patients to what they term "cold," or to scarlet fever or measles; but they often profess ignorance of any cause, or mention something which has obviously no connection with the affection. As a rule anything like reliable information regarding causation can only be got by special interrogation, when we should have in our mind such possible causes as nasal catarrh—post nasal adenoids—cold impressions on the ear—the exanthematous or other general diseases—injuries—heredity—age—previous disease in the ear—occupation—neglect of treatment, etc. The student is referred to the chapter on Etiology (p. 65) for full information on this subject.

Subjective Examination—Symptomatology. While the patient has probably already mentioned the symptom or symptoms, such as dulness of hearing or tinnitus, which more prominently affect him, it is usually necessary to enquire as to other possible symptoms, of the significance of which he may be ignorant, and which he may therefore not mention. The following scheme of symptoms will guide the student in his enquiries:—Defective hearing—sounds in the ear (tinnitus aurium)—pain in the ear (otalgia)—discharge from the ear (otorrhœa)—vertigo—nasal and throat symptoms. These are the six most frequent and important indications of ear disease, and are discussed in detail at pp. 46 to 59. They must always be enquired into. The following, however, should also be kept in view as very important, although not so frequent as the others:—Deaf-mutism—facial paralysis—headache—sickness and vomiting—psychical disturbances—pyrexia—intra-cranial symptoms—ocular disturbances—impairment of taste. These are also discussed from pp. 59 to 64.

Objective Examination. We should next proceed to the examination of the patient in the following order, although this exact order need not necessarily be pursued on every occasion:—1. Methods of testing the hearing and localizing the seat of the deafness (see p. 34). 2. Examination of the superficial or visible parts of the ear (see p. 3). 3. Examination of the tympanum through the external meatus (see p. 5). 4. Examination of the middle ear through the Eustachian tube (see p. 11). 5. Examination of the pharynx, nasal passages, and naso-pharynx (see p. 24).

General Health. Lastly, the general health should be carefully enquired into, as this may have an important relation to the aural disease. This enquiry should, where it seems necessary, include the examination of the urine for albumen and sugar; labyrinthine hæmorrhage may be connected with albuminuria, and furunculi with

glycosuria. The persistent presence of urates and oxalates may have a bearing on oto-sclerosis. In certain cases also the state of the nervous system, the circulation and the blood should be examined, such as when persistent vertigo and tinnitus are prominent symptoms, or when there are indications of intra-cranial complications. In the vascular complications of purulent otitis media valuable information may be obtained by a bacteriological examination of the blood. A leucocyte enumeration may also be of service in the prognosis and treatment of otitic intra-cranial complications, while the determination of the opsonic index, in such cases, will guide us in the administration of vaccines.

Of course, an examination such as has been sketched is not necessary in every case; but it is highly desirable that the student should conduct an exhaustive examination in a certain number of cases.

CHAPTER II.

SYMPTOMATOLOGY.

THE symptoms of ear disease may be conveniently divided into two groups. The first group includes the following six subjects of enquiry which, on account of their frequency and importance, should never be omitted in the examination of a patient.

- I. Defective hearing.
- II. Sounds in the ear (tinnitus aurium).
- III. Pain in the ear (otalgia).
- IV. Discharge from the ear (otorrhœa).
- V. Disturbance of equilibrium (giddiness and staggering).
- VI. Nasal and pharyngeal symptoms.

The second group of symptoms are not so frequent, but they are important when they do occur.

- VII. Mutism and speech defects.
- VIII. Facial paralysis.
- IX. Headache.
- X. Sickness and vomiting.
- XI. Psychological disturbances.
- XII. Pyrexia.
- XIII. Intra-cranial symptoms.
- XIV. Ocular disturbances.
- XV. Disturbance of taste.

FIRST GROUP OF SYMPTOMS.

I. DEFECTIVE HEARING.

Simple Defect of Hearing (see methods of testing the hearing at p. 34). This is the most frequent symptom of disease in the ear. Patients often believe that they hear quite well, when the application of tests shows a real defect in one or both ears. The degree of

impairment may vary from a defect so slight, that the patient is unconscious of its existence, to total loss of hearing; but the latter is very rare, even in deaf-mutes, of whom a large proportion hear very loud sounds, such as a loud bell or whistle. In very many patients both ears are affected, although one is usually worse than the other, the less affected one being often thought by the patient to be perfectly good. It is frequently difficult to draw from the patient a correct account of the origin and progress of the defective hearing. He may give six months as the duration, and afterwards admit that the hearing has not been good for years.

Many persons with defective hearing have a singular tendency to deny the existence of the defect, or, at any rate, to minimize the degree of it. Only when the deafness is so prominent that it would be absurd to ignore it, do they admit its existence. When friends suggest dulness of hearing, the blame is laid upon the indistinctness of the speaker; and there is no doubt that the prevailing slovenly enunciation of words adds very much to the difficulty of persons dull of hearing.

Defects of hearing are connected with most of the diseases of the ear. Affections of the middle ear are, however, the most common, although the most serious forms of deafness are due to disease in the nerve structures or labyrinth. It is noteworthy that marked lesions may be seen on the tympanic membrane, such as calcareous deposits, opacities, retraction, in persons with apparently normal hearing; even a perforation may exist with comparatively little defect of the hearing.

Lip-reading. We are sometimes apt to acquire a wrong impression of the degree of the deafness by not taking into account the effects of lip- and face-reading—the help given by the eye. It is well known that deaf persons often acquire great aptitude in reading the lips, and in guessing the meaning of what they do not hear from the sense of what they do hear. They are surprised at the degree of their deafness when tested while their eyes are closed or turned away from the speaker. This accounts for the fact that deaf persons often appear to hear worse at the time of dusk, when sight cannot give effective aid; and hence also they are less able to understand bearded and moustached men, from the greater difficulty of seeing the movements of the lips. Some deaf persons acquire extraordinary power of reading the facial movements, and, indeed, this is the basis of the German method of educating deaf-mutes. Only by careful testing of the hearing of each ear separately, as already described (p. 34), can we properly estimate the extent of the deafness.

Word-deafness. The hearing of words or speech may be very defective in certain cases, while the hearing of a mechanical sound, such as the tick of a watch, or music, or the falling of a pin, is

comparatively good. A watch-tick may be heard at a considerable distance from the ear, although loud speech may require to be uttered close to the ear before it is heard. Another form of word-deafness has been described by Broadbent and others, due to disease in the cortex of the left temporal lobe of the brain, while the organ of hearing is apparently healthy, and when, although patients hear speech, they are unable to understand it. Patients say they hear the sounds quite well but cannot gather the meaning. This power of forming word pictures, apart from ordinary hearing, seems to be resident in the first convolution of the left temporal lobe.

Disparity between Hearing a Watch and Speech. There may be, on the other hand, defective hearing for the tick of a watch or other mechanical sounds, while there is comparatively good hearing for words or speech. There is frequently a striking want of agreement between the hearing capacity for the watch and that for speech. A patient may hear lightly spoken words at a considerable distance, and yet not hear the watch even when in contact with the ear. Sometimes, in a patient with both ears affected, the hearing of conversation is better on the side where the hearing of the watch is worse. In the treatment of deafness, we occasionally find this disparity very marked, and the hearing of speech may distinctly improve, while the hearing distance for the tick of a watch may remain unchanged or even, as has been observed, actually become less; or the contrary may be observed. Persons who have become deaf in later life usually hear speech better in proportion than the watch, while the opposite holds good with those who have become deaf in childhood. Probably the greater knowledge of language in the former, as well as experience in reading the facial movements, partly accounts for this difference.

Partial Tone-deafness. It is most common for deaf patients to hear high tones best, such as a woman's or a child's voice, but occasionally we meet with persons who hear deep tones best. Many persons, especially those over sixty years of age, whose hearing may otherwise be regarded as normal, have a defective capacity for hearing notes of a very high pitch, such as the chirping of a cricket. An elderly gentleman, who loved the songs of birds, remarked that he first lost the song of the lark. This defect is also often noticed in persons, such as boilermakers, who have for long worked amid noisy surroundings. This diminished power of hearing notes of a high pitch seems to be generally associated with affections of the labyrinth. The greater capacity which some patients have of hearing the tick of a watch (comparatively high note) better proportionately than speech (comparatively low note) may be partially due to this peculiar defect. Partial tone-deafness is usually looked upon as evidence of

disease in the basilar membrane of the cochlea. The assumption is that a morbid condition of the longer fibres of the basilar membrane disturbs the correct perception of the low tones (bass deafness), while an abnormal condition of the short fibres impairs or destroys the power of correctly recognizing high tones.

False Tone-perception (*paracusis* and *diplacusis*). We occasionally find that the ear interprets the tone incorrectly; instead of the real tone proceeding from the sounding body, a sound may be heard, which is a half tone, a complete tone, a third, or an octave higher or lower. This is *paracusis* or false hearing. If only one ear be affected, we have the phenomenon of *diplacusis*: a double tone is heard, viz.—the true one on the normal side and the false one on the affected side. In these various anomalies of hearing, particular fibres or groups of fibres of the basilar membrane may be supposed to be in some way disturbed. In the hearing of a double tone, probably the fibres of the basilar membrane on the two sides corresponding with each other do not vibrate co-equally. Thus, supposing the sounding object vibrates 600 times in a second, the fibres on the normal side, which are in exact unison, vibrate that number of times, while the corresponding ones on the opposite side from some defect vibrate say 450 times in a second.

Another form of peculiarity is sometimes met with in the perception of tones, namely, the perception of the same tone twice over, or the hearing of a tone for a short period after the objective sound has ceased.

Hearing better in a noise (*paracusis Willisii*). In most deaf persons, absolute silence and stillness of the surroundings favour the hearing of spoken words or other sounds; but it has been long known that in certain forms of ear disease the patient hears better in a noise. This peculiarity is termed *paracusis Willisii*, because Willis, in 1680, first described a case, in which a husband could be heard by his wife only while the servant was beating a drum. Not unfrequently deaf persons hear much better when travelling in a railway carriage, or while in the vicinity of noisy machinery, than in complete stillness. Some writers try to explain such an apparent paradox by pointing out that in a railway carriage the confined space, the nearness to the speaker, the elevation of the voice, and the close attention of the listener may account for the apparently better hearing. This matter has, however, been put beyond dispute by the observation of Politzer and others, including the writer, that the tick of a watch or the click of the acoumeter is actually heard by some deaf persons farther away from the ear in a railway carriage than in a quiet room. The probable explanation is the one given by Politzer, namely, that it is the result of the severe shaking of the ossicles, when their joints have become

stiffened by a catarrhal or other process. In this way the small bones are made fitter for the transmission of ordinary sound. Hearing better in a noise, therefore, usually denotes that the cause of the deafness is in the middle ear and not in the labyrinth.

Defective Perception of Locality of Sound (*paracusis loci*). This is the inability to distinguish the direction of sound. This anomaly is generally connected with unilateral deafness, since the power of localizing sound is probably the result of binaural hearing. If the person is deaf in one ear, the report of a gun on that side may appear to him to be coming from the opposite side, a peculiarity which, in certain circumstances, may be fraught with danger.

Excessive or Painful Hearing (*hyperæsthesia acoustica*). Extreme sensitiveness to sound, especially sounds of a very high pitch, occurs in a variety of circumstances. In fevers, in the early stage of inflammation of the middle ear, in hysteria, in migraine, in persons who sleep lightly, and for a short time after the removal of a plug of cerumen which had caused great deafness, there is sometimes an unpleasant or even painful perception of sound, which may be limited to particular notes, especially those of high pitch. Even in persons who may be very deaf, loud sounds such as speech through a conversation tube, or a railway whistle, or loud music such as that of a large organ, are sometimes very disagreeable or even painful.

Hearing by Bone-Conduction. In normal hearing this mode of conduction is somewhat feebler than air-conduction. For we find that, after a vibrating tuning-fork, placed in contact with any part of the head, has ceased to be heard, it will again become audible if transferred to a point opposite to, but not touching, the orifice of the ear. With deaf people, whose defect is in the conducting structures, this is often reversed, and they may hear much better by bone conduction. This peculiarity may be turned to profitable account, so that the tones of a musical instrument, such as a piano, may be appreciated by a very deaf person, if a rod of wood, in contact at one end with some part of the instrument, be held at the other end between the teeth of the patient. In this way a melody, which would be a confused mass of sound under ordinary circumstances, may be heard clearly. The writer has been informed that when engineers wish to test the smooth working of a piston they place one end of a measuring rule upon the outside of the cylinder and hold the other end between the teeth, while the ears are tightly closed with the fingers. This is also the basis of the use of the audiphone, an artificial aid to hearing (see p. 92). In like manner, the movements of mastication and the sound of their own voices—*autophonia*—are heard much more loudly by deaf patients whose bone-conduction is in excess. Such patients often say that they

cannot hear during mastication owing to the loud sounds caused by the movements of the jaw. The various tests applied to determine the state of the bone-conduction in relation to the air-conduction and their value will be found at page 39, to which the student is referred.

II. SOUNDS IN THE EAR (TINNITUS AURIUM).

These are sounds perceived in the ear or head which have no objective cause outside the body. They are probably complained of in 60 per cent. of cases of ear disease, and are sometimes a much greater distress to the patient than the defective hearing, with which they are generally associated. These noises are not unfrequently the only symptom complained of, and the only one for which the patient comes for relief. They are described most frequently as being exactly *in* the ear, at other times as being in the side or back of the head, or "all over the head."

Varieties of Tinnitus. Probably the worst forms of tinnitus are caused by irritation of the cochlear branch of the auditory nerve, either due to pressure upon the roots or trunk of the nerve in the cranium, or to a primary lesion in the labyrinth acting upon the terminals of the cochlear nerve, or to intralabyrinthine pressure through the fenestrae *induced by middle-ear disease*. The irritation may also be due to vaso-motor changes in the labyrinth, reflex in origin, arising from more or less distant regions, such as the intra-nasal spaces or the digestive organs. The noises are in some cases really due to vibrations within the ear or in its neighbourhood (entotic and properly objective). For example, crackling or the sound of bubbles bursting may be due to secretion in the tympanum; a creaking or rubbing sensation may be due to cerumen or a foreign body in the external meatus; a slight drumming or buzzing may be caused by spasm of the tensor tympani or stapedius; while a crackling, heard on swallowing, is usually due to separation of the walls of the Eustachian tube when affected by catarrh. Again, a bruit may be heard in the jugular vein under the floor of the tympanum, while a pulsating or throbbing sound often arises from dilated arterioles due to congestion or vaso-motor disturbance in the external or middle ear, or in the labyrinth. A pulsating sound may also be caused by an abnormal condition of the internal carotid artery in the carotid canal; in this case the pulsation is usually stopped by pressure upon the artery in the neck.

The Character of these Sounds as described by patients is extremely varied. It is evident in many cases that patients have a difficulty in describing them or in comparing them with any actual sound outside the body. In the efforts to describe them they often employ terms or comparisons suggested by their particular surroundings or occupations. They are frequently described as buzzing (or "bizzing") hissing, ringing, singing of a kettle, humming, or crackling. They are compared by many to the sound of a shell held to the ear, to the ringing of bells, to the ticking of a watch, to the bursting of bubbles, to

the splashing of water, to the twittering of birds, to the rustling of wind among the trees. Those of an intense character are compared to steam blowing off, the noise of machinery, the rushing of a waterfall, the constant whistling of a locomotive, or the sound of a horn. Some again are said to be of a beating or pulsating character, and may be compared to a constant hammering or the working of a pump. Several different sounds may exist at the same time in the one ear, such as a pulsating and a buzzing one. During treatment it is sometimes found that one sound may pass away, while the other may remain unchanged.

While in some these sounds produce very little annoyance, in others they have a most worrying and depressing effect, diminishing power of work and apparently rendering life a burden; indeed cases are on record of sufferers seeking oblivion in self-destruction. Occasionally, though rarely, these sounds are said to be of a *pleasant* nature, such as the singing of birds or a beautiful melody. Complete tunes are sometimes alleged by patients to be heard in the ear without any objective cause.

The Sounds Vary in Intensity. Usually during stillness and solitude the noises appear to be much worse and more disturbing. Patients may declare that during the noise and bustle of daily work they scarcely perceive the sounds, but on returning home to the quietness of their rooms the sounds become very unpleasant. In other cases they are only experienced after indulgence in stimulants; after over-exertion, or mental emotion; during colds in the head; or in dull, damp weather, etc. They are sometimes associated with what is indefinitely called a "nervous state." In such cases the intensity of the symptom is likely to be modified by varying states of the nervous system, aggravated by worry or irritation, and diminished by moods of contentment and serenity. A nervous condition may, on the other hand, be excited by some of the distressing forms of this symptom. In many persons the sounds are unceasing, except during sleep, and they seem only occasionally to prevent sleep.

Relation of the Tinnitus to the Deafness. We sometimes find distressing noises with but slight impairment of hearing. Occasionally cases are met with where the hearing is normal. In such the tinnitus is probably due to a labyrinthine neurosis or to reflex influences, such as from the teeth or the naso-pharyngeal mucous membrane. It is often found in such cases that *defective hearing comes on sooner or later*. More frequently, when the sounds are intense and continuous, the deafness is very considerable. Generally, if the acuteness of hearing improve, the noises diminish; while, on the other hand, with gradually advancing deafness the intensity of the sounds generally increases, until the patient may be deaf to all external sounds while tormented

by noises in the head. Sometimes, however, when a state of total deafness has been reached, the sounds completely cease.

Hallucinations of Hearing. Schwartz and Köppe have directed attention to the association of subjective sounds in the ear with *hallucinations of hearing* in the insane. Even persons who have no mental defect may, for a time, confound noises in the ear, such as whistling or the ringing of bells, with actual sounds originating outside. Patients have informed the writer that the sounds were so real as to cause them to search, even by going out into the open air, for the source of them. Generally, however, a little careful observation on the part of the patient is sufficient to convince him that the sound has no existence outside his body. Von Trötsch relates a case of melancholia with hallucinations of sound in the ear like the crying of a child. The removal of impacted cerumen was immediately attended by the disappearance of the sound as well as of the melancholia. Other cases are on record of morbid states of the mind being connected with the existence of peripheral disease of the ear causing subjective sounds. Schwartz says, "Subjective sounds in the ears, which are occasioned by undoubted disease of the ear, may, in persons disposed to psychical disease, especially where hereditary tendency to such exists, be the direct cause of hallucinations of hearing, which may provoke at any time the outbreak of pronounced mental disease." The continuous hissing, buzzing, etc., which attend the ear disease, may be associated with the hearing of "voices." Two cases are related by Köppe, in each of which only one ear was diseased, and only on that side were the "voices" heard. In these two cases, as well as in several others, the noises and hallucinations disappeared under local treatment of the ear affection.

III. PAIN IN THE EAR (OTALGIA).

Earache is a frequent symptom of ear disease. We may conveniently distinguish two varieties: 1st, pain associated with an inflammatory process; 2nd, pain without any evidence of inflammation.

Inflammatory Pain. The first variety is obviously connected chiefly with *acute* inflammation, especially with acute inflammation of the middle ear (purulent or non-purulent). The earache is then frequently intense in character. At the beginning of the inflammation there may be simply heat, fulness, and pressure. Afterwards, however, it goes on to sharp, penetrating pain in the ear, which generally extends to the neighbourhood, to the temple above, towards the occiput behind, or to the forehead in front. It may be accompanied by throbbing in the ear, aggravated at night. In the purulent form, the pain often ceases with rupture of the tympanic membrane, and the appearance of discharge from the ear. In some cases, however, the pain continues after rupture, or returns after a period of intermission.

Mastoid inflammations, usually secondary to purulent otitis media, are important sources of pain. In mastoid periostitis there is usually oedema or abscess over the mastoid area, with jutting outwards of the auricle, and great tenderness on pressure. In purulent collections in

the mastoid cells, there may be little or no œdema over the mastoid, but often an appearance of bulging of the bone itself, with pain on pressure, especially over the front of the lower half of the mastoid. There is sometimes in such cases, however, very little pain apart from pressure.

In chronic purulent affections of the middle ear, while in most cases no pain may be experienced for years, there may arise at any time severe pain from an acute inflammatory attack, from pressure of retained matter, from caries or necrosis, or from furuncular inflammation in the meatus. It is to be remembered that intense pain in an ear affected with chronic purulent disease, extending to the side or back of the head, may be the first symptom of an intracranial complication.

Slighter and more intermittent pain may be complained of in connection with simple exudative catarrh of the middle ear or with interstitial or sclerotic processes. If great pain is experienced in such conditions, it generally means an intercurrent acute inflammation.

The external auditory canal is another common source of inflammatory pain, especially when it is the seat of furuncular inflammation. The pain in this case is usually aggravated by moving the auricle, pressing the tragus, or by mastication. This, as a source of pain, is often overlooked, and careful examination of the skin of the meatus with the help of a probe is necessary. Less frequently there is pain in the external canal from eczematous inflammation, from the pressure of cerumen in the osseous portion of the canal, from the presence of fungi, from exostosis, and from caries or necrosis of the osseous walls. In chronic eczema of the meatus the sensation is more that of troublesome itchiness.

Non-inflammatory Pain. The second or non-inflammatory variety of pain is often connected with dental caries, especially of the molars of the lower jaw, and is then often associated with pains in the vicinity—in the neck, temple, or cheek. Intense earache may be experienced in tonsillitis, without any signs of inflammation in the ear; also in carcinoma of the tongue or throat. It is sometimes a manifestation of a neuralgic condition due to anæmia or other constitutional defect. Rheumatic pain in the articulation of the lower jaw, felt during movement or pressure, is often thought by patients to be due to ear disease. A sensation in the ear, as if of a plug of cotton, sometimes complained of by persons with good hearing, has evidently a nervous origin.

It is very important, as a guide to treatment, to distinguish between the inflammatory and the non-inflammatory forms of pain. Objective examination is of course the only reliable means of doing so, and should never be omitted in such cases. We usually find in the inflammatory

variety more or less defect in the hearing as well as subjective sounds in the ear; and it is often distinctive of the non-inflammatory pain that it has been experienced for a long period, even for months.

It is well always to inquire whether the patient has been liable to earaches in childhood, or later on, as these may indicate past inflammatory attacks.

IV. DISCHARGE FROM THE EAR (OTORRHOEA).

Probably about a third of all diseases of the ear coming before the surgeon are attended by discharge, which is generally due to purulent inflammation of the middle ear. With comparatively few exceptions, there is perforation of the tympanic membrane, though in a small number of cases the discharge is caused by inflammation of the external meatus, especially eczematous. While there is frequently pain at the early stage, in a large number of cases no pain is complained of. Otorrhœa is generally attended by more or less defective hearing, and in many cases it has existed for many months or even years before coming under the surgeon's observation. The discharge may be very slight in quantity, so as *even to escape the attention of the patient*, or to be mistaken for thin wax, or it may be in such quantity as to fill the meatus very soon after syringing and drying.

Character of the Discharge. In character also it varies. It is most commonly muco-purulent. It may, however, be serous-looking, such as in the early stage of an inflammation of the middle ear, or when due to eczema of the meatus. The mucous element may predominate, giving the secretion a tenacious or stringy character, or there may be almost pure pus, which imparts a milky colour to the water used in syringing. It is sometimes tinged with blood, especially when there are granulations or polypi in the ear. It has frequently an offensive smell, particularly when there has been no attempt at cleansing, and in very chronic cases its odour sometimes resembles that of old cheese.

Bacteriological and Cytological Characters (see p. 71). The most serious forms are associated with the presence of streptococci. Diplococci are also frequently found; of these the pneumococcus is the most common, but there are also found the meningo-coccus and the gonococcus. The *staphylococcus pyogenes*, *albus* and *aureus*, is less virulent than the others, and is found in connection with furunculi in the meatus as well as in purulent middle ear disease. The tubercle bacillus is specially found in very young children. Cytological examination, which should be repeated in any case more than once, yields, in the opinion of so high an authority as Dr. Milligan, very important information. His conclusions are that the presence in the discharge

of lymphocytes indicates granulation tissue formation; of lymphocytes, epithelioid cells and myelocytes, bone disease; of lymphocytes and "acid-fast" squames, cholesteatomatous changes; of lymphocytes, epithelioid cells, myelocytes, and giant cells, tuberculous disease of the temporal bone.

The conditions associated with discharge from the ear are fully described under the objective symptoms of purulent inflammation of the middle ear. The dangers associated with this symptom are described in the chapter on "Intra-Cranial and Vascular Infective Complications of Purulent Inflammation of the Middle Ear." In all cases attended by discharge from the ear, objective examination is essential; and, in order to acquire a proper knowledge of the exact condition, it is generally necessary to syringe and dry the inside of the ear before using the mirror and speculum. Where there is a history of a past discharge, which may have been absent for a length of time, we often find a dry perforation, a cicatrix or a calcareous deposit.

V. DISTURBANCE OF EQUILIBRIUM (VERTIGO, GIDDINESS AND STAGGERING).

Since Ménière's classical paper on "Aural Giddiness," in the *Gazette Medicale de Paris* for 9th February, 1861, the profession has become gradually impressed with the importance of giddiness as a symptom of ear disease; and most practitioners now think of the ear when a case of giddiness or disturbance of equilibrium presents itself.

Frequency of Ear Giddiness. As a symptom of ear disease it occurs in all degrees of intensity, from that of a slight and temporary lightness in the head to so violent a disturbance of the equilibrium as to necessitate the recumbent posture. In a marked form it is far from being rare, while in a comparatively mild degree it is a very common concomitant of ear disease; probably in 6 per cent. of cases of ear disease it is a distinct feature.

Various Forms of Ear Giddiness. Ménière's discovery naturally stimulated much investigation, with the result not only of still more widely connecting the symptom of giddiness with disease in the ear, but also at the same time of modifying some of his views. In the light of the fuller experience of recent years, aural giddiness may now be conveniently described as manifesting itself in four distinct forms: (1) The typical form or true Ménière's disease (sometimes termed apoplectiform deafness), due to the presence of exudation in the labyrinth. In a person with previously normal hearing, the four great symptoms, namely—sickness and vomiting, giddiness and staggering, subjective sounds in the ear, and deafness, occur as a sudden seizure; accompanied it may be with pallor, cold sweats or faintness. In this class entire disappearance of all the symptoms is rare. (2) Another

form is due to pressure upon the walls of the middle ear of air, liquid, or inflammatory products. Here the symptoms are sometimes less severe in character—the sickness and vomiting being occasionally absent while the vertigo is in most cases preceded by other symptoms of auditory disturbance. In more serious forms purulent middle ear disease extends through the inner tympanic wall to the interior of the labyrinth. (3) The giddiness may be due simply to pressure upon the walls of the external meatus or outer surface of the tympanic membrane, such as by ceruminous masses. Here also it is usually preceded by disturbance of the hearing, and entire recovery is often brought about by treatment. (4) In the fourth class of cases, the giddiness is connected with chronic processes in the middle ear, leading to pressure upon the labyrinth at the fenestral openings, or to vaso-motor disturbance in the labyrinth. The vertigo of this class is that usually termed by writers, *vertigo ab aure laesa*, and may occur in almost any affection of the ear; but it is most frequent in the course of a chronic inflammatory affection of the middle ear. The giddiness is generally preceded, accompanied, and followed by subjective sounds and deafness; it is frequently, however, unaccompanied by nausea or vomiting. Recurrences of the giddiness are common from time to time. In most cases it eventually disappears; but the deafness and the noises in the ear are apt to remain permanently.

Characters of Aural Vertigo. In aural vertigo, the giddiness may be so extreme that, if the person cannot clutch a firm support or be supported, he falls to the ground or has to lie down; or it may amount to a mere sense of “swimming in the head,” when turning quickly or stooping, or to a tendency to reel when trying to walk in a straight line. The giddiness may be experienced in bed, the patient feeling as if the bedroom were turning round, or the bed rising or sinking. In the severe forms the objects around may appear to rotate, or the ground in front may seem to rise or fall, or there may be a feeling as if the patient were on a suspension bridge which sways under foot. The sense of movement may be confined to the patient's body, perhaps of the nature of a rotation round a vertical axis, when the tendency usually is to turn or fall towards the affected ear, or there may be a sense of moving backwards or forwards on a horizontal axis. Experiments on animals seem to indicate that irritation in the external semicircular canal causes horizontal movements of the head, while irritation in the posterior or superior produces backward and forward movements. In other cases there may simply be a staggering or want of control of the legs, especially in the dusk or dark, the movements resembling those of a drunken man. The giddiness may pass off or markedly diminish in a few minutes, or it may last for several days, necessitating the lying posture. It may return, even repeatedly, with

more or less severity. A certain degree of giddiness or tendency to reel may persist, with exacerbations from time to time, perhaps excited by other causes, such as gastric disturbance. While, in aural vertigo, there is good reason to believe that irritation of the vestibular and ampullary nerves, sending afferent impulses to the centre of equilibrium, is the real source of the mischief, there may supervene other exciting causes which provoke attacks, such as digestive or hepatic disturbance, nervous shock or strain, exhaustion, etc. Without these, while the ear disturbance may be permanent, the vertigo may be absent for long periods of time.

Relation of Ear Giddiness to Intra-cranial Disease. It is necessary to remember that in the course of chronic purulent middle ear disease, and also, but much more rarely, in acute purulent disease, giddiness may be due to extension of the disease to the interior of the labyrinth or to the intra-cranial cavity. In the latter case the giddiness is associated with other grave symptoms which point to involvement of structures more central than the organ of hearing. In this way meningitis, septic-thrombosis of the sigmoid sinus, cerebral abscess, or cerebellar abscess may be associated with more or less disturbance of the equilibrium. It is also to be remembered, however, that grave disease of the cerebellum, such as a tumour, sometimes exists in a person who may be at the same time afflicted with an ear disease, although no connection may exist between the two. In this way there may be great disturbance of equilibrium, which, at first sight, is regarded as of aural origin; but subsequent events show that the disease causing the disturbance of equilibrium is entirely in the cerebellum, having possibly no connection with the ear. It should never be forgotten that *marked giddiness, sickness and vomiting may exist in connection with purulent disease of the ear, which has not extended beyond the cavities of the labyrinth or middle ear.* There is no doubt that practitioners sometimes form an unnecessarily gloomy prognosis of such cases, concluding, owing to the presence of these symptoms, that extension of the mischief has taken place to the interior of the cranium.

Testing the Static Sense in Aural Vertigo. When manifest ear disease exists, and the patient complains of giddiness, we should first make sure that he understands what giddiness really is, and ascertain if deafness and tinnitus be present, also if there be vomiting. We should also inquire whether the giddiness has sprung out of an acute Ménière's attack, or if it has arisen in the course of a chronic ear affection. No doubt the worst forms occur in labyrinthine affections; and therefore it is well to employ the tests already described for differentiating disease of the nerve structures from that of the conducting structures. We should also ascertain whether the vertigo is produced or increased by such processes as inflation, syringing, or the use of Siegle's speculum; or if it is excited by certain movements, such as looking downwards or upwards, or turning to the right or left.

We should also inquire if the sense of movement refers to the patient himself or to external objects, and if the tendency is to turn or fall *from* or *towards* the ear affected. We should also determine the absence of any ocular disturbance sufficient to account for the giddiness. By employing the following tests, both with the eyes open and shut, we may, by observing whether there is any tendency to sway or fall, determine the condition of the static sense, and, if impaired, the degree of impairment: (i.) standing on both legs with feet together; (ii.) standing on the toes; (iii.) standing on one foot, noting whether equilibrium is more disturbed when standing on foot corresponding with affected ear; (iv.) jumping on the two feet; (v.) walking in a straight line, observing if the patient reels or walks zig-zag, or with his legs apart; (vi.) walking with knees straight; (vii.) rotation with feet together; (viii.) rotation on one foot.

VI. NASAL AND PHARYNGEAL SYMPTOMS.

Nasal and pharyngeal symptoms very frequently co-exist with ear disease. Persons suffering from middle ear affections often complain of "cold in the head," frequently manifesting itself in a sense of nasal obstruction, with or without excessive nasal secretion. Nasal obstruction may only show itself by oral breathing when sleeping. The obstructed nose and mouth breathing from post-nasal adenoids are the commonest signs of the catarrhal deafness of children. Nasal voice is sometimes a marked feature in children suffering from catarrhal deafness, the nasal tone being due to a concomitant affection of the nose. The frequent desire to clear out the throat, "hawking," is often associated with catarrhal conditions of the middle ear, due to post-nasal catarrh, which may be the root of the ear affection. For further information on the important subject of nasal and throat symptoms, the student is referred to the special chapter on "Affections of the Nose and Throat."

SECOND GROUP OF SYMPTOMS.

VII. MUTISM AND SPEECH DEFECTS.

Deaf-mutism. We may generally regard deaf-mutism as a symptom of ear disease, as it is in the vast majority of cases simply a consequence of total, or of a high degree of, deafness, which has either been congenital, or has originated in the early years of life. Deafness for speech, coming on under four years of age, is certain to be attended by dumbness, and even between four and eight years of age, if great care is not exercised, serious deafness is liable to be followed by loss of speech. Probably 75 per cent. of deaf-mutes hear such sounds as a loud bell or a whistle close to the ear, or a vowel loudly pronounced into the ear. In a smaller number, complete words are heard when spoken loudly into the ear or through a

conversation tube. It is not easy to determine positively, in the first year of life, whether a child hears. Usually the history of a case is that the mother is surprised to observe that the child is unaffected by noises which awake other children. After the first year, her anxiety may be aroused by the delay in beginning to speak, and by manifest inattention to loud sounds. Suspicion being excited, the child's hearing should be tested, preferably by the parents at home under the directions of the doctor (see p. 38). By objective examination the tympanic membrane is usually found to be normal, and when morbid changes are observed they do not account for the serious deafness, the cause of which is more deeply seated. The importance of the subject of deaf-mutism, however, has led the author to devote to it a special chapter, to which the reader is referred.

Defective Articulation. In less severe forms of deafness in a child, while mutism may not result, a less perfect articulation is very early observed, as he fails to hear all the shades of sound which make up articulate speech. The effect is thus to render the pronunciation indistinct and the voice toneless. If, however, the deafness becomes more aggravated, or if the child is very young and has only recently attained a slight knowledge of speech, the pronunciation becomes more and more imperfect, and, his knowledge and memory of words being insufficient to keep what he has, he may cease altogether to speak, or his utterance may be confined to unintelligible sounds. The child, unlike the adult, ceases to make any effort to hear, and finds it more easy to trust to signs, in the use of which he is usually encouraged by the parents. After a time, the parents, regarding the child as quite deaf, believe that it is useless to speak to him at all, and resort more and more to gestures, till the child comes to be classed as a confirmed deaf-mute. If the parents took pains to speak in a loud and distinct voice near to the ears of the child, as they would to a deaf adult, and by that means maintain and even increase the child's knowledge of words, the consequences might be much less serious.

VIII. FACIAL PARALYSIS.

This is not an unfrequent symptom of ear disease, especially of the purulent forms. It is more common in young children, and is generally unilateral, affecting the side corresponding with the ear disease. If due to an intra-cranial lesion, it is found on the opposite side, and it is then more partial in character. Rarely the paralysis is bilateral, and, in the only case seen by the author, it was due to syphilitic disease, involving also the auditory nerves. The symptoms produced by pronounced facial paralysis are well known, being chiefly due to the inaction of the facial muscles on

the affected side. A minor degree is probably more common in connection with purulent ear disease than is supposed, showing itself mainly in a less distinct naso-labial furrow. Different fibres of the nerve, having different areas of distribution, may be more markedly affected than others. The brow and the eyelids may, for example, be more affected than the mouth or cheek, or *vice versa*. When the lesion is above the origin of the twig for the stapedius muscle, there may be disturbances of the hearing with tinnitus, caused by inaction of the muscle.

IX. HEADACHE.

Headache is not unfrequently experienced in ear disease. In acute inflammatory affections of the middle ear or of the external meatus, shooting pains may be complained of in the temple and occiput. Such pains are often regarded as neuralgic in nature, and, in the absence of objective examination, the condition of the ear may be overlooked. In chronic non-exudative catarrh of the middle ear, similar pains may be experienced in the branches of the fifth nerve, originating in irritation of the mucous lining of the middle ear. In chronic purulent middle ear disease, heavy dull pain in the head is sometimes complained of, particularly by anæmic and weakly persons. When, however, in purulent ear disease pain in the head becomes a sudden, severe, and continuous symptom, especially if attended by sickness and vomiting, we should think of the possibility of an intra-cranial complication, such as abscess, meningitis, or thrombosis of the lateral sinus. Labyrinthine inflammation, especially the purulent variety, is usually attended by headache. Suppuration in the mastoid cells, or mastoid periostitis, is likely to be attended by pain in the neighbouring regions of the head. A benumbed sensation over the corresponding side of the head is often spoken of by patients suffering from acute catarrhal conditions of the middle ear.

Some patients, especially those who are neurotic, complain very much of a sense of pressure on the top of the head, especially in connection with non-exudative catarrh or oto-sclerosis.

X. SICKNESS AND VOMITING.

These symptoms, when arising directly from ear disease, are generally associated with giddiness and staggering (see p. 56). They usually begin soon after the disturbance of equilibrium, and are probably due to reflex action through the vagus nerve. They naturally suggest the possibility of brain mischief. On the other hand both patients and practitioners frequently regard such attacks as purely bilious in their nature. The sickness and vomiting rarely last beyond a day or two.

When a patient is seized with such symptoms as giddiness and staggering with sickness and vomiting, the organ of hearing should be carefully examined. It is also to be remembered that sickness and vomiting are marked symptoms in connection with the extension of purulent ear disease to the intra-cranial cavity or to the vascular system.

XI. PSYCHICAL DISTURBANCES.

A feeling of heaviness, confusion, or depression is often mentioned by patients suffering from affections of the middle ear, and they may also assert that an amount of mental work, which they could at one time perform with ease, has now become impossible. These symptoms probably occur in persons whose nerve force or resisting power is either naturally weak or has been impaired by causes acting on the system independently of ear disease. The distracting influences of noises in the ear, which frequently attend these affections, as well as the strain of attempting to hear, often produce much depression. A special form of diminished power of mental application, termed by Professor Guye "*aproxia*," is frequently noticed in children affected with post-nasal growths and exudative catarrh of the middle ear. As the result of the examination of six hundred school children, the writer found twice as many with defective hearing among the backward children as among the forward children. There is no doubt that by the loss or distinct impairment of hearing in youth, the mental faculties become damaged; and, even although hearing should return after some years, the baneful effects upon the mental development of the child of having been partially or wholly shut out from sound at the most valuable educational period of life can never be thoroughly repaired. The results of impaired hearing in youth upon the adult are thus described by von Tröltsch: "Men, who in early youth have suffered from impaired hearing, have, in many cases, as a consequence, something unstable, confused, or undecided, in their disposition and character. They are undecided and faltering in action, illogical and changeable in thought and speech, their answers often not being to the point. An experienced and observant physician can thus, in many cases, after a short conversation, even from the speech and manner of a patient, discover that most probably he had in youth defective hearing."

XII. PYREXIA.

Increase of temperature and other symptoms of febrile disturbance occur in most cases of acute purulent inflammation of the middle ear,

and, less frequently, in non-purulent inflammation. In certain cases these symptoms are very marked, and a temperature of 102° F. is not uncommon. Acute mastoid inflammations are also generally attended by rise of temperature. Even in the acute inflammations of the external meatus, some elevation of temperature is usual. When meningitis or thrombosis of the lateral sinus occurs, the feverish disturbance becomes, of course, a very notable feature of the case, and in the latter case presents striking intermissions, each rise of temperature being usually ushered in by a severe rigor.

XIII. INTRA-CRANIAL SYMPTOMS.

The more serious symptoms indicative of intra-cranial disease, such as delirium, convulsions, stupor, coma, and paralysis, are met with in connection with purulent middle ear disease. It is to be noted, however, that acute affections of the middle ear may, in infants and very young children, be attended by convulsions without meningitis or other intra-cranial disease. In the presence of such symptoms, the existence of otorrhœa is of great significance, and imperatively calls for careful examination of the ear.

XIV. OCULAR DISTURBANCES.

These, in the form of iritis or keratitis or both, are often associated with hereditary syphilis affecting the labyrinth. In purulent ear disease, changes in the fundus of the eye are not unfrequently noticed, especially if associated with cranial or vascular complications, when distinct optic neuritis is common. It has been shewn, however, that vascular changes in the optic disc, short of optic neuritis, are very common in persons with purulent ear disease even when there is no evidence of intra-cranial complications. Paralysis of one or more of the ocular muscles is a well-known symptom of the intra-cranial complications of ear disease, especially of temporo-sphenoidal abscess, when the third cranial nerve is frequently involved. It has been demonstrated, both by experiments and by clinical observation, that nystagmus may arise reflexly from labyrinthine pressure or irritation, especially in the semi-circular canals, when it is generally associated with pronounced giddiness. The examiner should observe whether the movements of the eyes are horizontal, rotatory, or vertical, corresponding with the planes of the semi-circular canals; also, if they are excited or made worse when the eyes are turned to the side of the affected ear or to the opposite side. Nystagmus is observed most frequently in purulent ear disease, especially in labyrinthine suppurations, and it is often present in cerebellar abscess. Temporary attacks

may sometimes be induced by syringing the ear, or by manipulating the deep parts, such as by applying the probe, or removing granulation tissue or a polypus.

XV. DISTURBANCE OF TASTE.

The sense of taste may be impaired, especially on one side of the tongue, from a purulent disease of the ear on the same side. This is due to implication of the chorda tympani nerve, either as it passes through the tympanum or before it branches off from the facial nerve. Pressure upon this nerve, or even the contact of certain medicaments, when the upper part of the tympanic membrane is destroyed, excites a peculiar taste on the corresponding side of the tongue. A disagreeable taste is, in some cases, due to the escape of pus from the Eustachian tube to the throat and back of the mouth.

CHAPTER III.

CAUSES OF EAR DISEASE.

ALTHOUGH, in the description of the individual diseases of the ear their causation will in each case receive attention, it may be useful to review in a general way the various predisposing and exciting causes which are apt to give rise to morbid conditions of the organ.

I. CAUSES ACTING THROUGH THE EXTERNAL AUDITORY CANAL.

Action of Cold. We do not here refer to the action of cold in producing, primarily, catarrh of the nasal and pharyngeal spaces, and, secondarily, catarrh or inflammation of the middle ear, but to the action of cold impressions directly upon the ear. A very large number of ear diseases originate in this way. The ear is remarkably intolerant of cold, which may act upon it in various ways, such as by the rushing of cold water into the ear while the person is diving; or by the trickling of drops of cold water into the ear during washing, a shower bath, or the application of ice to the head; or by exposure to cold wind, especially if accompanied by rain, sleet, or snow. Exposure to these causes is especially liable to excite an ear affection, if a predisposition to such exists in the individual, or if a chronic disease is already present, especially if attended by a perforation.

Cutaneous Extension. Disease may also affect the ear through the continuity of the interior of the ear with the cutaneous surface of the body. For example, the exanthemata sometimes affect the ear through the medium of the cutaneous lining of the external meatus. Erythema, erysipelas, or eczema, when affecting the head, may extend to the auricle and external meatus.

Mischievous Interference. Excess of ear wax, furunculi, and acute diffuse inflammation of the external meatus are not unfrequently the results of irritating the skin of the canal by efforts to relieve itchiness or remove wax. The point of a pen, a tooth-pick, a knitting-needle or hair-pin, a small twig, etc., are used for such purposes, and irritate the

delicate cutaneous lining and at the same time introduce micro-organisms. It occasionally happens that the person's elbow receives a sudden push, which thrusts the hard pointed object inwards, penetrating the tympanic membrane. Efforts to clean the interior of the ear by the use of so-called "aurilaves," or with the corner of a towel, not unfrequently lead to mischief such as the impaction of the ear wax. Needless and unskilful syringing of the ear, and the pouring into the ear of irritating or even caustic liquids, are sometimes responsible for acute inflammation of the canal, the tympanic membrane, or the middle ear. Even the indiscriminate pouring of bland oil into the ear may prove injurious, owing to its becoming rancid after being in the warm ear for a few days, when it may act as an irritant, or favour the growth of fungi. Boring the lobule of the ear and the irritation caused by ear ornaments may give rise to disease, especially to eczema, hypertrophy, or cleft lobule.

Injuries. Blows upon the ear, boxing or pulling the ears, or striking the surface of water with the side of the head, as in diving, may, by the sudden and great compression of air in the external meatus, rupture the tympanic membrane, or even some of the intra-tympanic structures, giving rise, it may be, to acute purulent inflammation of the middle ear. A severe blow may be followed by hæmatoma auris, especially if the auricle has been previously weakened by disease. A foreign body in the external meatus, or *the efforts to remove the same*, especially when it becomes firmly impacted, may cause perforation of the membrane and purulent inflammation of the middle ear. The same results are likely to follow the entrance of boiling water, molten metal, caustic substances, etc., into the ear.

Efforts at Treatment, especially when of an injudicious character, may produce serious mischief. Improper attempts to remove a foreign body, or violent and unnecessary syringing, may bring about acute inflammation of the canal and tympanic membrane. Certain methods of treatment, which are usually safe and beneficial, occasionally prove mischievous. Thus paracentesis of the tympanic membrane, perfectly safe in the vast majority of cases, is occasionally followed by acute purulent inflammation of the middle ear.

Very Loud Noises, especially if sudden and unexpected, as when a cannon is fired close to the ear, or when the piercing shriek of a railway whistle is suddenly heard, not unfrequently originate disease of the ear, and the former may even rupture the tympanic membrane. Constant and loud noises have also frequently an injurious effect on the ears, and hence it is found that a large proportion of men, who are exposed from the nature of their work to such noises, ultimately become deaf.

II. CAUSES ACTING THROUGH THE EUSTACHIAN TUBE.

Nasal and Naso-pharyngeal Disease. There is probably no greater predisposing or exciting cause (in producing or maintaining ear disease), than the presence of disease in the nasal and pharyngeal mucous membrane.

The chief nasal and naso-pharyngeal diseases which exercise an influence upon the middle ear are: (a) Acute rhinitis (acute cold in head). (b) Chronic rhinitis (chronic cold in head). (c) Adenoid vegetations in the naso-pharynx, with or without enlarged tonsils. (d) Acute and chronic pharyngitis.

A special chapter is devoted to this subject, to which the student is referred.

Exanthemata. The rhinitis associated with the exanthematous diseases, especially scarlet fever and measles, has often a virulent effect upon the middle ear. Any one of the diseases of the middle ear may thus have its origin in scarlet fever or measles, but the purulent inflammations arise in this way more frequently than do the simple catarrhs. Probably the most obstinate forms of purulent middle ear disease, and those which are attended by greatest destruction of the tympanic membrane, arise from scarlet fever. Diphtheria may affect the ear by extending up the Eustachian tube from the pharynx; and, when it occurs in conjunction with scarlet fever, a most serious form of purulent disease of the middle ear may be set up. Diphtheria may also damage the ear by causing paralysis of the muscles of the palate and Eustachian tube.

Syphilis. Syphilitic cicatrices, by closing the mouth of the Eustachian tube, or by producing adhesions about the soft palate or perforation of the palate, may lead to disease in the middle ear.

Pulmonary Affections. Pneumonia, bronchitis, whooping-cough, phthisis pulmonalis, etc., may excite morbid conditions of the middle ear, by simple continuity of the mucous membrane, by the strong expiratory efforts of coughing unduly condensing the air in the middle ear, or by the invasion of specific microbes.

The Nasal Douche and other forms of nasal treatment are also in some cases responsible for setting up middle ear disease. The entrance of liquid into the middle ear through the Eustachian tube, during the use of the nasal douche or syringe, is no doubt a common occurrence; but this accident is fortunately by no means always followed by inflammatory mischief. Patients, especially children, frequently mention that they experience pain in the ear during the act of syringing the nose, although no harm results. On the other hand, probably by the forcing up into the tympanic cavity of pathogenic micro-organisms, injury to the ear may ensue, such as purulent disease with all its possible consequences,

or simple catarrh with temporary or permanent injury to the hearing. The application to the nasal mucous membrane of the galvanic cautery or chromic acid, and operative treatment are sometimes responsible for the production of purulent ear disease.

Abuse of Inflation. The abuse of the various methods of inflating the middle ear, especially Valsalva's method, may injure the tympanic structures by producing an over-flaccid state of the membrane. Rupture of the tympanic membrane, however, is probably never caused by inflation of the middle ear, unless the membrane has been previously weakened by atrophy, or a cicatrix.

These various conditions influence the middle ear through the medium of the Eustachian tube in the following ways:—

Eustachian Closure. By closing the mouth of the Eustachian tube, through extension of congestion, swelling, and hypersecretion in the naso-pharynx to the mucous lining of the cartilaginous part of the tube, or by the encroachment upon its mouth of swollen, thickened, or hypertrophied tissue or adenoid growths; in either case bringing about mechanical closure, and the rarefaction of the air in the middle ear. Enlarged tonsils pressing the soft palate upwards upon the tube, and adenoid vegetations overlapping the mouth of the tube, are also examples of such mechanical closure.

Inflammatory Extension and Microbic Invasion. By further extension of the inflammatory process to the mucous lining of the tympanum, there may be produced, in the slight forms, catarrh, and in the more severe forms, simple or purulent inflammations of the middle ear. Mucus, pus, or blood forced from the naso-pharynx into the middle ear, when accompanied by pathogenic organisms, is no doubt a frequent source of mischief.

The Eustachian Muscles. The thickened (hypertrophied) or atrophied mucous membrane of the soft palate may interfere with the contraction of the tensor palati and levator palati muscles, which are intimately connected with the mucous membrane covering them. The thickened mucous membrane will impede muscular contraction, and bring about a disproportion between the resistance and the moving power. This impairs the muscular mechanism by which the walls of the membrano-cartilaginous part of the tube are in turn separated and approximated. Paresis of these muscles may also result from diphtheria.

Aerial Contents of the Middle Ear. Through interference with nasal breathing the ear is deprived of a proper supply of pure air. When the nasal passages are markedly obstructed, rarefaction of the air in the naso-pharynx is produced by every act of swallowing. This naturally leads to rarefaction of the air in the tympanic cavity through the aerial medium of the Eustachian tube. On the other hand, under the influence of vehement expiratory acts, such as coughing, blowing the nose, sneezing, etc., the air, unable to find its way through the nasal passages, may pass through the Eustachian tube with damaging effect upon the middle ear, through the sudden abnormal condensation of the air within it.

Reflex Effects. Probably certain forms of tinnitus aurium are due to the irritation caused by the pressure of thickened mucous membrane upon the nerves, especially upon the branches of the trigeminus in the naso-pharynx.

III. INTRA-CRANIAL DISEASE AND CRANIAL INJURIES.

Intra-cranial Diseases. Morbid intra-cranial conditions may injuriously affect the auditory nerve or labyrinth. The internal auditory artery may be narrowed or closed from some cause, leading to anæmia of the labyrinth, or there may be aneurism of this vessel. Atheroma in the vessels of the brain is likely to be associated with the same condition of the vessels of the labyrinth, leading, it may be, to hæmorrhage into the latter. Obstruction to the discharge of the venous blood from the labyrinth into the sinuses of the brain may lead to passive congestion. Apoplectic clots, inflammation of the brain or meninges, tumours, abscesses, etc., may damage the root, stem, or expansion of the auditory nerve. Cerebro-spinal meningitis is responsible for many cases of deaf-mutism. Through the aqueduct of the cochlea diseased processes or pathogenic organisms from the arachnoid space are in some cases propagated to the interior of the cochlea, while through the aqueduct of the vestibule extra-dural mischief may pass to the vestibule.

Blows upon the Head. Violent blows or falls upon the head may fracture some part of the osseous walls of the ear, especially the roof, and rupture the tympanic membrane and other soft parts, causing effusion of blood into the middle ear or labyrinth, and perhaps injury to the auditory or facial nerves. Blows on the head, however, not unfrequently produce permanent and severe, it may be total, deafness with great subjective sounds, without causing any rupture of the middle ear structures or other objective signs of injury.

IV. GENERAL DISEASES AND MORBID CHANGES INVOLVING THE CIRCULATION.

The strumous, tubercular, and syphilitic cachexiæ not only predispose to diseases of the ear, but they also engraft upon these diseases a specially unfavourable tendency.

In the Strumous Constitution acute inflammation of the middle ear is very apt to take a suppurative form, and to become chronic and persistent, and be attended by serious complication. Again, mucous catarrh of the middle ear is much more obstinate in the strumous child; while dry adhesive processes, when they do affect children, which is rare as compared with their frequency in the adult, usually occur in those of strumous constitutions.

In Tubercular Patients purulent forms of ear disease are not only common, but are apt to be attended by destructive softening of the tympanic membrane. In both scrofulous and tubercular persons chronic adhesive catarrh of the middle ear is more apt to take an

unfavourable course than in those of healthy constitution. The tubercle bacillus is sometimes found in purulent middle ear diseases, but there is reason to believe that many cases are really tubercular in which no bacilli can be found. No doubt many of the cases of so-called caries of the mastoid process, especially in children who have at the same time enlarged lymphatic glands in the neck, are really tubercular disease of the mastoid and petrous portions of the temporal bone. In ten such cases Dr. Milligan of Manchester inoculated the purulent material into guinea pigs, with the result of producing marked tubercular disease in eight of these.

Syphilis may affect the organ of hearing in several ways. In the stage of secondary symptoms, mucous catarrh of the middle ear may be excited by simple extension of the throat affection to the middle ear. A form of chronic catarrh is met with, involving the middle ear and labyrinth, and associated with rapid and serious loss of hearing. Great aggravation of the deafness in chronic catarrh of the middle ear may take place as the result of the syphilitic virus; and sudden and serious loss of hearing in one ear, or, less frequently, in both ears, with subjective sounds and vertigo, due to some form of effusion into the labyrinth, sometimes takes place as the result of syphilis. Labyrinthine disease, coming on gradually or suddenly, leading to serious or total loss of hearing, preceded by keratitis or iritis, and often associated with Hutchinson's teeth, is not unfrequently met with in children suffering from hereditary syphilis. Condyloma or ulceration in the meatus is rarely met with.

Exanthematous and Zymotic Diseases. We have referred to the influence upon the organ of hearing, through mere continuity of skin and mucous membrane, of the exanthematous diseases, especially of scarlet fever and measles; but these diseases may also cause changes in the ear, especially in the labyrinth, through the circulation, causing marked and permanent defect of hearing. The other zymotic diseases not unfrequently induce mischief in the ear. During *typhus* and *typhoid* fever, temporary deafness and tinnitus are often observed, and are probably in most cases due to hyperæmia of the labyrinth; but permanent changes may also originate in these affections. The aural disturbance sometimes found in those who have suffered from intermittent fever is probably due rather to the effects of quinine than to the disease itself. *Influenza* is often followed by acute purulent inflammation of the middle ear, characterized by an unusually great tendency to mastoid suppuration. Other forms of ear disease, presenting peculiarly severe and obstinate features, have been observed in connection with epidemic influenza.

General Diseases. *Bright's disease*, *acute and chronic rheumatism*, *gout*, *anæmia*, *marasmus*, are each not unfrequently associated with

ear disease, but the exact nature of the causative relation is not clear. An attack of *mumps* is sometimes attended by permanent and total deafness in one or in both ears, from some as yet unknown change in the labyrinth. In *leukæmia*, hæmorrhage may take place into the labyrinth or tympanum. *Hysteria*, *pregnancy*, and the *period of lactation* are occasionally associated with disturbance of the hearing. Serious aggravation of a previously existing deafness often follows *parturition*. Deafness is occasionally observed during *puerperal fever*.

Organic disease of the *heart*, *lungs*, or *large vessels*, by causing stasis of the venous circulation in the head, or by producing undue arterial tension, may lead to hyperæmia of the mucous membrane of the nose, throat, and ear, passing, it may be, into distinct tissue changes.

Medicinal Substances. Certain medicinal substances, notably quinine, salicin, opium, and alcohol, may induce disturbance in the organ of hearing, especially hyperæmia of the inner ear, producing deafness or some form of tinnitus. They have a more injurious effect if disease already exists in the ear, when even small doses may distinctly aggravate the aural symptoms, and the aggravation is in some cases permanent.

V. REFLEX CAUSES.

Morbid impressions are sometimes transmitted to the ear in a reflex way through the vaso-motor nerves, from various parts of the body. The effect of cold feet, in exciting inflammatory affections of the middle ear, is an example of this form of reflex influence. But probably the most marked instance is the production of neuralgic or even inflammatory affections in the ear by the process of teething in the child, or by caries of the teeth in the adult. The connection of the dental nerves with the middle and external ear, through the otic and Meckel's ganglia, is probably the path by which the irritation is transmitted from the teeth to the ear. Sympathetic hyperæmia of the ear probably also arises from reflex sympathy with the digestive organs and, in the female, with disturbances of menstruation and the menopause.

VI. MICRO-ORGANISMS AS CAUSES OF EAR DISEASE.

In the production or maintenance of certain forms of ear disease, micro-organisms play a very important part.

Favourable Conditions in the Ear. When we consider the structure of the ear, especially the accessory cavities of the middle ear, the numerous air-filled spaces, warm and moist, and the tendency to the accumulation of inflammatory and other debris; when, further, we remember its communication with the nose, throat, and outer air, it is not surprising that it should be the seat of bacterial activity.

The following are the chief organisms associated with, if not the actual cause of, disease in the ear.

In the External Meatus certain inflammatory conditions are associated with fungi belonging to the species of aspergillus. It is to be noted, however, that these fungi have been known to exist in an external auditory canal without exciting mischief of any kind. There

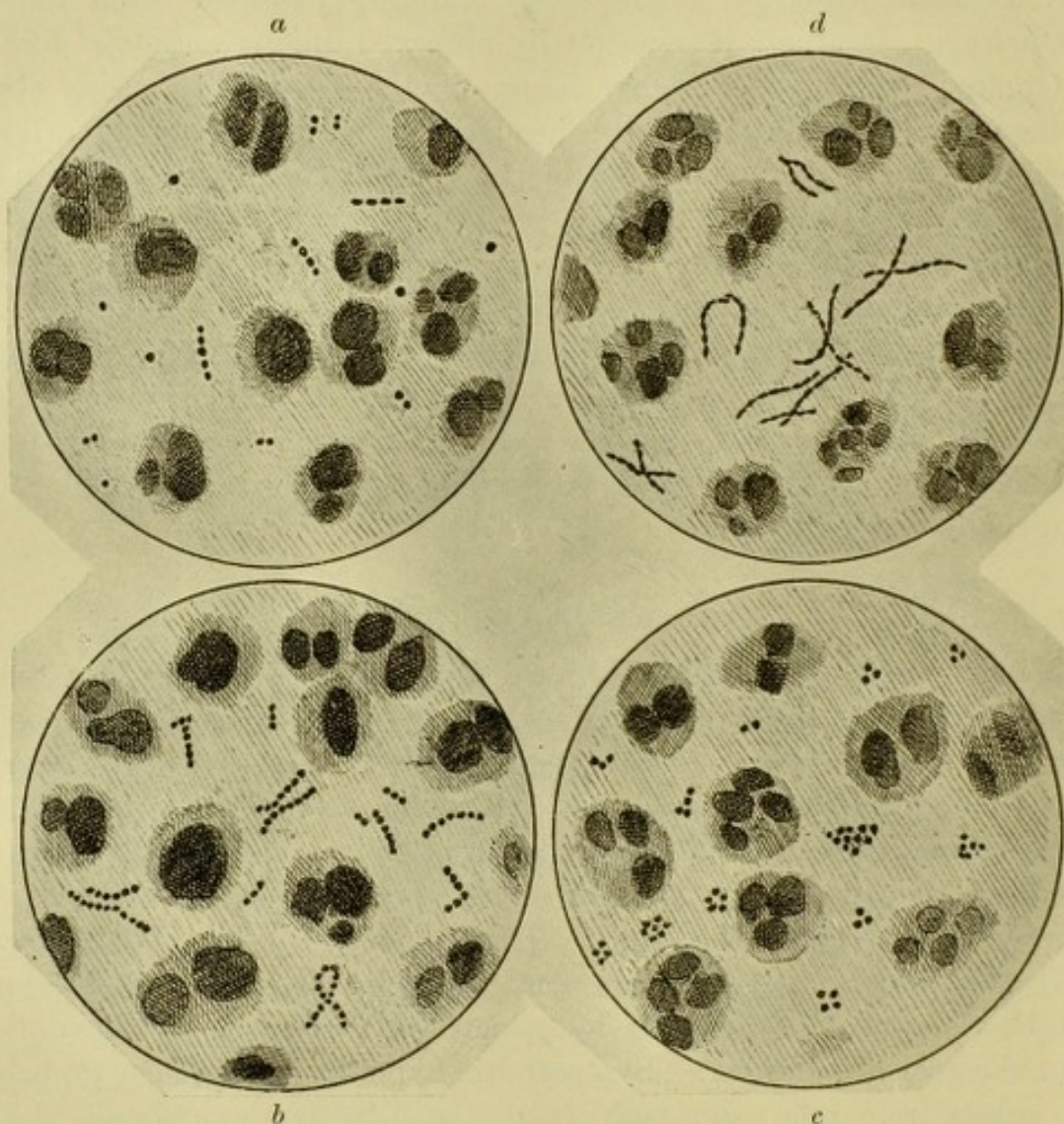


FIG. 46.—Micro-organisms found in purulent discharge from the ear. *a*, Diplococcus from a case of acute purulent inflammation of middle ear with nipple-shaped perforation, after influenza; *b*, streptococcus pyogenes from case of chronic purulent middle ear disease; *c*, staphylococcus pyogenes aureus from a furunculus in the external meatus; *d*, tubercle bacillus from case of chronic purulent middle ear disease in a child.

is reason to believe that furuncular inflammation is excited by a special micrococcus, which finds a habitat in the hair follicles, namely, the staphylococcus pyogenes (aureus and albus).

In the Middle Ear many pathogenic organisms are found in connection with inflammatory processes. The most important are the following: (1) Streptococci (Fig. 46, *b*), (including streptococcus pyogenes and streptococcus mucosus) are the most frequent and virulent micro-

organisms found in purulent disease of the ear. They are also commonly associated with intra-cranial suppurations especially septic thrombosis of the lateral sinus. (2) Diplococci (Fig. 46, *a*) are also frequently found, but not so frequently as streptococci, although they are also virulent. Of the diplococci the pneumococcus is the most common, but there are also found the meningo-coccus (Weichselbaum), the gono-coccus and the diplococcus catarrhalis. (3) The staphylococcus pyogenes (Fig. 46, *c*), albus and aureus, is less virulent, and is found in connection with purulent processes in the middle ear, as well as with boils in the external canal. (4) The tubercle bacillus (Fig. 46, *d*) is specially found in some purulent middle ear diseases associated with extensive tubercular infiltration of the mastoid and petrous portions of the temporal bone in young children. (5) Löffler's bacillus seems to migrate into the middle ear from diphtheritic conditions of the naso-pharynx. It has been found even in the labyrinth and the petrous bone. (6) The micrococcus of ozæna may invade the middle ear, and excite purulent disease.

In the Labyrinth, the diphtheritic bacillus, the diplococcus meningitidis of Weichselbaum in connection with cerebro-spinal meningitis, the streptococcus, the staphylococcus, and the pneumococcus are met with.

Effects of Micro-organisms. No doubt, in regard to all these organisms, their effects on the ear are modified by pathologico-anatomical conditions, the resisting power of the tissues, the nature of the pabulum, and the *presence or absence of other irritating causes*, such as cold or injury. In certain circumstances, these organisms may exist in the ear unattended by any morbid process. In order to determine the nature of the primary microbe, we should, if possible, examine the secretion after paracentesis of the tympanum or immediately after perforation of the membrane. Subsequently microbes may be found having no connection with the original source of the mischief.

VII. PREDISPOSING CONDITIONS.

Heredity. Hereditary tendency is a strong factor in the causation of almost all forms of ear disease, but more especially of those morbid changes which are usually designated chronic adhesive catarrh of the middle ear. We sometimes find the hereditary disposition extremely marked, almost every member of a family having some form of disease of the ear. It is to be noted, however, that the offspring may not be affected with the same disease as the parent. For example, the father may have chronic adhesive catarrh, while his children may be liable to purulent inflammation of the middle ear. We may find also that the hereditary tendency is not direct, that, while the father and grandfather have enjoyed a healthy state of the organ, the uncle or grand-uncle

has had ear disease. Politzer believes that the hereditary influence is stronger in the second generation than in the immediate offspring (atavism). It must be remembered, however, that these diseases are very common, and that, although we may frequently discover by diligent inquiry that some relative has dulness of hearing or an ear-discharge, we are not justified in all such cases in concluding that real hereditary tendency exists. Probably the hereditary peculiarity is in many cases what may be called the "catarrhal tendency," which almost always manifests itself at the same time in a special liability to nasal and pharyngeal catarrhs.

Age. The peculiarities attending different ages of life are important factors in the production of ear disease. In infancy and childhood there is a marked liability to exudative diseases of the middle ear, especially of a purulent character, as compared with persons of more advanced years. This frequency is strikingly shown by the examination of school children in whom a large proportion, in some schools 25 per cent., were found to be more or less dull of hearing. This is very much due to *the great frequency of adenoid vegetation in the naso-pharynx* in childhood as well as to the prevalence of exanthematous diseases at that time of life. It is also connected with certain peculiarities of structure existing in childhood, viz., the small size of the naso-pharyngeal space, the thickness of the mucous membrane of the Eustachian tube, and the shortness and width of the Eustachian tube. The rapid formation of mucous membrane in the tympanic cavity, which takes place soon after birth, probably induces congestive processes in the tympanum, and it has been shown that purulent collections are frequently found to exist in the middle ears of young infants. Otosclerosis, on the other hand, is common in female adolescents. In middle and advanced life chronic adhesive or "dry" catarrh of the middle ear is very much more frequent than in children. In old age auditory nerve impairment is common, while the flaccid soft walls of the cartilaginous Eustachian tube, as well as the feeble state of the tube muscles, may probably cause disease by disturbing the ventilation of the middle ear.

Position in Life, Occupation, Habits, and Surroundings have great influence in the causation and continuance of ear disease. In the case of the poor; their greater exposure to all kinds of weather, their cold, damp, ill-ventilated dwellings, their deficient nourishment and their scanty clothing render them more liable to inflammatory affections of the ear, which in such persons are also likely to be more persistent. We note especially the effects of these evil influences in the children of the poor, suffering from chronic purulent inflammation of the middle ear. Workmen exposed to loud or sudden noises, such as boiler-makers, riveters, or railway engine drivers, are particularly liable to

labyrinthine mischief, from undue irritation of the auditory nerve. Those, again, who have to work in the midst of air loaded with dust or dirt, or who are employed in an office where the air is confined, close, and impure, are prone to ear affections. More or less disturbance of the hearing may arise in those who are exposed to great changes in air pressure, such as caisson workers, divers and aeronauts. The injurious effects, acting through the tympanic membrane, are more likely to take place if the change of pressure is rapid, and more ready to occur during the relief from pressure. The immoderate use of alcohol and of tobacco may not only directly produce ear disease where the tendency to such exists, but, by bringing on a state of chronic catarrh of the naso-pharyngeal mucous membrane, ear disease may be in that way indirectly caused. Mental worry also predisposes to ear trouble in certain constitutions.

Pre-existing Diseases in the Ear. The previous or present existence of disease in the ear may predispose to a return of the same or to other diseases. As in almost all catarrhal diseases, one attack is apt to establish a tendency to future attacks. Thus, a person who has had at any time catarrhal or inflammatory disease of the middle ear, is more liable to have this again. So the existence of a chronic disease of the ear, such as chronic adhesive catarrh, or chronic purulent inflammation, exposes the individual to acute catarrhal or inflammatory attacks. Then, again, disease in one part of the ear frequently leads to disease in another part. Congestive or inflammatory conditions of the middle ear are often attended by hyperæmia of the labyrinth, leading, it may be, to more permanent changes. Chronic catarrhal or suppurative diseases of the middle ear are often followed in time by pathological changes in the labyrinth. Affections of the mastoid process are, in the great majority of cases, the result of pre-existing disease in the tympanic cavity. Again, furunculi, diffuse inflammation, or even hyperostosis of the external auditory canal, may arise from the irritating action of pus or other secretions upon the skin of the canal. Eczema of the auricle is also apt to excite a similar state of the canal, with thickening of the cutaneous lining.

Neglect of Treatment. We have to add neglect of proper treatment as an important element in the perpetuation of certain diseases of the ear. From this cause acute diseases frequently lapse into chronic conditions. Thus mucous catarrh, or acute non-perforative inflammation, may pass into the much less curable chronic adhesive catarrh. Probably, however, the disease, which is most frequently due to neglect of treatment, is chronic purulent inflammation of the middle ear, owing to the fact that no efficient efforts are made to cleanse the interior of the ear, although, from the anatomical peculiarities of the part, there exists such a tendency to retention of secretion.

CHAPTER IV.

METHODS OF TREATMENT.

MANY of the methods of treatment employed in diseases of the ear are useful in several affections, and, therefore, for the sake of convenience, and to avoid frequent repetition, we shall consider in this chapter, in the following order, the most important of them. The distinctly operative methods are taken up in the next chapter.

- I. Inflation of the middle ear.
- II. Syringing the ear.
 - Ordinary syringing.
 - Intra-tympanic syringing.
 - Syringing through the Eustachian tube.
- III. Local abstraction of blood.
- IV. Application of liquids or vapours to the middle ear through the Eustachian tube.
- V. Rarefaction and condensation of the air in the external meatus (pneumo-massage of tympanum).
- VI. Electrical treatment.
- VII. Mechanical aids to hearing.
- VIII. The artificial tympanic membrane.
- IX. Preventive and hygienic treatment.

I. INFLATION OF THE MIDDLE EAR.

Of all the therapeutic measures practised in diseases of the ear, this is probably the one most frequently employed. For a description of the various modes the student is directed to page 11.

The therapeutic value of inflation is mainly based upon the mechanical effects of the compressed air on the walls and contents of the middle ear. Its effects on the walls are confined to the yielding parts, namely, the tympanic membrane, the membranous

part of the Eustachian tube, the membrane of the fenestra rotunda, and the annular band of the foot-piece of the stapes.

Effects of Inflation on the Walls of the Middle Ear. In many pathological states the tympanic membrane and the ossicular chain are indrawn, so that the base of the stapes presses abnormally upon the fluid of the labyrinth. The vibrating power of the membrane and ossicula is at the same time impaired by this increased tension. The mechanical effect, produced by the pressure of the air upon the inner surface of the tympanic membrane during inflation, forces out the membrane and chain of bones, thus relieving the labyrinthine fluid, and helping to restore the proper tension. The action of the compressed air in the tympanic cavity will at the same time tend to break asunder adhesions or bands, if these have not become too much organized, and also help to overcome abnormal retraction of the tendon of the tensor tympani muscle. It is possible also that, through the mechanical effect of the pressure of air upon the fenestral membranes, if frequently repeated, any tendency to their becoming rigid may be partially resisted. The stream of compressed air, acting laterally on the Eustachian tube, will co-operate with the tube muscles in separating the outer or membranous wall from the inner or cartilaginous one, and thus open the tube.

Effects on Secretion in the Middle Ear. The current of air has also an important effect upon fluid secretion in the middle ear. In the tympanic cavity the secretion is finely divided, and scattered in various directions. In this way its absorption by the lymphatics and blood-vessels is assisted, while secretion lying on those parts whose vibrating function is of great importance, such as the ossicular chain or fenestral structures, may be removed to other parts, where its effect on the hearing may be less injurious, or, if there is a perforation of the membrane, into the external auditory canal.

Value of Catheterization. Catheterization (Fig. 26) is most useful in chronic forms of middle ear disease, when a strong and somewhat prolonged current of air is required to overcome the resistance offered by adhesions. It is also to be preferred, when the disease is limited to one side, and it is undesirable that air should be forced into the normal ear. When liquids, vapours, bougies, etc., require to be introduced into the middle ear, the catheter is generally indispensable. In a few rare cases the use of Politzer's method is attended by such unpleasant consequences that we have to resort to the catheter. Since the introduction of Politzer's method of inflating the middle ear, however, catheterization has been much less employed than previously.

Value of Politzer's Method. Politzer's method (Fig. 28) possesses the following advantages. (1) In the treatment of ear diseases in

children, in whom the Eustachian catheter can rarely be used. (2) In acute catarrhal conditions of the nasal and pharyngeal mucous membrane, so often associated with middle ear catarrh, it has the advantage over the catheter of not irritating the inflamed mucous membrane. (3) When, in the adult, serious difficulties stand in the way of using the catheter, such as extreme nervousness or sensitiveness, a peculiar formation of the nasal passages, etc., this method is a useful substitute. (4) It requires no such special dexterity as catheterization, and it can not only be carried out by any practitioner, but with proper directions, and under sufficient precautions, it may be employed by the patient himself or by a friend in the intervals between the visits to the surgeon. (5) In certain conditions it is found that a better effect is obtained by the sudden gust of air propelled into the middle ear by this method, than by the slower, more gradual current through the Eustachian catheter.

Value of Valsalva's Method. It is of most value in cases where the tympanic membrane is perforated. In these cases, when there is secretion in the middle ear, the patient is sometimes able to assist in the treatment by forcing the secretion from the tympanum into the external auditory canal. In the same class of cases solutions poured into the canal of the ear penetrate more effectually through a perforation into the middle ear immediately after air has been forced by this method through the fluid. When the membrane is intact, however, the patient is either quite unable to inflate the middle ear, or, if able, he generally injures the ear by too frequent repetition. Temporary improvement of the hearing may attend successful inflation by this method, and hence it is frequently practised by patients and recommended by surgeons. Such efforts, however, repeated by patients, perhaps many times daily, produce on each occasion a congestion of the tympanic vessels as well as excessive tension of the tympanic membrane, which in time becomes thinned and flaccid. The more frequently it is performed the slighter and shorter in duration is the improvement of hearing—the case usually becoming worse and worse. Strong expiratory efforts produce hyperæmia of the vessels of the head, and stasis of its venous circulation, so that in persons with an unhealthy state of the vessels of the brain, the very frequent and vigorous performance of Valsalva's method is not free from danger. Persons have been known to fall unconscious to the ground when in the act of thus inflating the ear. It is necessary, when the patient is recommended to try this method, that he be strictly cautioned against its too frequent use; and in elderly persons, especially if liable to giddiness, it should not be employed at all.

II. SYRINGING THE EAR.

The ear syringe is frequently brought into requisition both for diagnosis and treatment. Before the surgeon syringes the ear, he must first ascertain by examination whether ceruminous, purulent, or other accumulations really exist. Injury is no doubt sometimes inflicted by the use of the syringe when there is nothing to remove.

Suitable Syringe. A piston syringe (Fig. 47) is generally the most efficient. If the surgeon has to deal with ceruminous collections or a

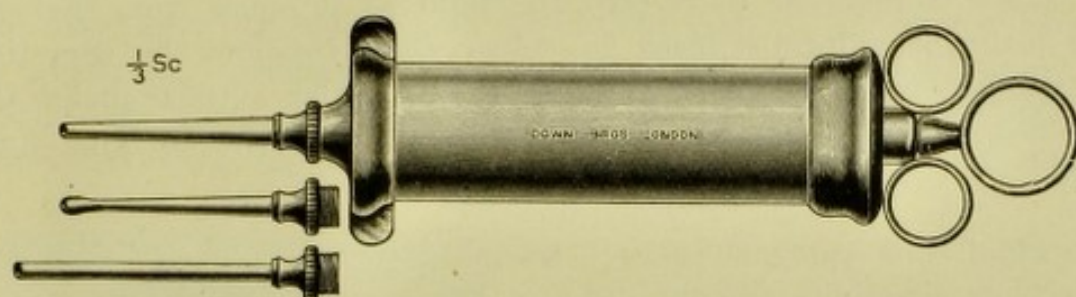


FIG. 47.—Ear syringe, made entirely of light metal.

foreign body, a syringe which contains four ounces is convenient, but, for other purposes, a two-ounce syringe is sufficient. One made of glass and metal or entirely of light metal, capable of being sterilized by boiling, is to be preferred. *It should be furnished with a fixed ledge, or other contrivance to prevent slipping of the index and middle fingers when the piston is being pressed down.* The nozzle should not exceed an inch and a half in length, should be slender, and should

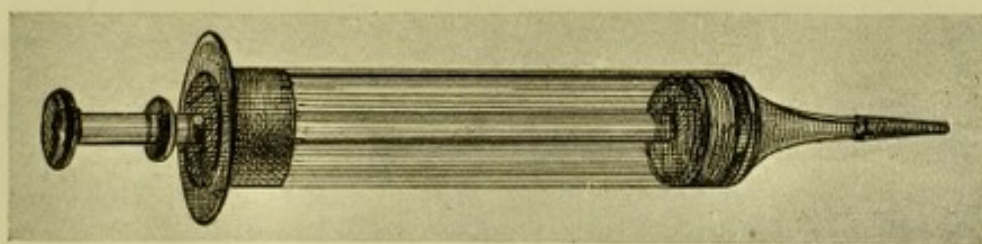


FIG. 48.—Glass ear syringe for use by patients.

not have a knob-shaped extremity. If the nozzle is too thick, or if it has a bulbous end, the canal of the ear is liable to be stopped up by it, and the injected fluid, having difficulty in passing out again, may produce dangerous pressure on the deep parts. The syringe put into the hands of patients should be smaller, as it is generally ordered for cleansing away purulent collections; one which holds an ounce of liquid is large enough. One made of strong glass (Fig. 48), furnished with a ledge for the fingers, the piston and barrel capable of being sterilized by boiling, is cheap and suitable. Whatever syringe is used by the patient, it should be provided with a piece of

fine, soft, india-rubber tubing, which covers the end of the nozzle and extends about a quarter of an inch beyond its point. This soft tubing may be introduced into the canal of the ear with greater safety by the patient or friend than a hard-pointed instrument. Ball syringes are useful when patients have to syringe their own ears, or for struggling children. For the latter the nozzle should be made of soft rubber and somewhat long (Fig. 49). The air should be well expressed from the ball, as bubbles of air mixed with the water are very unpleasant to the patient. A vessel (Fig. 50) of a suitable size and shape is required to receive the fluid as it issues from the ear. One made of vulcanite, black in colour so as to show the secretion and shaped as in the woodcut, fits the irregular surface under the ear, and, if held close to the skin, will prevent the escaping fluid

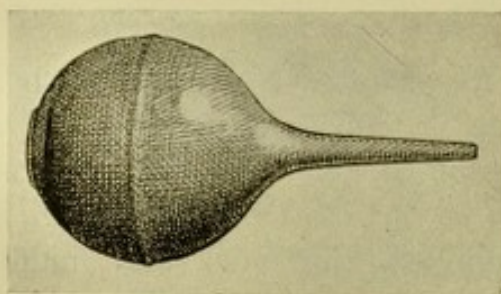


FIG. 49.—Ball ear syringe made of soft rubber.



FIG. 50.—Mode of syringing the ear.

passing down the patient's neck. The comfort of the patient is not unworthy of our attention, and the drenching which patients sometimes undergo, not to mention the trickling of water down the neck and under the collar, must be avoided when syringing the ear.

Mode of Syringing (Fig. 50). The syringe should be held only with the right hand, and the point of the nozzle, or the india-rubber tubing, should be placed in contact with the roof of the meatus, just within the external orifice. At the same time the auricle should be pulled upwards and backwards with the left hand, so as to remove the curve of the canal. When the object of syringing is to remove pus or other inflammatory products, the syringe should be used efficiently but gently, and with interruptions. A powerful stream of fluid propelled against the softened or perforated tympanic membrane may easily do injury. If the use of the syringe is entrusted to the patient or his friends, as in the treatment of purulent disease of the middle ear, it is essential first to give careful practical instruc-

tions. If this is not done, it will probably be found that the purulent secretion has not been removed from the deep part of the ear, the cleansing fluid having reached no further than the outer orifice of the canal. After syringing, the fluid which remains in the auditory canal should be allowed to drain out, and then the passage is to be dried with absorbent cotton fixed on a cotton-holder (Fig. 3). A plug of absorbent cotton should be worn in the meatus for a few hours after syringing for ceruminous collections.

Applications after Syringing. In purulent cases it is frequently necessary, after syringing and drying, to employ, as further means of treatment, insufflation of powder, instillation of solutions, or chemical or galvanic cauterization. These methods are described in connection with the treatment of purulent disease of the middle ear, Chapter XII.

Untoward Effects of Syringing. In some persons syringing the ear, even when it is done with caution, excites giddiness, and more rarely nausea and vomiting. These effects are more likely to be produced when the tympanic membrane is perforated, and especially when excessive force has been used, or when *cold* fluid is employed. The fluid may be sterilized water, or water medicated with some antiseptic substance, and it should always be pleasantly warm, say at a temperature of about 100° F.

The Intra-tympanic or Attic Syringe. In some cases of purulent disease of the middle ear, especially of the attic and antrum, it is desirable to inject fluid directly into the attic. For this purpose we employ a silver cannula (Fig. 51) attached at the outer end to a glass syringe (Fig. 48) by means of a short piece of stiff india-rubber tubing which by its resiliency softens the contact of the cannula with the tissues. Cannula and syringe can be easily sterilized by boiling. The inner end of the cannula is bent, for introduction into the perforation or other opening. The cannula used with the attic syringe has generally too narrow a lumen. A fairly good stream is required to dislodge the collections of epithelium in the attic, for which this method of syringing is often required. The attic syringe is often used after the operation of extracting the malleus and incus (see p. 111).

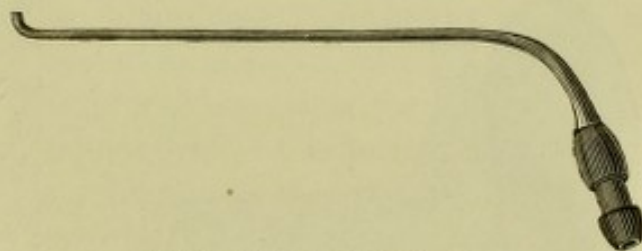


FIG. 51.—Cannula of attic syringe.

Mode of using the Attic Syringe. The syringe is held in the usual way with the right hand, the auricle being pulled backwards and upwards with the left, while light is reflected from the forehead

mirror (Fig. 52). The cannula is then carefully passed through the speculum into the inner end of the external meatus, and its bent point directed upwards, is cautiously placed in the aperture in the membrane,

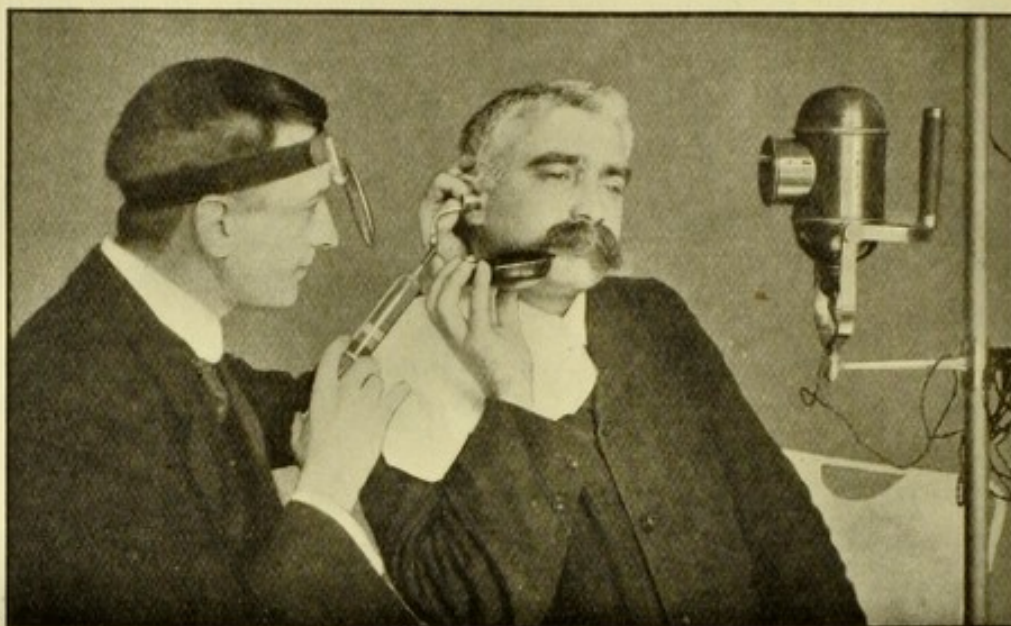


FIG. 52.—The use of the attic syringe.

which is usually in the membrana flaccida (Fig. 53). At first only one or two syringe-fuls should be injected at a sitting; afterwards, however, a stronger stream and four or five syringe-fuls may be injected with advantage. In this way we often succeed in dislodging

and bringing away quantities of cheesy-looking or epidermic masses. Sometimes giddiness is complained of while the stream of fluid is passing upwards, but this is rarely severe, and usually after a few applications it is no longer experienced.

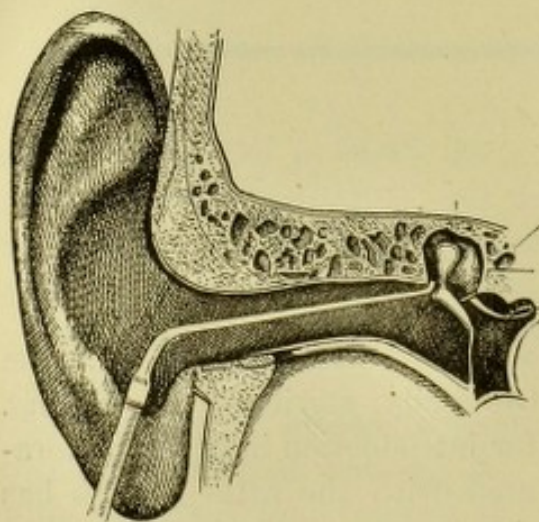


FIG. 53.—The introduction of the cannula of the attic syringe.

Syringing through the Eustachian Tube. This is usually done with an ordinary syringe, through a catheter introduced into the pharyngeal mouth of the Eustachian tube. This method must never be employed unless there is perforation of the tympanic membrane and free permeability of the Eustachian

tube. As wide a catheter as possible should be selected, and its beak must be well inserted into the tube, and then held *in situ* as directed at p. 15, while the fluid is slowly injected into the mouth of the catheter. The injection is more effective if the patient breathe through the almost closed mouth. Generally a considerable portion of the fluid escapes into the nasal passages and pharynx, although there should pass through the Eustachian tube a quantity sufficient to

drop, or even flow, out of the external meatus. The fluid is sometimes more effectually injected into the tympanic cavity through the tympanic tube passed through a catheter as far as the tympanic orifice of the tube. This is a fine elastic tube, one end of which is widened into a funnel-shaped orifice, the other end having a small opening, sometimes placed sideways, to give passage to fluid. In introducing this instrument, a catheter is first passed in the usual

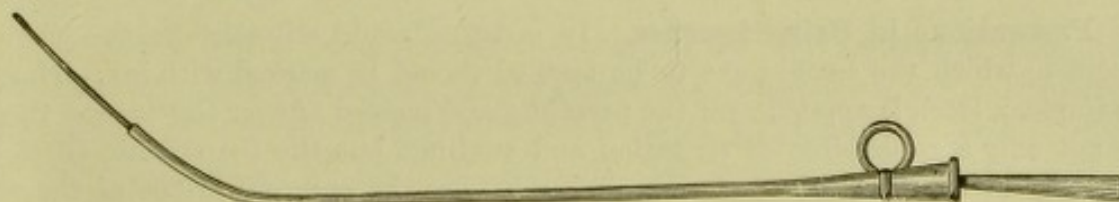


FIG. 54.—Fine tympanic tube introduced through catheter.

way, and through this the tympanic tube is pushed into the Eustachian tube (Fig. 54). The point of the instrument is known to be in its proper position when, by means of a mark at the widened end, it is known to have passed from two and a half to three centimetres beyond the point of the catheter.

Gruber's Method. When *both* tympanic membranes are perforated, Gruber's method of washing out the middle ear through the Eustachian tube is sometimes employed. This consists in forcing fluid into the nasal passage by means of a syringe furnished with a nozzle, which fits tightly into one nostril, while the other nostril is closed with the fingers. The act of swallowing is performed by the patient, as in Politzer's method of inflation, while the piston of the syringe is pressed home. This method must never be employed unless both membranes are perforated and the Eustachian tubes freely permeable.

III. LOCAL ABSTRACTION OF BLOOD.

In the treatment of the acute inflammatory affections of the ear, local blood-letting by means of leeches is often of value.

Application of Leeches. The proper situations for the application of leeches are in front of the tragus, behind the auricle, and over the stylo-mastoid foramen; depletion produces in these places the greatest effects on the ear. When the inflammation has its seat chiefly in the external meatus and tympanic membrane, the leeches should be applied over the tragus; when in the tympanum or mastoid cells, they should be applied below and behind the auricle. The deep auricular artery, after supplying the tragus, passes in to supply the deep parts of the external meatus and the outer layer of the tympanic membrane, so that, in removing blood from the tragus, we are more likely to affect the circulation in the meatus and in the tympanic membrane. The soft parts over the mastoid process and behind the lobule have their vascular supply from the stylo-mastoid artery, which provides also the chief arterial supply to the lining membrane of the tympanum and mastoid cells, where also arterial twigs inosculate with the small arteries of the labyrinth. Again, a communication exists between the veins over the mastoid process and the venous sinuses of the dura

mater, through the diploetic and emissary veins which pierce the mastoid part of the temporal bone. Hence, by abstracting blood from the soft parts over the mastoid process, we may exert an influence upon the circulation, not merely of the tympanum and mastoid cells, but also of the labyrinth and dura mater.

Precautions in Using Leeches. In order to avoid any mistake, the precise spots to which the leeches are to be applied should be marked with ink. If, for example, a leech is applied over the parotid gland instead of over the tragus, there is not only a probability of irritation and swelling, but the therapeutic effect is unlikely to be attained. Before applying leeches the external orifice of the ear should be stopped with cotton wool, so as to prevent the entrance of a leech or of blood. After they have come off, the bleeding may be allowed to continue for ten or fifteen minutes. Instructions should be given as to the proper methods of stopping the bleeding, in case this should prove excessive. If there is a purulent discharge from the ear, the leech bites should be covered with skin plaster or other material so as to protect them from the effects of the irritating pus, which might excite inflammation, ulceration, or even erysipelas.

IV. APPLICATION OF LIQUIDS OR VOLATILIZED SUBSTANCES TO THE MIDDLE EAR THROUGH THE EUSTACHIAN TUBE.

The Application of Liquids to the Middle Ear. A small graduated syringe (Fig. 55) capable of containing ten minims of fluid is employed. A wide catheter, having a long beak, should, if

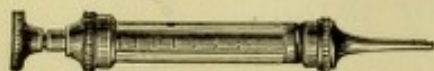


FIG. 55.—Small catheter syringe.

possible, be used; and the point of the beak is to be pressed well into the mouth of the Eustachian tube. The catheter, after being properly introduced, is held in position with the left hand; the syringe, which has been filled with the warmed liquid, is introduced into the outer opening of the catheter, and the fluid slowly and without much force injected into the catheter. The position of the patient's head should be such as to allow of the catheter being horizontal, so that the fluid may not flow out of it. By means of the air-bag a stream of air is then forced through the catheter, and the liquid is driven through the Eustachian tube and distributed as a spray upon the walls of the tympanic cavity. If the fluid be intended only for the Eustachian tube, the bag should be compressed with little force. If the head be inclined to the affected side and bent slightly forwards, the fluid may flow into the Eustachian tube without the stream of air.

In forcing the liquid through the Eustachian tube a portion always flows back into the nasal passages and throat. This may be partly due to faulty catheterization, but is mainly owing to the partial hindrance presented by the swollen mucous membrane, especially at the *isthmus tubæ*. Coughing or retching may be excited, but soon

passes off. When the fluid passes into the tympanic cavity, bubbling râles are heard during auscultation—one or two bubbles are often heard even after the inflation is over. A sensation of fulness and warmth is usually experienced in the ear, but pain is very rarely complained of, and inflammatory reaction almost never occurs, when suitable fluids are used.

Sterilized warm water may be employed for injection into the middle ear; but a variety of solutions are recommended. Probably the safest and most useful are 1 per cent. solutions of one or other of the following substances—bicarbonate of sodium, chloride of ammonium, and iodide of potassium. A 2 per cent. solution of pilocarpin is also employed; likewise liquid, sterilized, vaseline.

The Value of Liquid Applications. The solutions are chiefly employed in chronic adhesive catarrh of the middle ear; and the object aimed at is to irritate or stimulate the condensed, thickened, or rigid mucous membrane, so as to help to soften and render it more flexible, as well as to promote the absorption of the interstitial new-formation. It is right to state that some authorities believe that the good effects obtained by injecting solutions into the middle ear are in reality due to the air pressure. The preponderance of evidence shows, however, that cases, which have not been benefited by the simple air douche, have afterwards improved by the use of injections.

Application of Volatilized or Atomized Substances to the Middle Ear. Air impregnated with certain volatile substances is often introduced into the middle ear. A few drops of the substance, such as acetic ether, may be poured into the catheter bag and allowed to volatilize, when the air containing the vapour is forced by compression of the air-bag into a catheter properly introduced into the Eustachian tube; or, what is probably still better, the mouth-piece of an air-bag which is firmly compressed with the hand is placed inside the mouth of a bottle partially filled with the volatile fluid, and the bag is then allowed to fill with the vapour in the upper part of the bottle. Inflation is then effected through the catheter in the ordinary way. In the same way, volatile substances may be applied during Politzerization; or there may be connected with the tube of the bag a box (Fig. 56) containing a piece of sponge or cotton wool, on which the volatile substance is placed, to impregnate the air as it passes through the box. Dundas Grant's auto-inflator may also be employed to apply volatile substances to the middle ear. Sal-ammoniac vapour is often directed to be



FIG. 56.—Keen's valve and vapour box, used in Politzerization.

inhaled into the naso-pharynx from a Godfrey's or other apparatus and forced into the Eustachian tube by Valsalva's method. It is doubtful, however, if vapour reaches the tympanic cavity by this method.

Neboline or paroleine solutions of menthol, camphor, iodine, adrenalin, or cocaine may be very conveniently applied in a finely nebulized form, *via* the catheter, to the middle ear by means of the globe nebulizer of Oppenheimer and a catheter bag.

V. RAREFACTION AND CONDENSATION OF THE AIR IN THE EXTERNAL MEATUS.

This is useful in properly selected cases, especially in conjunction with inflation of the middle ear. We may employ simple rarefaction or rapidly alternating rarefaction and condensation (pneumo-massage of the tympanum). The former may be brought about by Siegle's pneumatic speculum or Delstanche's modification (Fig. 13). A simple air bag and an india-rubber tube similar to that used for Politzerization also serve the purpose, substituting for the nasal piece a conical ear piece covered with india-rubber tubing so as to fit air-tight into the meatus. The air bag is first emptied by compression of

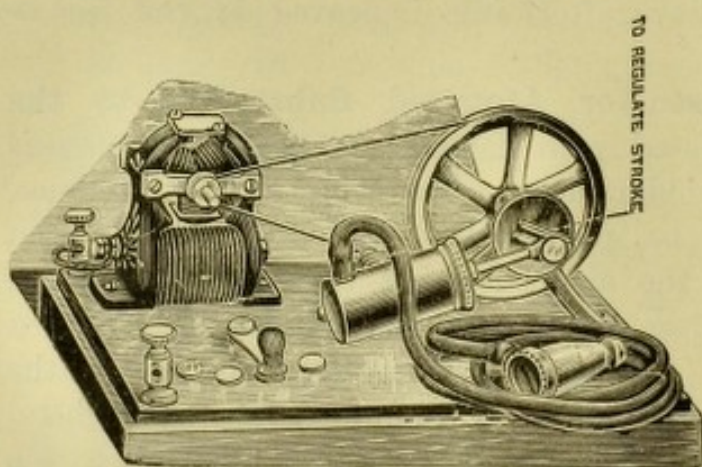


FIG. 57.—Electric oto-massage apparatus.

the hand, and the ear piece is *fitted air-tight* into the external meatus, the hand is then relaxed, when the air in the meatus becomes rarefied and the membrane is pulled out; this may be repeated four or five times at each sitting. Rapidly alternating variations of air pressure in the meatus is more frequently used. This may

be effected with the air bag and tube, so arranged that when the ear piece is fitted air-tight into the meatus frequent slight compressions and relaxations of the bag with the finger tips will produce rapid out and in movement of the tympanic membrane. More rapid movement is obtained by an instrument where the piston movement is propelled by a hand wheel, which regulates the length and frequency of the stroke of the piston. Still more rapid movement is obtained, even to the extent of several thousand strokes in the minute, by an electro-motor, when the length and frequency of the stroke is regulated (Fig. 57). As a rule the very rapid movements should

only be accompanied by short strokes. The rapid movement of the piston has the disadvantage of producing a loud sound, which may in some cases prove injurious.

Pneumo-massage of the tympanum is called for when there is an indrawn or retracted tympanic membrane, along with adhesions, or where there is rigidity of the ossicles or fixation of the stapes. Tinnitus is not unfrequently relieved by this method, even when the hearing is not improved. In purulent cases rarefaction of the air in the meatus may be employed to suck secretion out of the middle ear through a perforation.

VI. ELECTRICAL TREATMENT.

Electricity is employed in the treatment of ear disease, in the form of the continuous and the induced currents, as well as for its thermic effect (galvanic cautery). It is also used to propel a motor in pneumo-massage of the tympanum.

For applying these the writer uses a motor-transformer made by Schall, of London. This instrument, which is mounted upon an iron table, is adapted to various voltages up to 250, and therefore only requires to be connected to a plug in a room where electric light is installed. The following can be obtained from this equipment: (1) Motor power capable of driving an air pump, saws, drills, burs, etc.; (2) light for forehead mirror or transillumination; (3) Faradic and galvanic currents; (4) the galvanic cautery. An 8-volt accumulator, coupled up with the wiring to the electric light, so that the current supplying the electric lamp during the examination of patients charges the accumulator, forms a fairly efficient substitute for the motor-transformer in so far as providing motive power, the galvanic cautery, and transillumination.

Electrodes for the Ear. Various forms of electrodes are required, according to the method of application. The writer most frequently employs the constant and induced currents by way of the Eustachian tube and external meatus. The positive electrode is introduced into the meatus, and consists of a conducting wire passing through a vulcanite speculum, the end of the wire being capped with a piece of sponge which projects from the inner end of the speculum (Fig. 58). When introduced, the sponge is in contact with the walls of the canal, or, by pushing the speculum farther in, is placed in contact with the tympanic membrane. Before introduction, the sponge is moistened in a warm, weak solution of salt. The negative electrode consists of a conducting wire passing through a thin Eustachian catheter

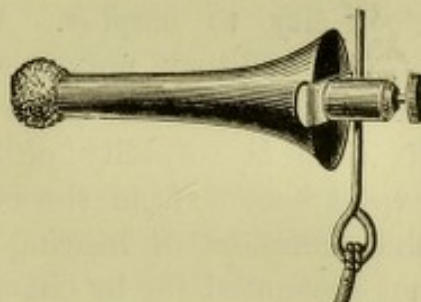


FIG. 58.—Electrode for applying electricity to interior of ear.

(Fig. 59). When used, the point of the catheter is introduced well into the pharyngeal mouth of the Eustachian tube, and is held *in situ* by the patient. The positive electrode is sometimes placed at the outer orifice of the ear, or over the tragus, instead of in the canal, by means of a bent metallic stem having a ball-shaped extremity covered with leather, while the other electrode, having a similar shape, is placed over the side of the neck. Electricity is also sometimes applied by filling the canal of the ear with a warm solution of salt, into which the end of the electrode is placed. In using the continuous current it

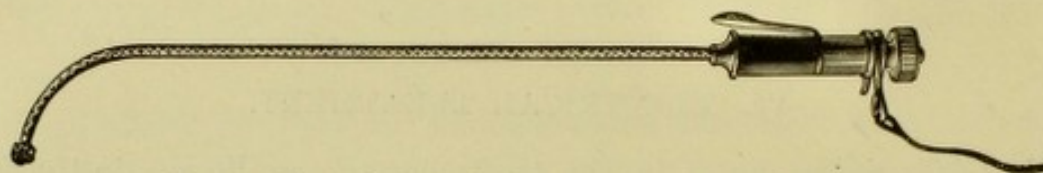


FIG. 59.—Electrode for applying electricity to Eustachian tube.

is often advantageous to alternate its direction. Galvanizing the ear, for therapeutic purposes, should not be employed more frequently than twice a week, and only for eight or ten minutes on each occasion. We must not employ a current so strong as to excite pain, burning, marked facial contractions, flashes of light, loud sound, or giddiness. During the application a sensation of taste or contraction is sometimes experienced in the tongue, the impression being conveyed through the chorda tympani nerve lying on the inner aspect of the tympanic membrane.

The Value of Electricity in Ear Disease. There are great varieties of opinion among aural surgeons as to the therapeutic value of the electric current, some extolling it as one of the most valuable remedies, while others deny that it has any real or permanent usefulness. This difference of opinion is probably due to the uncertain data upon which we are able to select this remedy, or the form of electricity to employ. When there is evidence of hyperæsthesia of the auditory nerve, with subjective sounds in the ear, galvanic excitement of the nerve should be avoided. On the other hand, if there is torpidity of the nerve (dysæsthesia), there is reason to expect benefit from the employment of the galvanic current. When the acuteness of hearing is liable to marked fluctuations which are not accounted for by changes in the middle ear, the galvanic treatment should be tried. In chronic adhesive catarrh of the middle ear, part of the impairment of hearing is probably sometimes due to functional disturbance of the nerve, which might be benefited by the galvanic current; and, at any rate, the nervous symptoms which sometimes exist in connection with that affection are occasionally relieved by electric treatment. *The high frequency currents* have

been tried for the relief of deafness and noises due especially to sclerosis of the middle ear.

Faradism is applied generally with the object of acting upon the muscles of the middle ear. Parietic conditions of one or all of these muscles are undoubtedly present in a certain number of cases of deafness or tinnitus, and in such cases Faradism may be useful. It is most efficiently applied according to the first method described.

It has to be observed that if either form seems to aggravate the noises in the ear, this mode of treatment should be discontinued.

The Galvanic Cautery. In the treatment of the ear and of the nasal and pharyngeal cavities, especially the latter, the galvanic cautery is largely employed for destroying morbid tissue. In the ear it is chiefly used for cauterizing fibrous polypi and hypertrophied mucous membrane in the tympanic cavity, as well as for making an artificial opening in the tympanic membrane. The writer has also removed on two occasions aural exostoses, having narrow pedicles, with the galvano-caustic loop. The handle of the cautery (Fig. 60) used by the writer for ear work is small and light, and the arrangement for interrupting and restoring the continuity of the current is at one side. The insulated electrodes are very slender, and bent at an obtuse angle (Fig. 61). Hence when introduced into the ear they take up very little space, and the view is only very slightly obstructed.

The Burner suitable for the ear consists of thin platinum wire, coiled in such a way as to present a small round disc to the diseased tissue (Fig. 61, *b*). A speculum introduced as far as the tissue to be cauterized prevents the burning of the walls of the canal. While good light is projected from a forehead mirror, the burner is introduced cold through the speculum. When it has been accurately applied to the morbid tissue, a slight pressure of the finger upon the spring at the side of the handle is instantly followed by a red-hot condition of the burner and the thorough cauterization of the tissue. This is accompanied by a hissing sound and the obscuring of the parts by vapour. For about two seconds the tissue is exposed to the red heat, and then the current is interrupted. The burner almost instantly cools, and the instrument is withdrawn. If required, the burner may be reintroduced



FIG. 60.—Handle of galvano-cautery for ear.

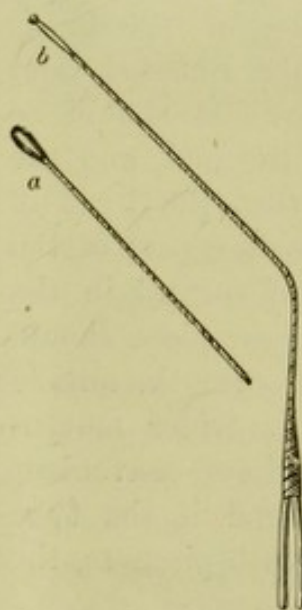


FIG. 61.—Burners for ear.

and reapplied two or three times at one sitting. It is very important that the moisture should be carefully removed from the part to be cauterized before the application of the burner, otherwise a longer contact with the tissue is required. The author has not seen any mischief result from the use of the galvanic cautery. The pain is but slight if a 10 per cent. solution of cocaine has been previously applied. Neumann's method of local anæsthesia (p. 106) is more efficacious, especially when the burner is used for perforating the tympanic membrane.

VII. MECHANICAL AIDS TO HEARING.

Mechanical contrivances for concentrating or strengthening the effect of sound upon the ear are sometimes of great benefit to persons whose hearing is very defective. Most frequently a deaf person uses his own hand or fingers to press the auricle forwards and outwards or to increase the reflecting surface behind, so that the sound waves coming from a point in front of him are more completely caught and reflected into the ear. This simple method is often a considerable help.

Aids to Conversational Hearing. As an artificial aid to the hearing of speech, when the speaker is near, as in ordinary conversation, a flexible conversation tube (Fig. 62, 2) is the most effective. This is about three feet in length, composed of silk or wool woven upon a tube of iron wire arranged spirally, and having a mouth-piece and an ear-piece made of horn. The mouth-piece should be funnel-shaped, and about two inches in diameter at its outer opening. During use the mouth-piece is held in front of, but not in contact with, the speaker's mouth, and ordinary loudness of speech is employed. The ear-piece is acorn-shaped, smoothly rounded, and is placed in the external orifice of the patient's ear. It should be bent almost to a right angle about an inch from the end, and the horn should extend from four to five inches, so that the hand of the patient may not wear and impair the flexible, softer part of the tube. Such a tube can be conveniently coiled and carried in the pocket. When the external meatus is irritable, the ear-piece should be shaped like an oval shell (Fig. 62, 3), and made to cover the auricle accurately. For use at table a longer tube with a wider mouth-piece, which may rest on a suitable stand, is sometimes convenient (Fig. 62, 5). There is greater concentration of sound if the tube becomes gradually somewhat narrower from the mouth-piece to the ear-piece.

Aids to Distant Hearing. It is much more difficult to enable the deaf patient to hear a speaker at a distance. Probably the most

suitable instrument for this purpose is a conical tube having a wide mouth, shaped like a speaking trumpet or horn of a cow, and made of silver, vulcanite, or horn, the ear-piece being placed at a right angle with the rest of the tube. A parabolic metallic cup fitted to a tube with an ear-piece (Fig. 62, 6, 7) is found by many persons to be fairly effective. Others prefer an instrument such as that depicted in Fig. 62, 1, which gives less fatigue in holding. In imitation of

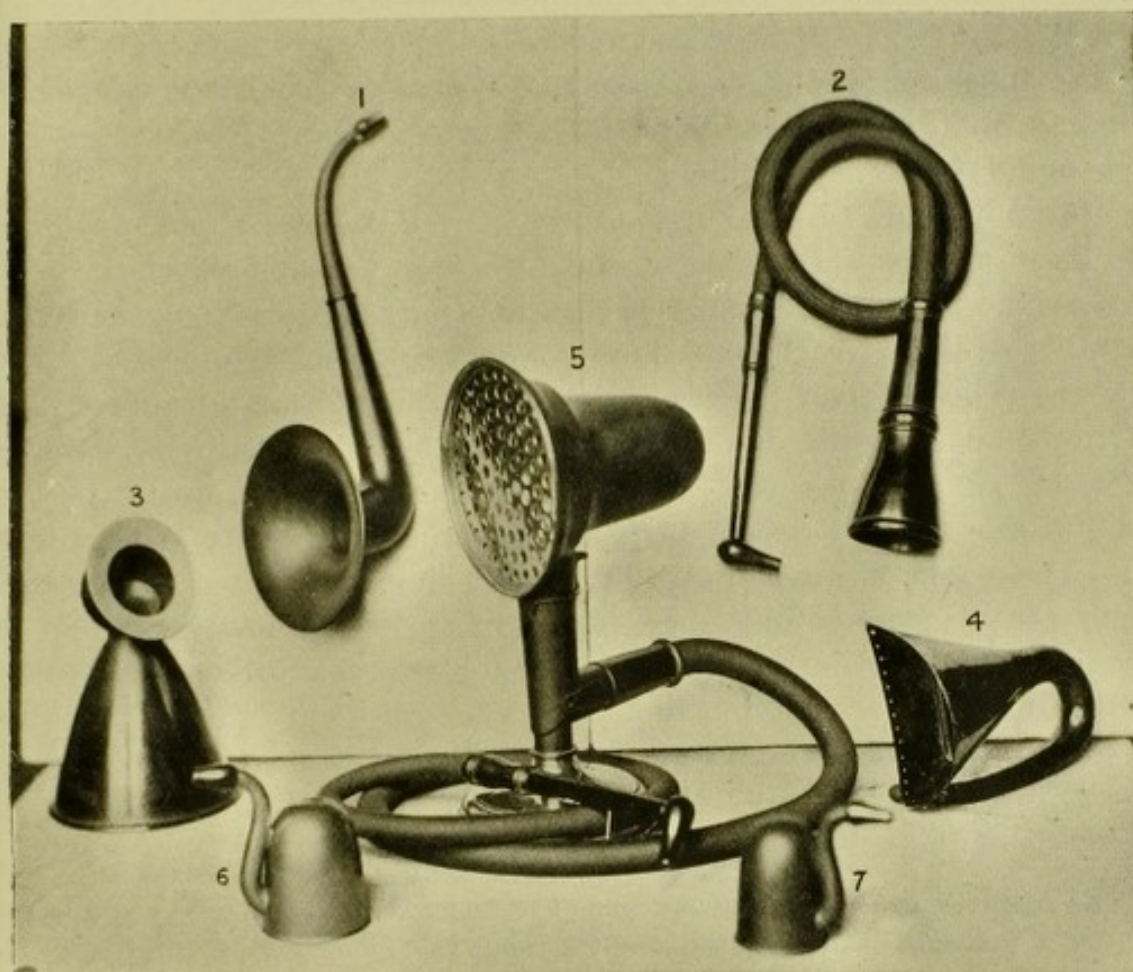


FIG. 62.—Mechanical aids to hearing.

the efforts of deaf patients to improve their hearing by placing the hand behind the ear, ear-shells are made to fit on to the auricle, increasing the surface of the latter. This form is specially suitable for those whose auricles have been much flattened by the compression of caps, etc., and is, to the patient, probably the most agreeable, though not the most effective. A flattened, curved tube, covered when in use with silk, and fixed by a spring to the head, is more useful (Fig. 62, 4).

Small Instrumental Aids. Small instruments, invisible during use, for augmenting the hearing power are in great request by deaf persons, who, in consequence of their inclination to conceal their

infirmity, dislike and delay the employment of the somewhat conspicuous appliances just described. These so-called invisible tubes are generally worthless, except in cases where the defect of hearing is due to collapse of the cartilaginous walls of the canal. Politzer has intro-



FIG. 63.—Poltzer's small hearing tube.

duced a small tube, the shape of a hunting horn, made of vulcanite and about an inch in length (Fig. 63). The narrow end is introduced into the meatus, and the mouth of the wider end is directed to the hollow of the concha. The object of this contrivance is to increase the normal effect of the inner surface of the tragus in reflecting the waves of sound, coming from the concha, into the external canal. The writer has not found it of much value.

Value of Aids to Hearing. In any given case we should try each of these various contrivances, until we find the one which is most beneficial. The improvement of hearing derived from the use of one or other of these instruments is often of great benefit to deaf persons, and the relief to their friends is also a not unimportant advantage. It is to be remembered, however, that some persons with *hyperæsthesia acoustica* cannot tolerate the use of the hearing tube, owing to the painful sensation produced upon the ear when words are spoken into it. These aids are not to be employed in cases of recent deafness from acute inflammations. In old standing cases, however, there is no objection to their use, provided they prove comfortable and beneficial. Indeed, by applying to the auditory nerve its proper stimulus—sound vibrations—the use of these appliances may prevent or delay the atrophy which is apt to result from the deprivation of the proper stimulus of the nerve.

The Acousticon. This is an instrument on the telephone principle. It consists of (1) a vulcanized rubber disc for receiving the sound waves, which may be attached to a suitable part of the dress by a clip, (2) a small battery which may be accommodated in the vest pocket, and (3) a flat ear piece, held over the ear by means of a handle or attached with a band. These are connected by silk covered wire. A large type is used in halls and churches. The writer knows of four reliable observers who found it distinctly useful in social intercourse and in public meetings. It is, however, a very expensive instrument.

The Audiphone consists of a thin plate of vulcanite, nine inches by ten inches, furnished with a handle. By means of a silk cord it may be bent to any degree of curvature and tension. The upper edge is placed in contact with the upper incisors, or pressed between the upper and lower incisors, while it is held with the convexity forwards. It is asserted that the waves of sound coming from the speaker's mouth and falling upon the convex tense surface are transmitted to the teeth, and thence through the bones of the head to the labyrinthine fluid and nerve, independently of the external and middle ear. Out of very many cases in which the writer has tested it, he can remember only two in which it was clearly useful, and in these a piece of cardboard, bent, and in a state of

tension, was equally serviceable. While it is generally useless in aiding the hearing of speech, it is probably more effective in enabling a very deaf person to hear loud music.

VIII. THE ARTIFICIAL TYMPANIC MEMBRANE.

Yearsley, in 1848, was the first in this country to draw attention to the improvement in hearing which is sometimes produced by introducing a moistened pellet or ball of cotton wool *where the tympanic membrane is partially destroyed by suppuration.*

Toynbee's Artificial Tympanic Membrane. Toynbee, making use of the suggestion, introduced in 1853 his so-called artificial drum (Fig. 64), which consists of a disc of india-rubber connected with a silver wire. This silver wire is fixed at the one end into the centre of the disc, by means of two very fine silver plates, while the outer end of the wire is formed into a ring for convenience of holding. Gruber substituted for the wire a thread passed through the centre of the disc, which is, in this case, introduced into the ear by means of forceps, or of a vulcanite tube. The thread is passed through the tube so that the disc rests on the inner end of the tube. This is introduced, pushing the disc before it, until the latter is placed in proper position, when the tube is withdrawn. Keen improved this by combining the tube with a probe (Fig. 65). A small piece of soft lint is sometimes used instead of india-rubber. Whichever of these modifications is used, the disc should be cut to the proper size, and, before being introduced, it should be moistened with sterilized vaseline. If we use Toynbee's membrane, or any kind of disc with a wire attached, the latter is held

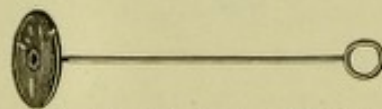


FIG. 64.—Toynbee's artificial "drum."



FIG. 65.—Keen's tube with probe for introducing artificial "drum."

by its ring-formed end, and the disc is gently pressed down the canal of the ear, till there is a feeling of obstruction, when it will usually be found to rest on the remains of the membrane. If it produces a ringing in the ear, or other unpleasant feeling, or if no improvement in hearing takes place, its position should be modified. Several alterations are often necessary before it is efficient and comfortable, and after a little practice the patient is better able than the surgeon to make these adjustments. When it acts efficiently, the patient often knows simply by the sensation in his ear; or he finds, by applying such a test as creating a slight noise with his finger-nails or the rustling of his clothes, that he hears better.

The "ear-drums," "ear-discs," etc., advertised so extensively by quacks, are usually either modified forms of Toynbee's artificial drum, or an elongated india-rubber cap introduced with forceps. When we consider that this aid to hearing is only useful in a limited and defined number of cases (mainly those with partial destruction of tympanic membrane especially involving the upper and back part), and that careful guidance and precautions are necessary, it is easy to understand the frequently mischievous results which follow response to these advertisements.

Yearsley's Pellet of Cotton. The use of the cotton ball or pellet of Yearsley (Fig. 66), or some modification of it, is now generally preferred by aural surgeons to the india-rubber disc. The cotton is sometimes used dry, especially when it is intended to soak up moisture in the ear; but a moistened ball or disc of sterilized cotton wool is, in the author's experience, much more efficacious in improving the

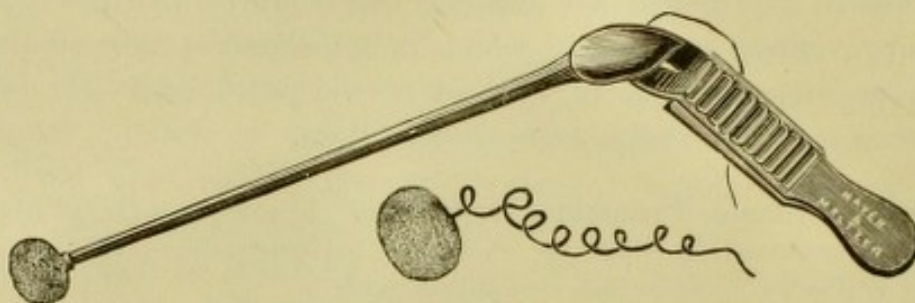


FIG. 66.—Yearsley's ball of cotton and introducer.

hearing. Rigorous cleanliness is necessary, and the cotton ball or pellet should first be immersed in boiling water for a few minutes, the water squeezed out, and further moistened with sterilized liquid vaseline or glycerine and water. If there is still suppuration, it may



FIG. 67.—Forceps for patient's use in introducing cotton pellet.

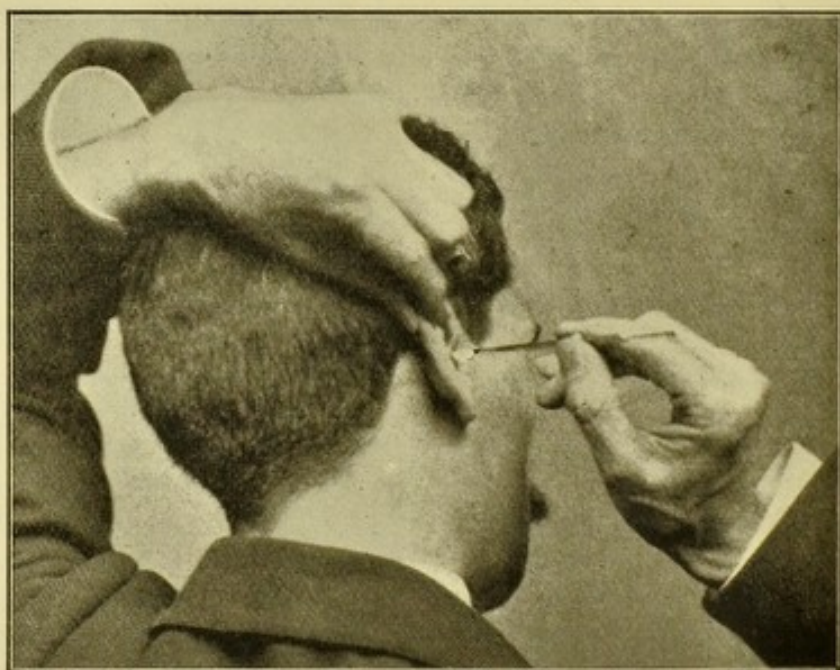


FIG. 68.—Patient introducing disc of cotton. (Yearsley's "drum.")

with advantage be soaked in a suitable antiseptic solution. The cotton may have the form of a ball (Fig. 66), or it may be disc-shaped, while a piece of thread attached to it, which lies in the canal of the ear while the cotton is in position, enables the patient to remove it at will. The cotton is introduced by means of fine forceps having a weak spring (Fig. 67). When the surgeon has satisfied himself of

the usefulness of the cotton pellet, he should carefully instruct the patient in the method of introducing and withdrawing it (Fig. 68). Very frequently, after such training, the patient becomes much more efficient than the surgeon in manipulating the cotton wool in the ear.

The use of the cotton has the following advantages over Toynbee's artificial membrane: 1st, It is softer and excites less irritation; 2nd, it is a convenient medium for applying medicaments to the interior of the ear; 3rd, it does not cause disagreeable noises in the ear during chewing, as does the wire of Toynbee's membrane; 4th, it is not visible at the orifice of the ear. In very few cases, indeed, is the india-rubber disc useful when the cotton pellet fails.

Proper Situation. The efficacy of either form depends very much on the precise place to which it is applied, and the degree of pressure exerted by it. The situation where it is most likely to be beneficial is the upper and back part of the inner wall of the tympanum, over the situation of the stapes, when the posterior half or the postero-superior quadrant of the membrane is destroyed. But in determining whether, in a given case, this mode of treatment will prove useful, we must patiently and carefully try the moist cotton pellet on one spot after another with varying degrees of pressure. In many cases we must, before admitting failure, repeat our efforts at two or three different times. As a rule, when we hit upon the proper place we have the good effect immediately; but the author has known patients who found no benefit until it had remained in the ear several hours.

Precautions in the use of the Artificial Drum. When we find that this method of improving the hearing is successful, caution should at first be exercised so as to avoid irritating the ear and producing inflammation or suppuration. Great variety is met with among patients in regard to the irritability, which may be produced by such a foreign body as a piece of india-rubber or cotton wool. In a small number it is quite impossible to wear it, owing to the irritation or suppuration produced by contact even for half-an-hour; while, on the other hand, we meet with those whose ears can tolerate the contact of moist cotton wool for months at a time without inconvenience. In a large number of persons it is well at the beginning to limit its use to half-an-hour each day for a few days, gradually extending the time until we reach six or eight hours per day; neither form should be used at night. During the first few days the patient should be seen daily, and it is well, at first, that the cotton employed should have a piece of thread attached to it, so that the patient may, after the allotted time has expired, remove it. When acute inflammation exists in the ear, or when there is suppuration, no form

of artificial membrane should be applied until these conditions have been removed. It should not be persisted in when its most limited use excites inflammation or giddiness; it is also inapplicable to young children. Generally we should not recommend it in persons whose hearing is very good in one ear, or even, although both ears are affected, where the deafness is not marked.

Value of the Artificial Drum. These artificial helps to hearing have sometimes an excellent effect, restoring deaf persons from solitude to all the enjoyments of society. Many persons, without such aid, can hear speech only when spoken close to the ear, while with the aid of a pellet of cotton wool properly adjusted they hear ordinary conversation perfectly well. Even in cases of almost total deafness decided improvement is occasionally effected, although, as a rule, when the deafness is extreme, no benefit is produced by the artificial tympanic membrane. Slight improvement is very common, and even such moderate improvement may be of great value, perhaps averting exclusion from public meetings. The experience of the writer accords with that of Politzer, that an occasional pause of a few days is often followed by still better hearing. We now and again find that improved hearing continues for some time after the removal of the cotton.

It has to be admitted, however, that in a number of cases the artificial support has no effect in improving the hearing, even when the condition of the ear would lead us to expect improvement. The test of experiment is our only guide. Such a test is sometimes provided by the patient before coming to us. If he informs us that the pouring into the ear of a few drops of oil, glycerine, or water, or the insufflation of a little fine boracic acid powder, has the effect of improving the hearing for a time, we shall probably find that the moist ball of cotton has a beneficial effect on it. It is in some cases very disappointing to find, while improvement takes place in hearing the tick of a watch, that there is no change in the hearing of speech.

How the Improvement is Effected. The way in which the improved hearing is brought about by the artificial tympanic membrane is not fully understood. It is certain that this is rarely due to the mere closure of the gap in the membrane; indeed this has often an injurious effect on the hearing. The good effects are probably produced, in most cases, by pressure exerted upon some part of the ossicular chain, either directly or through the intervention of the remnant of the tympanic membrane. When, on account of disarticulation between the incus and stapes, or when a portion or the whole of the incus has been removed, the continuity of the ossicular chain is lost, the stapes is deprived of its proper support, and fails to exercise a due amount of pressure upon the fluid of the labyrinth. The application of the cotton pellet probably restores the continuity of the chain, and affords the due amount of pressure upon the labyrinthine fluid. We frequently find that the cotton wool has to

be well pressed into the situation of the stapes before a beneficial effect is secured. Advantage to the hearing has been sometimes derived from the pressure of a moist disc of cotton wool upon the tympanic membrane, when the latter was not perforated. We may suspect in such rare cases that the continuity of the chain of bones has been, from some cause, disturbed.

IX. PREVENTIVE AND HYGIENIC TREATMENT.

Direct Action of Cold. When there is a predisposition to ear disease, or when some form already exists in the individual, precautions should, if possible, be taken against the direct action of cold water or cold air upon the ear. Cold water must never be allowed to pass into the ear, especially if a perforation exists in the tympanic membrane. Even in ordinary washing, in such cases, the ears should be plugged with cotton to avoid the trickling of water, perhaps containing pathogenic organisms from the meatus, through the perforation. In diving, or in the use of the shower bath, the precautions should be still more minute, cotton plugs soaked in fluid vaseline, or india-rubber ear protectors, being employed (Fig. 69). In sea bathing, a waterproof cap should be used in addition. There is probably no popular delusion more common than that splashing or laving cold water upon the ears and sides of the head strengthens the organs. The fact is, the ear is very intolerant of cold, especially in persons who have a hereditary tendency to ear disease, or in whom an ear disease already exists. If such persons be exposed, as in travelling in an open vehicle, to cold wind, especially if accompanied by rain, sleet, or snow, the ears should be carefully protected by cotton plugs, or by a suitable head wrapping, to avoid catarrh, or inflammation of the ear. Of course during mild summer weather, or even in winter if there is no wind, plugging or wrapping up the ear is not desirable, and should not be practised.



FIG. 69.—Macnaughton Jones' aural protectors.

Nasal Catarrh or other nasal trouble must if possible be avoided, and, when a person with aural weakness is so afflicted, he should take measures to get cured as soon as possible (see p. 153). The removal of post-nasal adenoids in children is eminently a preventive measure.

Exanthematous Diseases. During and immediately after the exanthematous diseases attention should be given to the state of the ears, and, if necessary, prompt treatment employed. In view of the not infrequent absence of subjective symptoms in an acute inflammation of the middle ear occurring during one of the exanthemata, and the serious consequences which may ensue from this disease, it is very desirable that medical men should occasionally inspect the ears, during

the course of those diseases which are known to be frequently attended by aural complications, and that they should, on leaving off attendance upon such a case, instruct the patient or friends to report if any symptom, such as a discharge from the ear or defective hearing, shows itself. Timely treatment is of very great importance, and may prevent serious mischief to the organ.

Improper Interference. Patients are also to be advised against irritating the ear, either by hard pointed objects, unnecessary or improper syringing, or by the indiscriminate pouring of liquids into the ear.

Loud Noises, either sudden or constant, should be avoided by aural patients. As is well known, gunners usually become deaf, either suddenly after a report or gradually. The loud shriek of a railway whistle not infrequently injures an ear even when previously healthy, and, as the writer has shown, boiler-makers and others working amid noisy surroundings nearly always suffer from defective hearing. Such sounds should therefore be carefully avoided by persons with ear disease.

It would be well if boiler-makers, gunners, and others who are exposed to great noise could be persuaded to use an india-rubber plug or other means for deadening sound. Cheatle has recently suggested "clay fibre," a plastic substance which can be moulded to fit the orifice of the ear. Dr. Legge suggests plasticine, used in school modelling, containing cotton wool fibre. The writer finds that this suits the purpose very well, and could be used also for keeping the water out of the ear while bathing. It is interesting to know that many gunners are in the habit of keeping something between the teeth during gun-fire, to ensure the mouth being open, which they say lessens the effects of the sound upon the ear.

Hygiene. The purity of the air, the cleanliness of the skin, the suitability of the diet, and the healthfulness of the whole surroundings have an influence on the progress of diseases of the ear, especially those which are chronic.

The purity of the air breathed by the patient while sleeping, and absence of dampness and smoke are of importance. The impure air breathed in school-rooms, offices, and workshops, in some instances loaded with mechanical or chemical irritants, is very likely to maintain catarrhal processes in the nose, throat and middle ear. Out-door exercise in suitable weather with proper precautions, especially if the air is not only pure and fresh but also dry, conduces to a healthy state of these mucous membranes.

In some cases of exudative middle ear catarrh, when local treatment proves unsuccessful, a residence of two or three months in the country, especially in a mountainous or upland district, has proved most satisfactory in maintaining a permanent state of improvement. In all cases a change of air from town to country is a powerful aid to local treat-

ment. In chronic dry catarrh, while change of air has not usually so beneficial an influence upon the ear, it is very often advantageous. A mild, dry, equable climate probably acts by diminishing the tendency to nasal and pharyngeal catarrh.

Baths of warm or luke-warm salt water, repeated every second day, have often a useful effect upon the catarrhal process in the ear, when thorough friction of the skin is employed after each bath. Sea bathing or cold water bathing is sometimes beneficial in chronic dry catarrh, where every precaution is adopted to keep the water out of the ear. Judiciously employed, it protects the system against catarrhal attacks; but, if the dulness of hearing or the tinnitus become aggravated, the bathing must be abandoned.

Tobacco—Alcohol—Medicines. Excessive use of tobacco or alcoholic drinks exercises a deleterious influence in inflammatory or catarrhal affections, not only inducing a hyperæmic condition of the ear, but also tending to produce a state of chronic pharyngitis. These luxuries must therefore be employed in very great moderation. Quinine and salicin or their compounds, should also be used with great caution or avoided altogether, when an ear disease already exists. The addition of hydrobromic acid is said to prevent the injurious influence of quinine upon the hearing.

CHAPTER V.

OPERATIVE TREATMENT OF THE EAR.

IN this chapter we shall limit ourselves to the description of operations performed directly upon the ear itself. In the treatment, however, of ear disease and its consequences, extra-aural operative treatment is often required. For example, operations on the nasal passages and naso-pharynx (pre-eminently the removal of post-nasal adenoids) are very frequently necessary in the treatment of ear disease; these are described in Chapter VII. So also the intra-cranial operations, which are necessitated by the effects of purulent ear disease, are described in Chapter XV. The following are included in the present chapter:—

- I. Anæsthesia in operations on the ear, nose and throat.
 1. General anæsthesia.
 2. Local anæsthesia.
- II. Removal of aural polypi and granulation tissue.
- III. Incision of the tympanic membrane (myringotomy).
- IV. Intra-tympanic operations.
- V. Mastoid operations.
 1. Wilde's incision.
 2. Opening into the vertical mastoid cells for acute empyema.
 3. The simple antral operation.
 4. The radical mastoid operation.

I. ANÆSTHESIA IN OPERATIONS ON THE EAR, NOSE AND THROAT.

1. GENERAL ANÆSTHESIA.

We shall briefly indicate the advantages and disadvantages of each of the various anæsthetics used in operations on the ear, nose and throat, and so facilitate the selection of that anæsthetic

which will be most suitable for the operation in view. Those in common use are chloroform and ether in the longer operations, such as the radical mastoid; the chloride and bromide of ethyl and nitrous oxide gas in those operations requiring only a short anæsthesia, such as the removal of post-nasal adenoids or tonsils. All these may be used alone, or in mixture or in sequence, and the best results are not always got by the routine use of one anæsthetic alone, but by intelligently taking advantage of the different properties of each, according to the various types of patients and the ever-changing conditions of the patient during the operation. If, however, through want of experience and opportunity, the administrator cannot attain a reasonable proficiency with each of the several agents, he will probably obtain the best results by using as a routine a mixture of chloroform and ether (equal parts, or better, two of chloroform to three of ether—freshly prepared), the advantages of which over either alone are explained later. In operations of more than a few minutes' duration it is necessary to employ chloroform or ether, but any of the others may be and often are used for the rapid and pleasant induction of anæsthesia; for example, in children or nervous adults ethyl chloride may precede either chloroform or ether, and nitrous oxide gas, which is practically without taste or smell, is a favourite method whereby the pungent and irritating vapour of ether is wholly avoided.

Anæsthetics Suitable for Prolonged Operations. Taking a *mastoid operation* as a type of a long one, chloroform must be regarded as the proper anæsthetic so far as the nature of the operation is concerned, ether increasing the hæmorrhage to such an extent as to add considerably to the difficulty of the operation and thereby unduly prolonging it. But there may be reasons, such as a weak or feeble heart, on account of which one would like to give the more stimulating anæsthetic, ether. It is quite practicable, as will be shewn, to keep the patient anæsthetised with chloroform and at the same time to give him the benefit of the stimulating qualities of the ether without causing undue engorgement of the vessels of the head and neck. In this operation—indeed in all operations, long or short, in which chloroform is the agent used—the strictly recumbent posture must be insisted upon. The head should be on a level with the body, or better, even a little below it. (This is one of the little and apparently trifling details in chloroform administration which has, however, marked effects and far-reaching consequences.) A pillow or two may be used at first, as the patient frequently desires his head high, and the anæsthesia may be commenced so, but, as he loses consciousness, they should be gradually withdrawn, till, well before the conjunctival reflex is abolished, the head is at least on a level with the body—preferably, if the operator

can put up with it, a little below it. The head, too, as soon as the muscles of the neck become sufficiently relaxed, is turned to the side—the lower jaw pushed forward and the chin held up. As it is usually this period—just before the abolition of the corneal reflex—that is looked upon as the most dangerous period in chloroform administration, it is a good plan, as a routine precautionary measure, to further slightly lower the head and pour freely on the towel or mask ether, or a mixture of chloroform and ether with a large proportion of the latter. The effect is usually at once marked—respiration becomes deeper, the face a good colour, and the pulse fuller and stronger. Continue this, using chloroform and ether alternately or using a mixture, till the corneal reflex is just abolished. When the proper depth of anæsthesia is established the head may be raised to the level of the body and a return to chloroform alone be made.

The anæsthetist must hear every breath, noting its character and any change in its rhythm and depth, the colour of the face and the state (dilatation or contraction) of the pupils. A finger should also be kept on the facial or temporal artery. On the slightest sign of anything going wrong, on the slightest appearance of pallor or any change in the rhythm of respiration or pulse, recourse should be had at once to the slight lowering of the head and the free use of ether just mentioned. It should be remembered that without an inhaler, *i.e.* an apparatus to restrict the air and allow a greater concentration of ether vapour, ether, in the course of a chloroform administration, poured freely on the open towel or mask, has practically no effect in deepening the anæsthesia, but by stimulating the patient it seems almost to really first rouse him to a lighter anæsthesia, and if the disquieting symptoms have been due to sickness supervening (which in nearly every case means a return to a too light anæsthesia) it will usually sufficiently rouse the patient to induce vomiting. The operator will at once notice the effect in increased oozing, but this oozing will quickly cease when recourse is again had to chloroform. Should the patient's condition continue to give anxiety with chloroform, it may be advisable to maintain the anæsthesia throughout with a mixture. If the proportion be equal parts of chloroform and ether, or two parts of chloroform and three parts of ether (the old ACE mixture without the alcohol), the ordinary mask or towel, made slightly larger, may be used, but the mixture must be poured on very freely. Any proportion may be used, the dosage being determined according to the proportion of chloroform in the mixture, the ether being of little or no account as an anæsthetic. It is better, however, to employ either a Silk's inhaler, a Rendle's mask, or a Hewitt's CE inhaler, when using such a mixture—necessary, indeed, if a larger proportion of ether is in the mixture.

With children, the ordinary mask or towel does well enough. Towards the end of a long administration, when the patient's powers are waning, the proportion of ether is with advantage increased as the operation goes on or effects of shock become apparent. In operations on the mastoid, a moderately light anæsthesia only is required. After the skin incision the corneal reflex may be maintained throughout.

In the radical operation on the maxillary antrum chloroform is preferable to ether, for the reason already mentioned, viz. less hæmorrhage. The inhaler, too, would be much in the way of the operator. When the patient is satisfactorily anæsthetised with chloroform, anæsthesia can be readily maintained by means of a mouth tube passed alongside a gag and attached to the bellows of a Junker's inhaler. A gag must always be in the mouth to allow the throat to be swabbed out.

In operations for removal of the turbinates, operations on the septum and other operations of considerable duration—for the same reasons chloroform is to be preferred. If, however, in any of these operations, the sitting posture is desired, then of course ether must be the anæsthetic employed—the position contra-indicating the use of chloroform. There is this disadvantage in using ether in such operations, unless they are of short duration, that the operation has to be temporarily stopped every few minutes to allow of the re-application of the face-piece of the ether inhaler, and this, where there is much bleeding, increases the difficulty of keeping the air passages free from blood.

Anæsthetics in the Removal of Tonsils and Post-Nasal Adenoids.

In operations for the removal of *tonsils and adenoids* any of the anæsthetics may be used—the selection being made according to the position of the patient preferred by the operator (all but chloroform and any mixture containing chloroform, however small the proportion, being permissible in the sitting posture) and the time required for the operation. In no class of case does the anæsthetist require to be so much on the alert, since the airway is the field of operation, hearing every breath, noting its character and the presence or otherwise of blood in the throat.

Nitrous Oxide Gas alone or combined with oxygen is an anæsthetic much favoured by some operators, and where time is an important consideration, as in dispensary practice, it is very useful. The advantages are the undoubted safety of the anæsthetic, the upright position, the rapid induction (about 40 to 50 seconds when given alone, about 100 seconds when given with oxygen) and the equally rapid recovery with no ill after-effects. The chief disadvantage is the very short anæsthesia, about 15 seconds in a child and 30 seconds in an adult from nitrous oxide alone—from 10 to 14 seconds longer when

combined with oxygen. This allows no preliminary examination to be made, and requires the operation to be performed with great rapidity. Nor is there time to examine the throat afterwards for tags, etc. Moreover, relaxation of the muscles of the jaw is seldom obtained, so that, to allow of easy and quick introduction of the gag, it is necessary, before beginning the administration, to insert a mouth prop, a thing which children at all events will rarely retain. The apparatus, too, is apt to frighten children, while, owing to the increased turgidity of the veins of the neck, hæmorrhage is usually profuse—a factor regarded by some as important in determining the amount of after shock. Unless for getting through a large number of cases in a short time, or where adenoids alone are to be removed, especially in older children or adults, nitrous oxide is not to be recommended.

Ethyl Chloride has come to be much used during the past few years, occupying a position between nitrous oxide and chloroform, giving a longer anæsthesia than the former and being looked upon as much safer than the latter. The induction, with a dose of 2 or 3 cubic centimetres for children and 5 or 7 c.c. for adults by means of a closed inhaler with an accurately fitting face-piece, is generally complete in less than a minute—in about 50 seconds. Children take it quietly as a rule, but some adults give a good deal of trouble by struggling in the early stages, chiefly muscular men and others addicted to the excessive use of alcohol and tobacco; also neurotic women. The usual signs of anæsthesia being complete are slight stertor, the eyeballs fixed and often turned downwards and pupils dilated. The conjunctivæ are sometimes insensitive, but it is not advisable to push the drug to the abolition of this reflex. The available working anæsthesia is from one to one and a half minutes. The recovery is nearly as rapid as the induction. The after-effects vary from none, or some slight giddiness and nausea, to actual vomiting with in some instances faintness or collapse—the latter in some cases supervening several hours after. Ethyl chloride thus gives a distinctly longer time for the operation than nitrous oxide gas, while it is regarded as much safer than chloroform. One unsatisfactory feature of the anæsthesia with this drug is that (as in nitrous oxide anæsthesia) muscular relaxation is seldom obtained. In fact, there frequently occurs clenching of the teeth through spasm of the masseters, rendering it difficult to open the mouth. As in nitrous oxide induction, it is advisable, therefore, at the outset to insert a mouth prop—not necessarily a large one, but one sufficient to allow of the rapid introduction of the blades of a Mason's gag. This is a matter which in children is not always feasible, and in very young children not possible.

Bromide of Ethyl, in use before ethyl chloride, has been very generally displaced by it. Given in doses of a drachm to a drachm

and a half, in much the same way as the chloride, struggling and excitement during induction are uncommon. The anæsthesia is similar as regards symptoms and duration, and unpleasant after-effects rather more common and accompanied by depression. It is looked upon as a cardiac depressant and is liable to decomposition—two factors sufficient to outweigh any advantages which might exist.

Ether alone, or better, preceded by nitrous oxide or chloride of ethyl, may be regarded as the *safest* anæsthetic in the operation for the removal of post-nasal adenoids and tonsils. It may be given in any position—owing to the smart hæmorrhage the erect posture with head well forward may be regarded as the best. Apart from the fright which the apparatus causes in children, the induction with nitrous oxide gas can be carried through without any excitement or struggling, and a working anæsthesia of from two to five minutes, according to the amount of ether given, can be obtained. The chief drawbacks are the hypersecretion of mucus and the congestion of the vessels of the neck and throat with the resultant increased hæmorrhage, which both add to the difficulty, and thus to the danger of the operation. The after-effects are similar to those of chloroform—the sickness perhaps occurring in a larger proportion of cases, but being as a rule more transient.

Chloroform, though admittedly the most dangerous of all those anæsthetics mentioned, possesses, nevertheless, so many advantages over them as to almost outweigh the increased risk; and, with the precautions and procedure already described, viz.: the head slightly below the level of the body and the free use of ether poured on the towel or mask during the induction, or the combination all through with a proportion of ether, it is doubtful whether, owing to the manner in which it is possible then to conduct the operation, there is not after all less danger with chloroform in these naso-pharyngeal operations. When the patient is sufficiently anæsthetised—it is preferable not to abolish the conjunctival reflex—there is time to examine the throat and nares, remove each tonsil and the adenoids, applying pressure by means of a swab on a stick between each step, during which a little more chloroform may be given, if necessary, and to examine afterwards for tags. There is no undue haste on the part of the operator, no engorgement of the vessels of the neck, and thus less hæmorrhage—there is muscular relaxation allowing the easy introduction of the gag (without the necessity of first having had a mouth prop inserted) and no apparatus to frighten the child.

2. LOCAL ANÆSTHESIA.

Various solutions have been used for instilling into the ear in order to produce anæsthesia of the tympanic membrane during

operation. Politzer recommends equal parts of cocaine hydrochloride, concentrated carbolic acid and menthol. Gray's solution consists of cocaine hydrochloride 2 parts, aniline oil 10 parts, and absolute alcohol 10 parts. The writer prefers a combination of 4 minims carbolic acid (liquor), 8 grains cocaine hydrochloride, 8 grains menthol, and 80 minims rectified spirit—a few drops to remain inside the ear for 10 minutes.

Neumann of Vienna has, however, originated a much more efficient method of producing anæsthesia of the interior of the ear. By means of a hypodermic syringe Neumann injects under the cutaneo-periosteal lining of the external auditory meatus a few drops of a 1 per cent. solution of cocaine combined with a small quantity of a solution of chloride of adrenalin (1:1000). After careful mopping of the meatus with hydrogen peroxide, followed by syringing with a $\frac{1}{2}$ per cent. solution of lysol, a plug of gauze or cotton wool, soaked in a 5 per cent. solution of carbolic acid, is lightly introduced into the meatus and left there for five minutes. This, besides acting antiseptically, partially anæsthetises the spot at which the injection is to be made. The cocaine-adrenalin solution must be sterile, hence Parke, Davis & Co.'s codrenine is very suitable. This is made up in glass ampullae, each containing 10 minims of a 2 per cent. solution of cocaine hydrochloride to which has been added a few drops of the solution of adrenalin chloride. The syringe, carefully sterilised and warmed, is filled with codrenine heated to 40° C., and the point of the needle is inserted at the postero-superior angle of the meatus, where the cartilaginous portion passes into the bony. This spot is indicated by a whitish wrinkle of skin when a speculum slightly wider than the meatus is inserted. The point of the needle is made to pierce this wrinkle at its postero-superior border and, after a few drops of the fluid have been injected, the needle is thrust still deeper, keeping its point, however, in close contact with the bony surface. The piston of the syringe is then slowly pushed home and, as the solution passes inwards under the periosteum, it causes bulging and blanching of the skin of the roof of the meatus; the bulging, however, soon subsides as absorption takes place. The surgeon must now wait at least ten minutes before commencing the operation. The advantages of this method are (1) an almost bloodless field, and (2) complete anæsthesia, lasting for fully half-an-hour, of the skin lining the meatus and the walls of the tympanum. The pain caused by inserting the needle is in most cases trifling, and any difficulty in carrying out the procedure is overcome by a little practice. The writer can testify that the anæsthesia produced in this way permits of the removal of polypi and granulation tissue, incisions and excisions of the tympanic membrane, and intra-tympanic operations, such as ossiculectomy with removal of the outer wall of the attic, being painlessly and almost

bloodlessly performed. These can be carried out safely with the patient in the sitting posture. When the method is employed for operations upon the mastoid (a Schwartze operation or a radical) two to three syringefuls, each containing 10 minims of a 1 per cent. solution of eucaïne with adrenalin, should be injected and distributed subperiosteally over the mastoid region and the auriculo-mastoid fissure, in addition to the meatal injection of 10 minims of a 1 per cent. solution of cocaine. While by this method it is possible to perform these mastoid operations practically without pain, it is, in the opinion of the writer, preferable to employ a general anæsthetic for such prolonged and difficult operations. This method is not suitable when the operator has to deal with a collection of pus under the periosteum such as squamo-mastoid abscess.

Local anæsthesia is also very usefully employed in operations upon the nasal septum and the inferior turbinated body; the methods of employing it in these cases are described in Chapter VII.

II. REMOVAL OF AURAL POLYPI AND GRANULATION TISSUE.

The safest, simplest and most effective means is by encircling the morbid tissue with a wire loop, as near the root as possible, and then by constriction and traction removing the growth. The instrument frequently used for this purpose is Wilde's snare (Fig. 70), or some modification of it, such as Baber's (Fig. 71).

Wilde's Snare consists of a steel shaft bent near the middle at an obtuse angle. To the outer end is attached an oval ring for the reception of the thumb of the operator. The inner end, for introduction into the ear, has a short canal at each side for the passage of the wire. At the angle of the shaft there are also two canals for the reception of the wire. A moveable

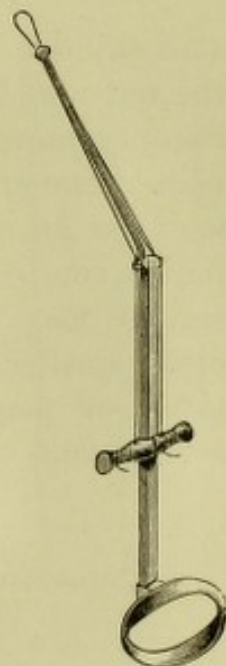


FIG. 70.—Wilde's snare for removing aural polypi.

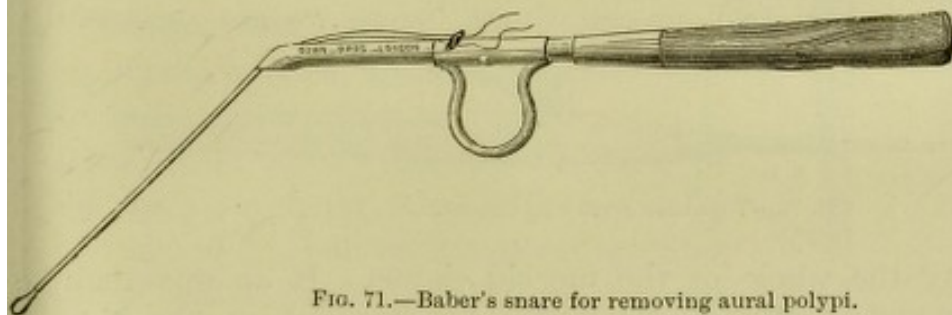


FIG. 71.—Baber's snare for removing aural polypi.

cross-piece perforated by two canals is connected with the outer part of the stem. The end of the wire is first passed through the three canals on the one side, beginning with the cross-piece, and then through the three on the opposite side, beginning at the inner end. A loop of the size desired is then formed by drawing down the two ends of the wire, which should afterwards be fixed by winding them round the cross-piece. For small soft polypi well annealed iron

wire is suitable. If the tissue of the polypus is firm and tough, fine steel wire or thin platinum is necessary. Cat-gut is employed by some, and fine fishing gimp is recommended by Dalby.

Mode of Operating. To diminish the risk of septic absorption by the freshly cut surfaces, the ear should be syringed and treated antiseptically for several days before. In using Wilde's snare, where the polypus is so large as to protrude from the outer orifice of the

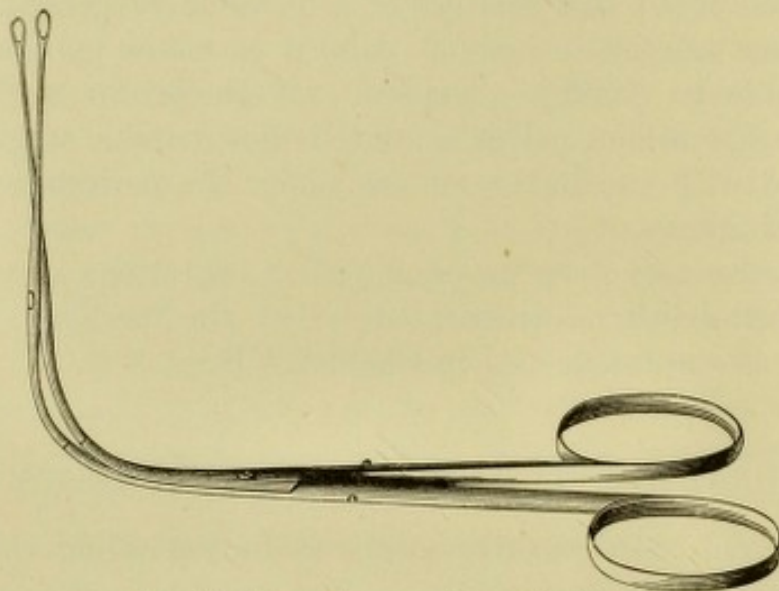


FIG. 72.—Forceps for removing small polypi.

ear, the affected side is turned towards good light, and by means of a probe the length of the polypus and, if possible, the position of its attachment are ascertained. The snare is then held by means of the thumb in the ring, while the index and ring fingers support the cross-piece.

The wire loop, bent at a suitable angle to the stem of the instrument, is made to encircle the outer end of the growth, and then gently insinuated, by a kind of rotatory movement, as far as is possible without exciting very great pain. The cross-bar is then firmly pressed down towards the thumb, and the growth is completely divided, or tightly constricted and pulled out by the root. When we get access to the deep part of the ear, we may find not only a portion of the large polypus, but also other smaller ones and granulation tissue. If an anæsthetic is not given we may find it necessary to use the snare or suitable forceps at intervals of a day or two, several times, before we are successful



FIG. 73.—Toynbee's lever ring forceps.

in clearing away the whole of the morbid tissue. If an anæsthetic is given the whole of the growths may be removed at the time, followed by the introduction of a strip of gauze. The bleeding is sometimes considerable, but is usually quickly staunched by pressure with gauze or a cotton plug.

When the polypus or granulation tissue does not appear at the outer end of the meatus, the operation must be done with the aid of

the forehead mirror and as wide a speculum as possible. The position of the morbid tissue and its place of attachment should be first determined with the aid of a probe, and the loop is made to encircle it with the greatest gentleness possible. In the removal of small soft growths, or the remains of larger ones, such forceps as are represented in Figs. 72 and 73 are very useful. For young children an anæsthetic is usually necessary; for adults some form of local anæsthesia (see p. 105) may be employed. For the after-treatment of polypi, see Chapter XII.

III. INCISION OF THE TYMPANIC MEMBRANE (MYRINGODECTOMY).

Instruments. Politzer uses a lance-shaped, two-edged needle (Fig. 74, *a*) about two and a half inches in length, connected by means of a small screw with a handle, the arrangement being such that the incision in the tympanic membrane may be made either in a vertical or horizontal direction. Gruber employed a narrow, curved, sharp-pointed blade (Fig. 74, *e*), which can also be fitted to the handle to suit any direction in which the incision may be required. In these instruments the blade or needle is connected to the handle at such an angle that the hand of the operator does not interfere with his view of the parts in the ear. The writer prefers the small narrow blade of Gruber, because it takes up rather less space than the lance-shaped instrument.

Mode of Operating. The canal of the ear should first be cleansed carefully with an antiseptic solution and dried. If it is a case of serous or mucous collection in the tympanic cavity, the middle ear should be inflated by Politzer's method in order to increase as far as possible the distance between the tympanic membrane and the inner wall of the tympanum. As wide a speculum as the canal of the ear will accommodate is introduced, and the interior is well illuminated by means of a mirror attached to the head. The patient's head is

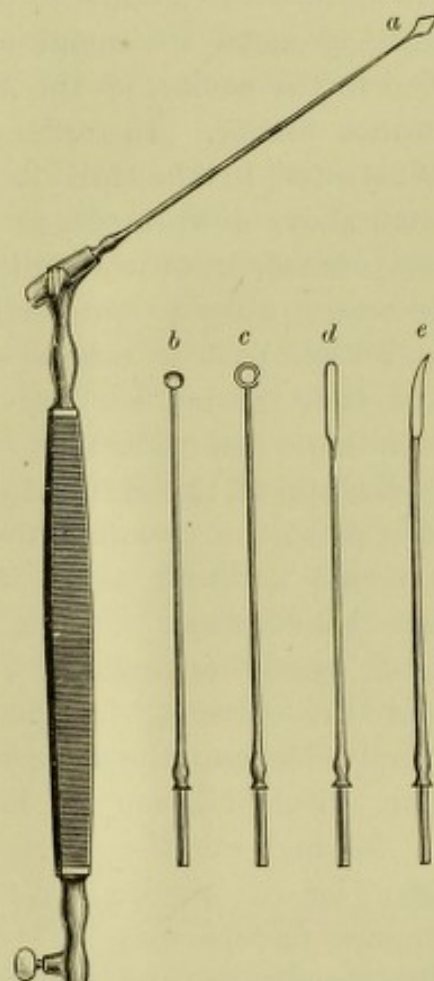


FIG. 74.—Various instruments suitable for the same handle—*a*, lance-shaped needle for paracentesis; *b*, sharp spoon; *c*, ring-knife for removing polypi; *d*, knife for cutting the posterior fold; *e*, curved blade for paracentesis.

firmly held by an assistant, while both patient and operator are seated. The auricle and speculum are supported as in the examination of the ear. The blade is passed through the speculum, and, when the point is close to the part of the membrane to be incised, the membrane is quickly pierced, and the opening at once enlarged to from three to four millimetres in length. If there be a distinct bulging of a particular part of the membrane, that is to be selected as the place for the incision. When there is no special bulging, a point midway between the umbo and the postero-inferior part of the periphery of the membrane is probably the most accessible part, while here also the membrane is pretty well removed from the inner wall of the tympanum. The antero-inferior quadrant of the membrane is also a suitable place for the incision, unless, as we sometimes find, the projection of the anterior osseous wall of the meatus prevents access to this part of the membrane. The operator, if inexperienced, may fail from over-timidity to penetrate all the layers of the membrane, or he may make too small an opening. In the latter case the secretion in the cavity of the tympanum, especially if tough and stringy, cannot escape. In order that the membrane may be completely penetrated in the full length of the incision, he must, in cutting from above downwards, or from behind forwards, push the point of the instrument inwards while making the incision. This is required because, owing to the oblique position of the membrane, the upper and back part is nearer the hand of the operator than the lower and front part. The galvanic cautery is also used to perforate the membrane (see p. 89).

Escape of the Exudation. If the exudation in the middle ear be thin or serous it will immediately flow through the opening into the external auditory canal, from which it may be wiped away with absorbent cotton. If, on the other hand, it be thick and viscid, a small pearly-looking ball is usually seen protruding from the opening, and the patient—by performing Valsalva's experiment, or even simply blowing the nose—is frequently able to assist in its expulsion. But inflation by Politzer's method is often necessary to help in forcing out the secretion, while suction with Siegle's speculum may be of service. When the secretion consists of very viscid mucus, forceps may be required to pull it out of the opening in the membrane, and the mucus is sometimes thus drawn out in the form of a long string.

Incision of the tympanic membrane is usually attended by pain, sharp but momentary, unless there is distinct bulging of the membrane from secretion, when the operation is usually less painful. The mixture of carbolic acid, cocaine, menthol and spirit (see p. 106), instilled into the ear ten minutes before operation, usually dulls the pain, and is

an antiseptic. Neumann's local anæsthesia is more effective (see p. 106). There is usually very little bleeding, and the wound heals quickly. In twenty-four hours a black streak of dried blood marks the site of the incision, which has generally healed by that time. Inflammatory complications are rare, but it is a judicious precaution for the patient to rest in the house for the remainder of the day after the operation.

Cases suitable for Incision. This operation is practised in two classes of cases: 1st, when there is purulent, mucous or serous exudation in the cavity of the tympanum, or in the interstices of the tympanic membrane; and, 2nd, cases in which the membrane is thickened, adherent, atrophied, or indrawn.

The propriety of the operation in the former class of cases cannot be gainsaid, as it is based on ordinary surgical principles. With an acute purulent collection in the middle ear, where the tympanic membrane has become thickened and more unyielding in consequence of previous disease, the operation is eminently called for. In such a case timely incision of the membrane may prevent the extension of the disease to the mastoid cells, labyrinth, or even to the meninges. In mucous or serous exudations in the middle ear, the operation is indicated (*a*) when the quantity is so great as to cause a distinct saccular bulging of the membrane, especially at its posterior part, and (*b*) when inflation only produces a temporarily good effect. Here the operation may avert permanent structural changes in the tympanum.

In the second class of cases the operation is undertaken in order (1) to make a permanent opening in a thickened membrane (here a portion of the membrane should be cut out), (2) to incise the posterior fold or an atrophic part, (3) to separate adhesions or bands binding the membrane to adjacent parts, or (4) as a preliminary to the cutting of the tendon of the tensor tympani muscle. There is no doubt that the operation of incising the membrane is of greatest value in fluid exudations in the middle ear; and, in these cases, repeated inflation by Politzer's method is usually required for some time afterwards.

IV. INTRA-TYMPANIC OPERATIONS.

1. *EXTRACTION OF THE MALLEUS AND INCUS (OSSICULECTOMY).*

This operation is mainly undertaken for the cure of chronic purulent middle ear disease, when the seat of the disease is in the attic of the tympanum, usually with perforation of the membrana flaccida. If the hearing be fairly good, as it frequently is in these cases, we must explain to the patient the possibility of its being damaged by the operation; in the event of the opposite ear being deaf this consideration would be very important. The operation

is most indicated when the ossicula are in a state of caries; but the absence of this as tested with a probe (Fig. 75) should not deter us, if there are other indications, such as the presence of cholesteatomatous masses or persistent sprouting of granulation tissue from the perforation, with the failure of other modes of treatment. Persistent giddiness and headaches strengthen the indications for the operation.



FIG. 75.—Attic probe.

Mode of Operating. The best position is either the lying posture with the head pretty well raised, or the sitting posture with the head firmly supported. The ear should have been treated previously for some time with antiseptics, and the operation should be preceded by careful antiseptic precautions. Local anaesthesia (see p. 106) does very well, and is compatible with the sitting posture. If a general anaesthetic is preferred, adrenalin applied to the parts before the operation materially checks the bleeding; chloroform necessitates the lying posture. If the greater part of the membrane remains, it is divided with a suitable knife (Fig. 76, *a*) from each side of the short process

of the malleus along the periphery so as to include fully the upper half; the membrane is then cut across so as to include the whole of the handle of the malleus. By means of a spade-shaped knife (Fig. 76, *c*) the head of the malleus is separated from its connection, and with suitable forceps (Sexton's) (Fig. 77) the malleus is brought away, the traction being downwards and then outwards. The small oval ring knife of Delstanche may be used; this encircles the handle of the malleus and is pushed up so as to cut the tendon of the tensor tympani muscle, then, by pulling outwards, the malleus is luxated and extracted with Sexton's forceps. If we are dealing with a wide meatus, the outer wall of the attic can be removed with a suitable chisel (see p. 129), the attic being first packed with gauze to protect the deeper parts from the chisel. Sometimes it is impossible to remove the incus owing

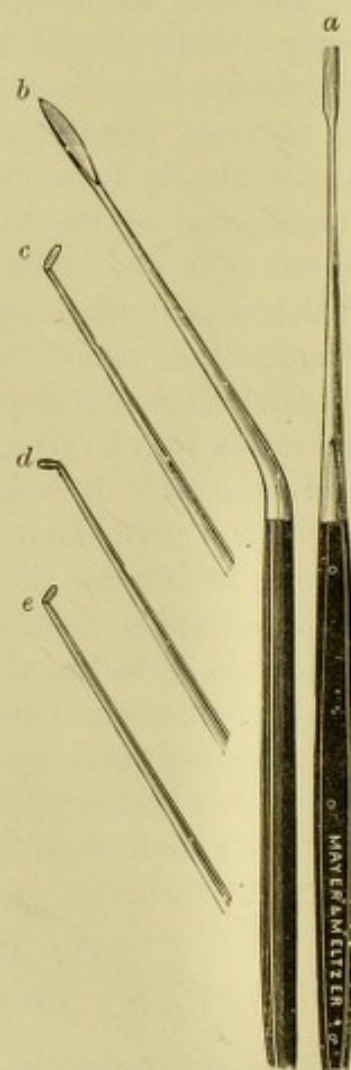


FIG. 76.—Sexton's knives for excision of the ossicles: *a* and *b*, knives for excising membrane; *c*, spade-shaped knife; *d* and *e*, knives for separating the incus from the stapes.

to its being in the antro-tympanic passage out of reach, but it should be removed if possible with the incus hook (Figs. 78 and 79) introduced into the upper tympanic space; the hook with the concave surface directed backwards is turned backwards and downwards, usually bringing the incus with it. A number of hooks of different sizes are required for the different dimensions of the attic.

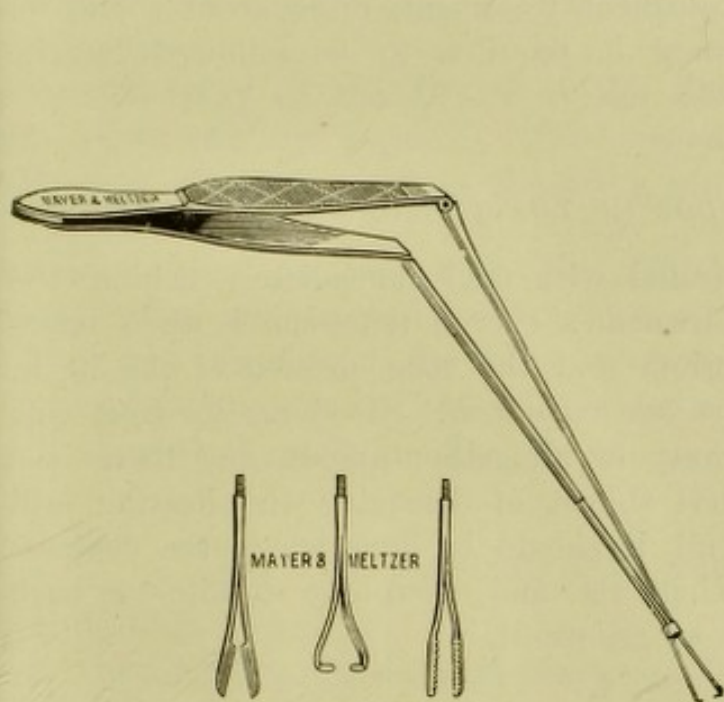


FIG. 77.—Sexton's forceps for extraction of malleus and incus.



FIG. 78.—Ludewig's incus hook.



FIG. 79.—Kretschmann's incus spoon.

Kretschmann's spoons (Fig. 79), used in a similar manner, are preferred by some for removing the incus. If the incus is still connected to the stapes, they should first be separated with a suitable knife (Fig. 76, *d* and *e*). The bleeding may be staunched by the pressure of cotton wool on a cotton-holder. Iodoform and boracic powder (1 to 4) should be insufflated, and a narrow strip of gauze introduced so as to fill the meatus; a pad of sterilized gauze should be placed over the auricle. If no untoward symptom occur, the ear need not be disturbed for two days; then the gauze should be removed, the ear carefully mopped and fresh gauze introduced. It is necessary, however, after a week or two, if the discharge continue, to begin the use of the attic syringe as described at page 81. Although this operation properly performed is attended by very little risk, rest in bed for a few days afterwards is desirable.

Stacke's Method. If the meatus be very narrow Stacke's method may be necessary. By this method the outer surface of the tympanic membrane is exposed by making a long incision behind the auricle, raising the tissues in front, separating the membranous part of the meatus from the bone and drawing the auricle with the

cartilaginous part of the meatus downwards and forwards; this is a part of the radical mastoid operation (see p. 126). The tympanic membrane being thus made accessible, the external ossicles and the outer wall of the attic are removed as already described. Stacke sometimes goes on at the same time to the opening of the antrum from the meatus (see p. 133). Only in a minority of cases does ossiculectomy, with the subsequent treatment, bring about a cure of the discharge; in most cases it requires to be followed by the radical mastoid operation.

2. *DIVISION OF THE TENDON OF THE TENSOR TYMPANI MUSCLE.*

An incision is made parallel with, and immediately behind, the handle of the malleus. Hartmann's curved tenotome is then introduced between the manubrium and the long process of the incus, and the tendon is cut *from below upwards*. Good results from this operation are either temporary or altogether absent, and there is a possibility, as experience has shown, of damaging the hearing still further. If attempted at all, it should be done where the deafness is already of an extreme character, and where the tinnitus is such as to demand every effort to relieve it.

3. *EXCISION OF THE TYMPANIC MEMBRANE AND REMOVAL OF THE MALLEUS AND INCUS.*

This is sometimes undertaken for the relief of chronic non-exudative catarrh, progressive in character and attended by painful subjective sounds and giddiness. For this object Lucæ and Sexton are its most ardent advocates. These eminent authorities report somewhat favourably of it, but the general impression amongst aural surgeons is that this operation for such conditions is only on its trial, and we have not yet had a sufficient number of results to justify anything like its general adoption. It is certainly not regarded with the same favour as the operation undertaken for the purulent cases just referred to. The tympanic membrane should be completely separated at its peripheral attachment with exception of the malleus connection. The tendon of the tensor tympani, and the articulation of the stapes and the incus are then severed by a suitable knife (Fig. 76, *d* and *e*). By means of forceps (Fig. 77) the malleus is laid hold of at the short process, and pulled downwards and outwards along with, in some cases, the incus. Politzer recommends that an aperture in the membrane should be previously made with the galvanic cautery; and if, while this is open, the hearing be improved, the operation might then be undertaken.

4. THE EXTRACTION OF THE STAPES.

Stapedectomy has been advocated by Kessel for ankylosis of the stapes, and the results given by L. Jack, who reports that he has operated with improvement in sixteen cases, are surprisingly good. The experience of others is by no means so favourable, however, and further information is required before its safety or usefulness can be determined.

Synechotomy of the Crura of the Stapes has been suggested and performed by Politzer. This operation is for dividing or separating adhesions between the crura of the stapes and the walls of its niche. He admits that further experimental operations are necessary before deciding upon its usefulness. The description of the operation will be found in the fourth edition of his own work.

The best resumé of the value of intra-tympanic operations in non-purulent affections of the middle ear is to be found in a paper, by Arthur H. Cheate, in *The Practitioner* in 1897.

V. MASTOID OPERATIONS.

1. Wilde's incision.
2. Opening into the vertical mastoid cells for acute mastoiditis—mastoid empyema.
3. The simple antral operation (antrectomy)—the typical Schwartze operation.
4. The radical mastoid operation.

In order to avoid repetition, the descriptions of these mastoid operations have been written in such a way as to render it desirable that they should be read in connection.

1. WILDE'S INCISION.

In acute mastoid periostitis, especially the primary variety, a free incision, made through the swollen infiltrated tissues down to the bone, tends to cut short the inflammatory process with its attendant symptoms, even before the stage of suppuration. This, on account of its having been first recommended by Wilde of Dublin, is usually known as *Wilde's incision*. The hair should be carefully removed from the neighbourhood, and the skin treated as described at p. 117. A strong-bladed scalpel is used; and, if there is distinct fluctuation at any part, that should be chosen for the incision. This may be, especially in the young child, rather above the auricle (squamo-mastoid) than over the mastoid. But if in the adult no fluctuation is found, the best position for the incision is parallel with the

auricle and about a quarter of an inch behind. The cut should extend to from an inch to an inch and a half in length, and the tissues should be severed to the bone, which is sometimes *at a considerable depth*. In an infant there should be less pressure of the knife in case of there being a gap in the bone exposing the dura mater. Should the posterior auricular artery be cut, pressure or torsion will usually suffice to check the hæmorrhage; a ligature is rarely required. Even if there is already a sub-periosteal abscess, with perhaps the bone denuded of periosteum, but no carious aperture, *rapid cessation of the discharge* from the ear and relief of the pain may take place, followed in a short time by a very satisfactory result. After the incision, a drainage tube should be inserted in the opening, or it may be lightly packed with iodoform gauze, in order to prevent premature closing of the wound and recurrence of the disease; antiseptic dressings are applied externally. Some surgeons introduce a few sutures at the time, but delay the tying till the swelling has subsided. If, after a few days, the pain in the mastoid region is not relieved by the incision, and the discharge from the meatus continues as before, we must not hesitate to *perforate the bone* (see p. 117). If, with a purulent collection under the periosteum, there is already an aperture in the cortex (whether acute or chronic), operation on the mastoid cells is required (see p. 117), for the subperiosteal abscess is simply due to the rupture through the cortex of an intra-mastoid abscess. The tendency in recent years has been to open the bone in nearly all cases of mastoid periostitis consequent upon purulent otitis media, yet there is no doubt that the simple incision, when it was practised more frequently than now, had, in a good many cases, quite satisfactory results.

Incision in External Meatus. More rarely a sub-periosteal abscess makes its way to the meatal wall of the mastoid corresponding with the postero-superior wall of the osseous part of the meatus. If there be marked swelling and pain in that situation, incision is indicated. If an opening already exists from which matter escapes when the bulging behind the auricle is pressed upon, an incision may be unnecessary, as by sustained pressure upon the abscess we may bring about complete evacuation and healing.

2. OPENING INTO THE VERTICAL MASTOID CELLS FOR ACUTE MASTOIDITIS—MASTOID EMPYEMA.

Preparations for Operation. Besides the anæsthetist, one assistant, who stands at the head of the table, is required to take charge of the retractors, and another to frequently mop out the cavity in the bone, and remove the chips of bone caused by the chiselling; a nurse may work the dental engine if it is required, and another may hand instruments to the operator or change the burs.

The operation should be performed under rigid antiseptic precautions. After the hair has been shaved from the neighbourhood in the female, and from the corresponding side of the head or the whole head in the male, the skin, including the auricle (especially its depressions), is well washed with soap and hot water, then rubbed with turpentine, followed by rectified spirit, and a piece of lint moistened with a 1 in 40 solution of carbolic acid is kept in contact with the skin for several hours and replaced by a fresh dressing of 1 in 20 carbolic acid an hour before the operation. The instruments are sterilized by boiling, and during the operation they are placed in a 1 in 40 carbolic solution. The ear should also be carefully syringed with a 1 in 30 solution of carbolic acid, dried and packed lightly with a strip of iodoform gauze. A towel pressed out of a 2 per cent. solution of carbolic acid, is wrapped round the head, and another is placed over the neck; one is also laid over a waterproof sheet on the breast of the patient or other convenient place, upon which the pieces of gauze for mopping are laid for ready use. Strong light, reflected from a mirror on the forehead, is necessary, especially when working in the depth of the bone.



FIG. 80.—Raspatory for mastoid operations.

Exposing the Bone. After the patient has been anæsthetized by chloroform or ether (preferably the former), the head being placed on a firm pillow with the affected ear uppermost, the auricle is held forward by an assistant, while an incision is made through the soft parts immediately behind, and parallel to the auricle, from one to two inches so as to extend to half an inch above the linea temporalis, the soft parts being completely divided down through the periosteum to the bone. To control the posterior auricular artery, the finger is



FIG. 81.—Retractor for mastoid operation.

pressed on the bone near the tip of the mastoid, from which the incision is carried upwards, if on the left side. If on the right side, it is more convenient to begin the incision above, extending it downwards. When there is œdematous swelling over the bone the incision should be still longer, or it may be necessary to make a second incision backwards from the middle of the first. If pus is found between the periosteum and the bone it should be carefully cleared away, and any unhealthy granulation tissue on the inner surface of periosteum should be thoroughly removed by curetting. The soft

half an inch below the linea temporalis, or three-quarters of an inch above the apex (Fig. 90, B). The gouge, held at an angle of 45 degrees to the surface, is worked with a heavy hammer made of soft copper (Fig. 84)

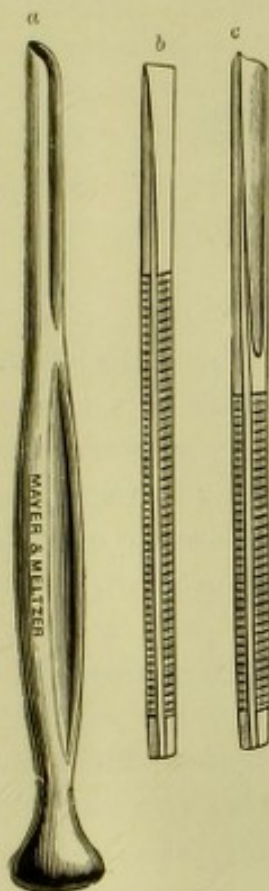


FIG. 83.—Gouge and chisels for mastoid operations; a, gouge; b, straight chisel; c, curved chisel.

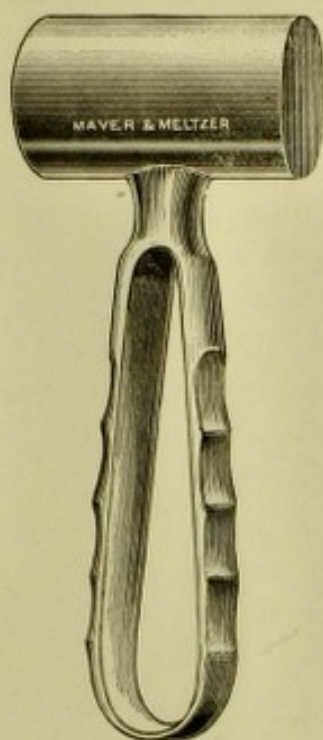


FIG. 84.—Mallet for mastoid operations.

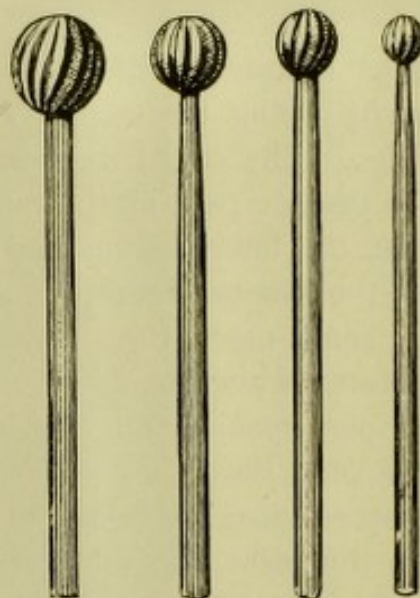


FIG. 85.—Burs used in perforating the mastoid.

inwards, forwards and downwards. As in these acute cases the pus is frequently near the surface, a few taps of the hammer are usually followed by the appearance of pus escaping rapidly as if under pressure; this should be quickly mopped up with gauze sponges.

The dental bur is preferred by some surgeons to the chisel, while others limit its use to certain stages of the mastoid operation. Sir Wm. Macewen first drew attention to the globular dental bur (Fig. 85) which he believes to be safer and more satisfactory than the chisel and hammer. The burs should be very hard and sharp, and those made at White's Dental Manufactory, Philadelphia, are at present the best. A dental engine of considerable power, either worked with the hand or foot, or with an electric motor (Ballance and Milligan) is required. The hand-piece is held like a pen and the lateral part of the bur is applied to the bone, which, as the bur rapidly rotates, is removed as a powder. To prevent excessive heat from developing, as well as to allow of inspection of the parts, the bur should be momentarily removed every few seconds. While the bur is very useful at certain stages of the mastoid operation, as will be pointed out further on, the writer does not now limit himself exclusively to it, but prefers the chisel and hammer for the work of excavating the bone, reserving the bur for special parts of the operation.

The Mastoid Cavity. The opening should now be enlarged as far as is necessary with a Volkmann's spoon (Fig. 86) or bone forceps (Fig. 87), and the fungoid looking granulation tissue often present in

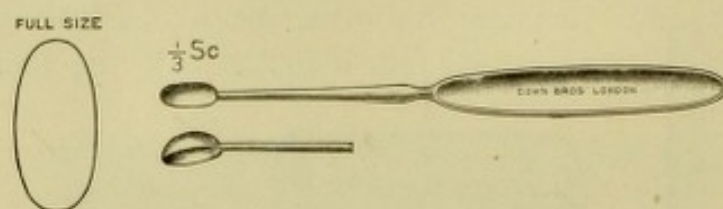


FIG. 86.—Volkmann's spoon (oval).

great quantity with cario-necrotic debris cleared out, the walls of the cavity being thoroughly scraped so as to remove all the soft carious bone. The cavity remaining may be very large, involving sometimes the greater part of the mastoid process. It is important to remember that the lateral sinus and dura mater behind may be already exposed by the disease, requiring much caution in the use of the sharp spoon. In some cases the disease will be found, even after only a week's illness, extending down not only as far as the apex but through a carious opening on the inner aspect of the apex into the digastric groove, "Bezold's abscess," when the pus usually burrows under the deep cervical fascia in the neck, causing a large, firm, brawny swelling. In this case the apex should be resected, care being taken not to

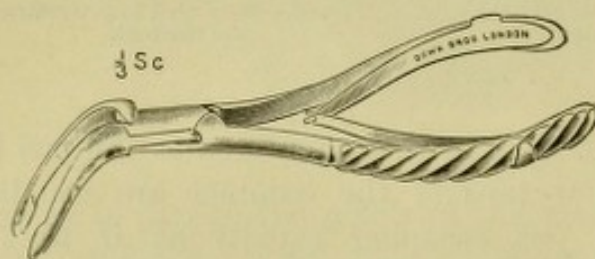


FIG. 87.—Bone forceps for mastoid operations.

cut through the sterno-mastoid muscle, and a counter opening efficient for drainage is required lower down in the neck. The clearing out of the cavity is attended by considerable hæmorrhage from the granulation tissue and bone, but pressure with gauze

will usually staunch it sufficiently. If the case is one of osteomyelitis or tuberculous disease, extensive necrosis of the mastoid cortex and of the surrounding bone over the dura mater may be found, and the soft necrotic bone should as far as possible be carefully removed with bone forceps, with due regard to the anatomical peculiarities in the young child.

If, as is often the case, there seem to be no communication between the abscess cavity and the mastoid antrum, the intervening bone being firm, as tested by a probe, it is well not to open into the antrum. Irrigation with a 2 per cent. solution of carbolic acid should be employed, followed by careful mopping with gauze, the walls of the cavity being then dusted with iodoform and boracic powder, and the cavity

lightly packed with strips of iodoform gauze (Fig. 88). The external wound may be shortened by a stitch or two at the top and bottom, and if no complication arises the packing need not be removed for five or six days; the packing should be softened with peroxide of hydrogen before removal. Afterwards, the cavity is mopped and lightly packed every day or two with iodoform or sterilized gauze, the meatus being also occupied with gauze, until the wound is filled with healthy granulation tissue and closed; if the granulating process is too active, and secretion excessive, antiseptic syringing may be necessary, with the application

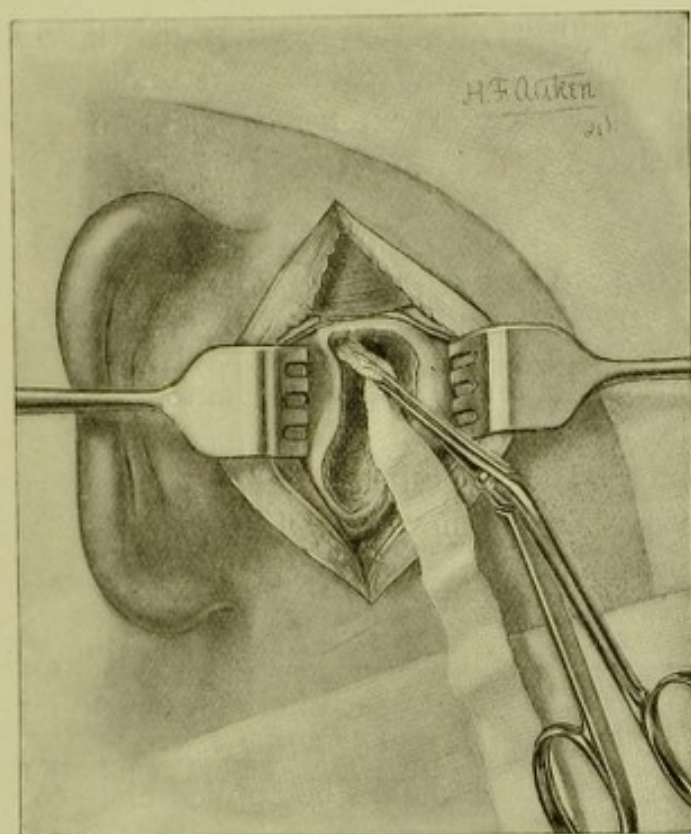


FIG. 88.—Inserting the gauze packing into the mastoid cavity (Barnhill-Wales).

of a bead of nitrate of silver. The closure is usually complete in from six weeks to three months. The after treatment may be reduced to two or three weeks by the use of Moorhof's method of iodoform bone plugging, a week after the operation. For the success of this method it is essential that all disease be thoroughly removed at the operation, and this unfortunately we cannot always be assured of. Some operators do not pack the cavity, but allow it to fill with blood clot, and immediately suture the edges of the wound together. It is claimed that by this means the healing is greatly expedited, from the organization of the blood clot, but this is not a method to be recommended. The operation has usually a remarkably good effect, the discharge from the ear, previously profuse, ceasing in a few days, with disappearance of the pain and ultimately with marked improvement or even restoration of the hearing.

Opening Antral Cavity. If careful probing shows a softened condition, with perhaps granulation tissue in the direction of the antrum, that is, above and in front, a narrow curette (Fig. 89) should be cautiously used to open and widen the connection with the antrum, which should be carefully curetted with a Volkmann's spoon and



FIG. 89.—Small curette for mastoid operations.

freed from pus and granulation tissue, then lightly packed with strips of gauze, followed by the packing of the lower and more external cavity. The tympanic cavity must not be interfered with. With indications, however, of extensive antral disease the following operation should be carried out.

3. *THE SIMPLE ANTRAL OPERATION (ANTRECTOMY)—THE TYPICAL SCHWARTZE OPERATION.*

By this operation the antrum is opened into, its outer wall removed and a communication made with the tympanic cavity. The preparations and the method of exposing the bone are the same as in the previous operation. Here, however, the incision should be carried further upwards and forwards so as to allow of the superior wall of the bony meatus being clearly exposed.

The Chiselling of the Bone. A gouge (Fig. 83, *c*) is applied just below the linea temporalis (supra-mastoid ridge, posterior root of zygoma), slightly behind and below the level of the roof of the meatus. If this ridge is indistinct, the chisel should be applied close to the junction of the mastoid surface with the meatus, just behind the level of the roof of the meatus; here is the so-called supra-meatal triangle. This is formed by the posterior root of the zygoma above, the postero-superior segment of the external meatus, and a perpendicular line, passing through the hindermost part of the edge of the canal, joining them (Fig. 90). In the triangle will often be found a small bony projection—the supra-meatal spine—behind which is the supra-meatal fossa (Fig. 82), corresponding with a point a little above the floor of the antrum. If the supra-meatal spine is present the cutting edge of the gouge should be applied slightly behind it directing the instrument at first inwards, forwards and downwards, working always towards the posterior wall of the meatus; the external opening should be widened in a direction downwards, and, as the surgeon penetrates more deeply, smaller sized chisels are employed.

Situation of the Antrum. The depth of the antrum varies very much. In young children it is usually quite superficial and higher

up, rather above the meatus than behind, and easily reached. In the adult, in the normal condition, the antral cavity should extend out as far as the middle of the meatus, but when enlarged by disease it may be found much nearer the surface. On the other hand, it is often very deeply placed, even to the extent of three-fourths of an inch, and, when reached, it may be very small; it is even occasionally obliterated. When great depth is associated

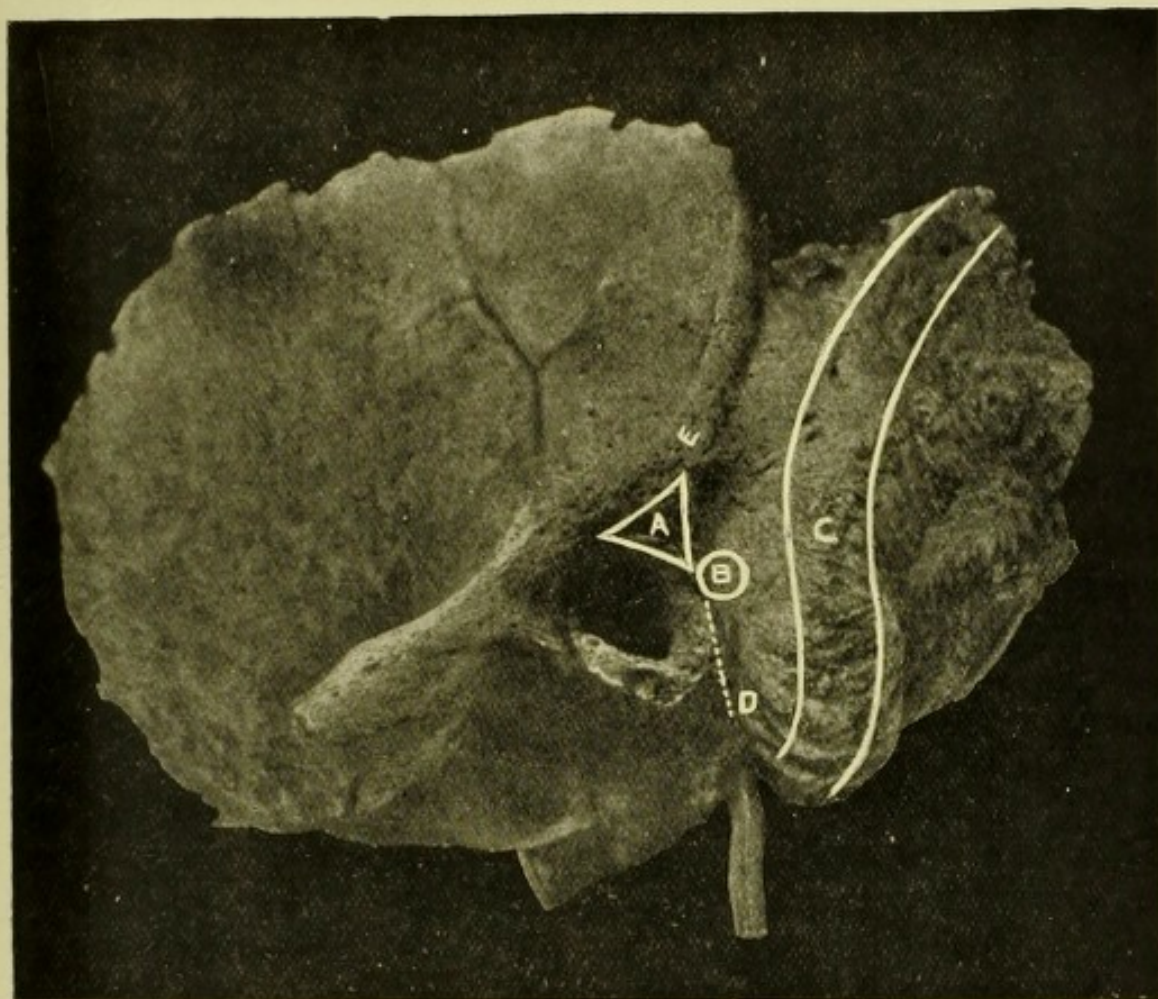


FIG. 90.—Temporal bone, showing, A, supra-meatal triangle, from the posterior base of which is the safest position for perforating the mastoid in order to open the antrum; B, the situation for perforating in acute purulent formations in the *vertical* mastoid cells; C, shows the commonest situation of the sigmoid sinus; D, the dotted line above marks the situation, about an inch inwards, of the facial nerve; E, the posterior root of the zygomatic process, or supra-mastoid ridge, corresponding with the floor of the middle cranial fossa.

with eburnated ivory bone from sclerosis, the task is a somewhat difficult one, and great care must be taken. The gouge should be sharp-edged, the field of the operation kept clear of blood and chips of bone, while good light should be reflected into the cavity, and frequent use made of the exploring probe and small curette. If, in such cases, the sigmoid sinus is far forward and close to the posterior wall of the meatus (Fig. 91) it may be impossible to avoid exposing it. The antrum is sometimes surprisingly *high up*, and we may be in fear of entering the middle cranial fossa. Likewise

in brachycephalic skulls, where the floor of the middle fossa is low down, there is considerable danger of injuring the dura mater, which may indeed be already exposed by the disease. Experience, however,

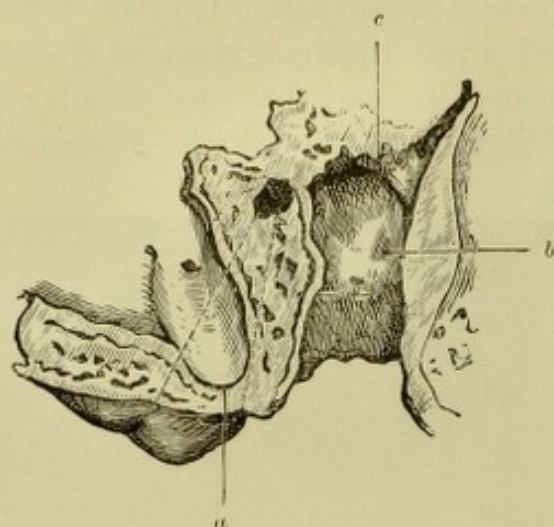


FIG. 91. - Horizontal section through external meatus and mastoid process, showing the sigmoid sinus near to the surface, and close to the posterior wall of the external meatus. (Politzer.) *a*, Sigmoid sinus; *b*, floor of the meatus; *c*, cavity of tympanum.

has shown that the mere exposure of the dura mater or sinus (Fig. 92) need not be followed by serious results, care being taken that in the subsequent stage of the operation the exposed part is not injured. Even if the wall of the sinus is perforated with the chisel, which can be avoided with ordinary care, while there is a great gush of blood, the application of plenty of gauze with pressure will usually stop it; and a serious result does not necessarily follow. To mistake the middle fossa of the cranium, however, for

the antrum would be a grave matter in the event of a chisel or gouge penetrating the dura mater, though even this would not be necessarily fatal. If the operator come upon a greyish membrane, and be in doubt as to whether it is dura mater or a pyogenic membrane lining the antrum, he must be very careful, before using a curette, to make sure, by further exposure of the membrane downwards and the careful use of the probe, that he is not dealing with the dura mater.

Treatment of the Antral Cavity. When the antrum has been reached and opened, the surgeon, by the use of the chisel, bur, or sharp spoon, enlarges the opening in all directions, removing the whole outer wall and overhanging ledges. Any pus, granulation tissue, cholesteatomatous masses, or osseous sequestra or debris which may be found, are carefully cleared away. Afterwards, the walls should be scrutinized above, behind and below, and all softened or diseased bone removed with the curette or sharp spoon. The bur is here useful for bevelling the edges of the bone and smoothing away projections and irregularities. If we are dealing with a case of cholesteatomata, the free use of the bur to the walls of the antrum is desirable in order to remove the membrane or "matrix," and eradicate the parts where epithelium seems to come out of the bony tissue. Every corner and recess should be searched, with the aid of good light, for diseased bone or fistulous orifices leading, it may be, to the lateral sinus behind or the dura mater above. When such orifices are found in the posterior wall of the antrum, and especially if the symptoms point to involvement of the lateral

sinus, they should be followed up as far as the sigmoid groove, when pus and granulation tissue may be found external to the sinus, or the latter may be found thrombosed. If carious erosions or fistulous orifices are found in the roof of the antrum, the dura mater should be uncovered in case an extra-dural abscess should exist in that situation. It is important to remember, however, that, both at the sinus and the roof, an extra-dural abscess may exist without a carious aperture.

We must now make sure that the passage from the antrum to the upper part of the tympanum (aditus ad antrum) is clear,

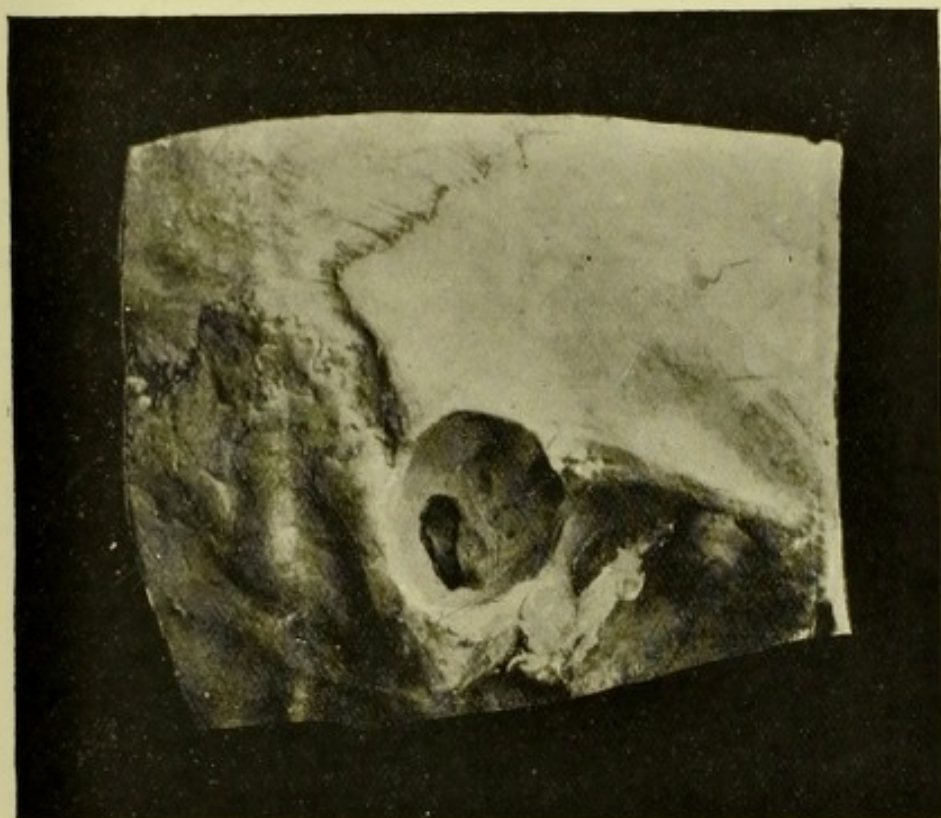


FIG. 92.—Temporal bone, showing large opening made with bur and dental engine, leading into antrum and attic, with two branch openings; the one behind exposed the sigmoid sinus, and the other, further in, exposed the dura mater over the roof of the antrum.

so that we are able, with a cannula attached to a syringe, to send a stream of antiseptic solution into the tympanum, and thence through the perforation into the meatus. At the subsequent dressings it is important that this passage should, by means of the curette or cauterization with chromic acid, be kept clear of granulation tissue or other obstruction so as to admit of the washing out process being carried out at each dressing. After the antral cavity has been thoroughly dealt with, as described, and irrigated with a 2 per cent. solution of carbolic acid, the walls are dried with gauze, and the cavity packed with iodoform gauze. The external wound may be shortened by a stitch or two. The external dressings are

the same as in the previous operation. The packing should be removed after three or four days and the cavity irrigated with an antiseptic solution, which is also syringed through the antro-tympanic passage so that it escapes by the meatus. This is done daily until the discharge from the meatus has ceased, after which the cavity behind is allowed to fill up and close.

This operation is insufficient in most cases of chronic purulent disease, as in these there is usually disease in the antro-tympanic passage and tympanum, especially the attic, such as caries of the walls or ossicles, granulation tissue or desquamative matter, which cannot of course be efficiently dealt with by this operation, and requires the radical mastoid operation. It is therefore generally limited to the more acute cases, although Schwartze held it to be quite sufficient in certain cases of chronic disease, such as those in which the perforation is not at the postero-superior periphery, or where there is no evidence of the presence of cholesteatomata, or disease of the attic. Its advantages are that it is a less formidable operation than the radical mastoid, and that there is less likelihood of injuring the hearing, especially when the ossicles are intact.

Heath's Modification. In Heath's modification the antrum is first opened into and cleared out pretty much as has been described. In addition, however, he removes the posterior wall of the osseous meatus as far as close to the tympanic ring; he may also include part of the roof and floor of the meatus, but he saves the "bridge" and the ossicles. By means of a cannula, with an air bag, he blows air forcibly into the antral end of the aditus, so as to blow through the tympanum and perforation, afterwards forcing, in the same direction, an antiseptic solution followed by an air current to dry the interior. Flaps are formed from the membranous part of the meatus, as in the radical mastoid operation. The wound is at once sutured behind, and a wide indiarubber tube is placed in the meatus for drainage, but no packing. The aditus and tympanum are regularly cleared out with the cannula from the antral direction as at the operation. Heath believes that in chronic purulent ear disease, the essential seat of the mischief is nearly always in the antrum, and when that cavity is efficiently dealt with by operation, the aditus and attic readily recover. He reports very favourably of the results of this operation, especially of its effects upon the hearing.

4. *THE RADICAL MASTOID OPERATION—SCHWARTZE-KÜSTER-STACKE OPERATION.*

In most cases of chronic purulent disease Schwartze's operation will prove insufficient. In these the disease usually involves not only the antrum, but also the aditus or antro-tympanic passage, the attic and possibly also the inner wall of the tympanum lower down. In order to expose and render accessible to examination and treatment the whole of these cavities, it is not only necessary to open freely the antrum as already described, but we must also

remove, as completely as possible, the postero-superior wall of the osseous meatus and the outer wall of the attic (Küster and Stacke).

First Stage of the Operation. In this more thorough operation the incision in the soft parts, as described in Schwartz's operation (see p. 122), is prolonged in a semi-circular fashion round the upper part of the auricle so that the roof of the meatus may be well exposed. When the intention is to suture the post-auricular wound immediately after the operation, some operators prefer to make the incision much further back than in Schwartz's operation—as far back as the edge of the hair. The advantage claimed for this is that the anterior flap covers the breach in the mastoid, and the sutured wound, being further back than the septic cavity, is more likely to heal without complication. If there be an old bony cicatrix, the firm adhesion of the periosteum may necessitate its careful dissection from the bone. As the cutting of the fibres of the temporal muscle is usually attended by troublesome bleeding, the incision should extend no deeper than the fascia, the muscle being pushed out of the way with the raspatory. The posterior and superior

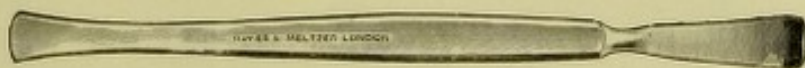


FIG. 93.—Spatula for reflecting meatal lining.

borders of the osseous meatus are well exposed, and the whole of the mastoid surface is thoroughly cleared. The rigid periosteum above the osseous meatus should be cut through horizontally so as to join the vertical incision. With a small spatula (Fig. 93), the periosteal-cutaneous lining of the posterior and superior walls of the bony meatus is separated almost as far as the tympanic membrane, and, along with the auricle, is drawn downwards and forwards upon the anterior wall by means of a small retractor or hook, so as to expose to view the region of the tympanic membrane. Some use a broad strip of gauze instead of a retractor for drawing the membranous meatus forwards and downwards. The gauze is drawn through the meatus backwards forming a loop with which the membranous structures are pulled and retained forwards by an assistant. The gauze has the disadvantage of sometimes tearing the membranous tissue, and partially spoiling it for the flap operation. The skin lining the anterior and inferior walls of the meatus should not be separated.

Removal of the Postero-Superior Bony Wall. The antrum should now be opened and dealt with as described in the Schwartz operation (see p. 122). It will generally be found, in the cases for which the radical mastoid operation is performed, that the bone is hard, dense and without cellular structure, till we reach the antral cavity.

Good sharp-edged gouges are therefore necessary, and great care must be taken in cutting away the sclerosed bone. What remains of the postero-superior wall of the meatus, corresponding with the antero-

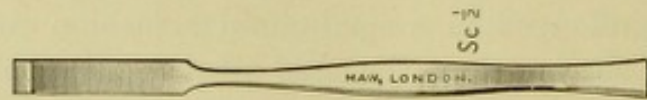


FIG. 94.—Small chisel for opening aditus.

inferior wall of the antrum, is now removed as far as the antro-tympanic passage. This may be done by means of a small chisel (Fig. 94), or bone forceps (Fig. 87), but, as the operator approaches

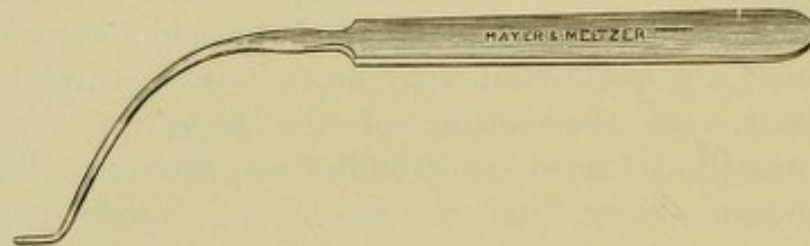


FIG. 95.—Stacke's guard.

the aditus, great care must be taken to avoid injuring the *facial nerve* and the *external semicircular canal*. Stacke's guard (Fig. 95) should, if possible, be introduced through the aditus from the antrum to the tympanum. This is a useful guide to the situation,

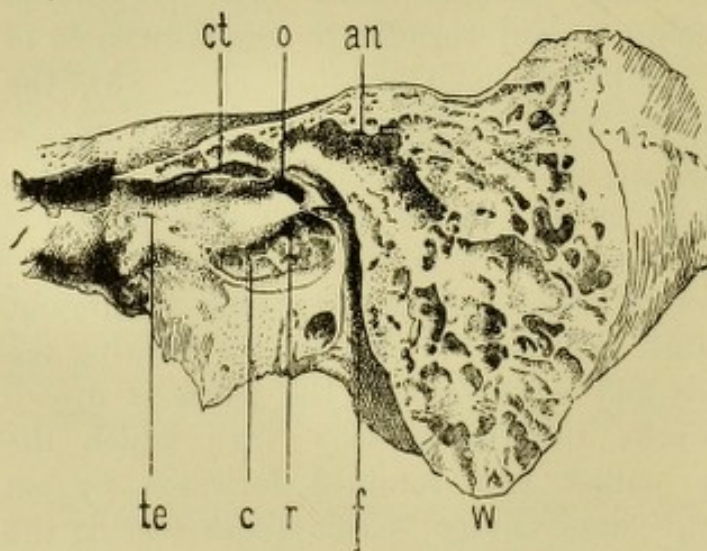


FIG. 96.—Sagittal section through the roof and floor of the tympanic cavity, showing the course of the facial nerve; *te*, osseous Eust. tube; *ct*, canal for tensor tympani muscle; *c*, floor of tympanum; *o*, fenestra ovalis; *r*, fenestra rotunda; *an*, antrum; *f*, canal for facial nerve; *w*, mastoid process. (Poltzer.)

and by many surgeons is retained there during the chiselling so as to protect the facial nerve and external semicircular canal. The writer, however, prefers to pack the aditus with a strip of gauze which acts very well as a buffer to the chisel. The external semicircular canal appears as a whitish prominence 3 mm. above and behind the Fallopian canal on the inner wall of the aditus. The facial nerve lies above and behind

the pelvis ovalis in the inner wall and below the floor of the aditus, where it takes a curve downwards and outwards, behind the tympanum (Fig. 96), to the stylo-mastoid foramen. Its injury

may be inevitable when, in the region of the aditus and back wall of the tympanum, the nerve is denuded of bone and embedded in granulation tissue (Fig. 97). In clearing away the granulation tissue in these regions, if the curette is directed downwards and backwards, there is less likelihood of injuring the nerve. While operating in this neighbourhood the corresponding side of the face should be carefully watched so as to detect the slightest twitch, which might indicate danger to the nerve. Facial paralysis, showing itself immediately after the operation, is more serious than that showing itself a day or two afterwards, which generally passes off, being due to inflammation of the neurilemma of the

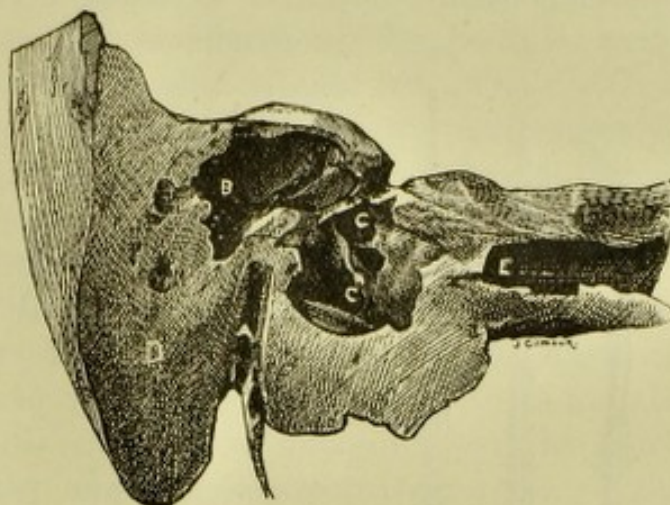


FIG. 97.—Inner half of temporal bone, showing facial nerve denuded of its bony covering above and behind in the tympanic cavity. The nerve was embedded in granulation tissue. A, Lower part of facial nerve; B, antrum; C, carious apertures on inner tympanic wall; behind and above C is the exposed facial nerve; D, mastoid process (sclerosed); E, carotid canal.

nerve, or the pressure of the packing or exudation. When the paralysis shows itself immediately after the operation it is generally due to injury of the nerve inflicted with the chisel or bur, and is more likely to be permanent, although it often improves considerably in the course of time. With the removal of the slender bridge of bone at the inner end of the posterior wall the aditus is freely exposed, and the passage from the tympanum to the antrum opened to view and inspection.

Removal of the Outer Wall of Attic. The outer wall of the attic, which is the inner end of the roof of the osseous meatus, is now carefully and thoroughly removed so as to ensure the clearing out of all products of disease from the attic and tegmen tympani. With



FIG. 98.—Small curved gouge for removing outer wall of attic.

Stacke's guard introduced into the attic, or the interior packed with gauze so as to protect the inner wall (the plan practised by the writer), the ridge of bone is taken away, either by means of a small bevelled chisel (Fig. 94) or curved gouge (Fig. 98) and mallet, or by a small fine bur, and we must not rest contented until the tegmen tympani and the meatal roof are quite continuous, without any

intervening ridge. If present, the malleus and incus should now be removed with the aid of a hook or curette (Fig. 99, *b* and *c*), and the attic and antro-tympanic passage carefully cleared of all products of disease, such as granulation tissue, cholesteatomata, or softened bone; this is done by means of a small curette, and too much care and

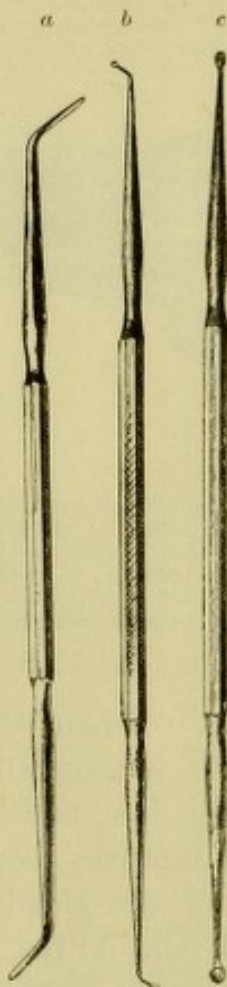


FIG. 99.—*a*, Instrument for separating periosteum of meatus; *b*, hooks for removing contents of attic; *c*, small scoop.

thoroughness cannot be employed in order to ensure this result. Constant mopping and pressure with pieces of sterilized gauze are necessary during this curetting, as the oozing blood constantly obstructs the view.

Inner Tympanic Wall. In order to see the inner tympanic wall, especially its lower and back part, as well as to make a wide connection between the cavity of the antrum and the meatus and tympanum, which is very desirable, the remaining lower part of the posterior wall of the osseous meatus should be scaled down with the bevelled chisel (Fig. 94) as far as is compatible with the safety of the facial nerve. The bulging called "the facial spur" at the inner end should be cautiously removed; and, external to that, the posterior wall may be chiselled away almost as far as the floor. This is carefully done, while the face is watched for twitching. The bony rim, forming the posterior part of the sulcus tympanicus, should be carefully removed. At this stage, in order to secure a better view of the deep parts, an incision may be made in the posterior membranous wall, anticipating the plastic operation (see p. 131), the flaps being pressed upwards and downwards by small retrac-

tors. The lower tympanic cavity, being exposed by the removal of the posterior osseous wall, should be carefully examined for caries or granulation tissue, especially in the region of the sinus tympani, and the recess below the Fallopian canal behind the promontory; the tympanic mouth of the Eustachian tube should also be examined for granulation tissue or caries. It is important to avoid luxation of the stapes, and in using the curette for removing granulation tissue from the inner tympanic wall the movements should be made from behind forwards.

Operating on the Labyrinth. The labyrinthine cavities are in some cases involved in the disease, and if there is any suspicion of this the external semicircular canal should be carefully examined for caries by means of a fine probe or searcher as also the promontory and fenestra ovalis. A carious opening is most frequently found leading

into the external semicircular canal on the inner wall of the aditus, and this is the direction in which the labyrinth is usually opened. With a small chisel or bur the carious aperture is opened forwards and upwards, above the facial aqueduct, into the ampulla of the superior semicircular canal as far as the roof of the vestibule which is removed (superior vestibulotomy). Extending further back to the posterior canal, the whole three canals may be exposed and cleared out. The vestibule may also be opened *below* the Fallopian canal (inferior vestibulotomy), by removing the stapes and cutting away the promontory as far as the fenestra rotunda. By working forwards, the first half-turn of the cochlea, and ultimately, if necessary, the anterior part, including the modiolus, may be dealt with. Both operations (double vestibulotomy) may be carried out when the whole interior of the labyrinth has to be operated upon. Bony sequestra of portions of the labyrinth may be found and removed from the inner tympanic wall, in which there is sometimes a large opening, through which the interior of the labyrinth may be found to contain sequestra, cholesteatomata and granulation tissue; these must be cleared away. These operations are undertaken in order to cure labyrinthine suppuration and remove the great risk of extension of the disease through the internal auditory meatus to the arachnoid space or cerebellum. Great caution requires to be exercised in opening the labyrinth, and, even when there is carious erosion at the external semicircular canal, it is well to see the result of the radical mastoid operation, before proceeding to open out the labyrinth, an operation which should only be undertaken by a very experienced operator. Vestibulotomy has also been practised with encouraging success in non-purulent cases, especially by Lake, for the relief of severe and persistent vertigo.

Meatal Flaps. The membrano-cartilaginous meatus is next dealt with. When replaced in position it forms, in the absence of the bony wall, a soft curtain between the meatus and the cavity behind, thus preventing free drainage and access to the cavity behind, besides tending to stenosis of the meatus. To get rid of this curtain a plastic operation is performed. There are several methods of operating (Fig. 100). Panse's method is to make a horizontal slit with a blunt-pointed bistoury from behind as far outwards as the outer end of the meatus, where two short vertical incisions are made at right angles to the horizontal one;

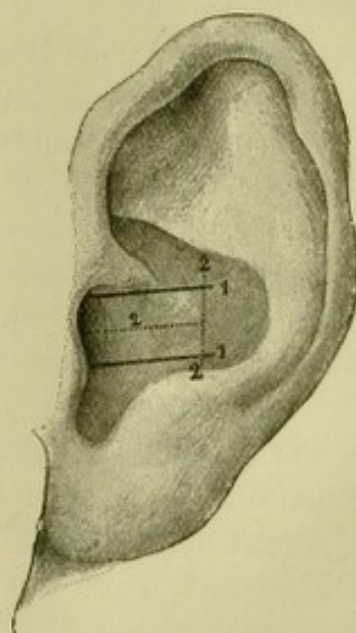


FIG. 100.—Plastic operations on the membrano-cartilaginous meatus: 1, After Körner (solid lines); 2, after Panse (dotted lines).

this allows of two rectangular flaps being formed. The flaps should be thinned as much as possible by dissecting away the cartilage and paring the raw surfaces with scissors, the upper flap being pressed upon the roof, and the lower upon the floor of the cavity behind, and retained there by the pressure of strips of gauze introduced through the widened meatus or fixed with one or two sutures to the adjacent periosteum, the object being to secure a *permanent skin lining* for at least a portion of the artificial cavity. Siebenmann's modification consists in making the outer end of the incision Y-shaped, thus forming three flaps of which the small outer one is cut off. By Körner's plastic operation—only suitable when primary union of the mastoid wound is aimed at—two parallel longitudinal incisions are made in the posterior wall, extending well into the concha where the flap should be 8 mm. broad; the back surface should also be well trimmed with scissors and brought into close apposition with the back wall, being maintained there by a carefully applied strip of gauze. Politzer introduces a wide rubber drainage tube, slit in front, where it lies against the anterior wall, while the posterior surface presses on the flap. Pieces of gauze fill the interior of the tube, and the tube may be omitted at future dressings. Milligan makes an incision along the junction of the roof and the back wall of the membranous meatus to the concha, then curving downwards and parallel to the antihelix, as far as the floor of the meatus. After thorough trimming, the flap is pressed downwards and backwards and kept in position by two silk-worm strands, passed first through the skin of the neck, then through the flap, and back again to a point close to the original point of entry and tied over a rubber tube. Ballance's flap will be referred to further on. There is considerable bleeding from the incisions in making these flaps, which can usually be checked by torsion or pressure with gauze. These various flaps, besides forming a partial covering for the bare bone, become starting places at their edges for the epidermization of the layer of granulation tissue which lines the remaining surfaces of the cavities made by the operation.

Treatment of the Wound behind. Most operators now suture the wound over the mastoid at once, conducting the subsequent treatment through the widened meatus. This is a great boon to the patient, who is relieved of the head bandages in a week or two, instead of wearing them for several months, as is the case if the treatment is conducted through the cavity behind. When, however, a very large cavity has been made behind, extending backwards to the lateral sinus, or when masses of cholesteatoma have been removed from an enlarged antrum, it is safe practice to pack the cavity from behind for several weeks and then suture or allow the wound to heal. Some prefer, in cholesteatomatous cases,

to leave a permanent opening behind. If the operation has extended to the intra-cranial cavity, immediate suturing is undesirable, and a permanent opening may be inevitable. When the surgeon aims at a permanent post-auricular opening, he should pack behind, till the epidermis of the outer mastoid surface is continuous with that lining the cavity; if the packing behind is discontinued too soon, the post-auricular opening will gradually close.

Stacke's Modification. Stacke operates through the meatus, first separating the membrano-cartilaginous part of the meatus and the auricle, as in the ordinary radical operation. After separation from the bony walls of the meatus, the membranous lining is cut through obliquely with small curved scissors close to the tympanic membrane and drawn forwards so as to give access to the tympanum. The malleus is then removed as in ossiculotomy, and also the remnant of tympanic membrane. The outer wall of the attic and the incus are next removed. The antrum should then be chiselled into from the meatus, after introducing Stacke's guard, or packing the aditus as far back as possible with gauze, so as to protect the deeper parts from the chisel. The osseous meatus, antrum and attic are thus converted into one cavity and carefully cleared of disease by curetting; afterwards the cavity is packed with gauze. The wound behind the ear is immediately sutured, the subsequent treatment being carried out through the meatus. Stacke's method is recommended when there is reason for believing that the antrum is deep and small, or the sinus abnormally far forward. It requires much less removal of healthy bone than the radical mastoid. It is not suitable, however, if there is disease in the vertical mastoid cells, or a sinus over the mastoid, or stenosis of the meatus; it is likewise unsuitable when intra-cranial complications have supervened.

Irrigation, Packing and Dressing. The exposed cavities in the bone should, at the end of the operation and before suturing, be irrigated with an antiseptic solution, such as a 2 per cent. solution of carbolic acid, or a 1 in 5,000 solution of bichloride of mercury, so as to cleanse away all the blood clots, fragments of bone or other debris. After irrigation, the parts should be carefully mopped with strips of iodoform or sterilized gauze. The walls of the spaces are then dusted with iodoform and boracic acid (1 of the former to 3 of the latter), and lastly the cavities are packed with strips of iodoform gauze introduced through the widened meatus. This packing checks the bleeding, maintains the contour of the cavities, and helps to retain the flaps in position. The post-auricular wound is now carefully sutured with silk-worm or horse hair sutures, unless it is decided to treat the cavities from behind. Several layers of iodoform gauze, having a semi-lunar shape, are placed over the wound behind. In most cases iodoform suits admirably, but in a certain number it produces severe dermatitis or eczema in the neighbourhood of the wound, which, in a case of the writer's, eventuated in erysipelas. A thick woodwool pad or several layers of gauze, for absorbing the exudation of bloody serum, which

follows the operation during the first twenty-four hours, is placed over the ear and side of the head, with an aperture for the auricle, and a large gauze bandage applied over all.

The patient should rest in bed and be placed under restricted diet for a fortnight, during which the temperature should be regularly taken and recorded. High temperatures with rigors would mean general septic infection. Slight and temporary rise of temperature may take place within the first two days without any special significance. After that any considerable and persistent or recurring rise of temperature generally indicates something wrong; it may be a stitch abscess, septic infection of the wound, or even erysipelas; the dressings should in these circumstances be removed and the wound carefully examined. Such complications should give rise to suspicion regarding the sufficiency of the antiseptic precautions at the operation, or the purity of the surroundings of the patient. Iodoform dermatitis may account for some elevation of temperature.

After-treatment. The local after-treatment is of great importance although there is not so far unanimity of practice. The method which, in the experience of the writer, has yielded the best results when the post-auricular wound is sutured at the first, the after-treatment being carried out through the meatus, is as follows:—A few days after the operation the external dressing is changed and, about a week after the operation, if no complication has shown itself before, the packing is removed, after having been saturated with peroxide of hydrogen, which loosens it and tends to prevent bleeding. The cavities are syringed with a sterile normal saline solution and carefully mopped with sterilized cotton wool on forceps or a cotton holder, then again packed more lightly with narrow thin strips of iodoform gauze, or small pieces of folded iodoform gauze are introduced into every recess with forceps through a wide speculum. The objects are to keep the flaps in position and to exercise some pressure upon the walls of the cavities made by the operation, so as to encourage the formation of a uniform layer of granulation tissue over them; also to maintain the contour of the cavities left by the operation, the obliteration of which is very undesirable. It is well to pack lightly when the granulation tissue is healthy, and more firmly if it becomes exuberant. The stitches may be removed from the post-auricular wound about a week after the operation. For several weeks it is usually necessary to change the packing daily, on each occasion syringing and again packing. If there is little secretion, simple mopping with sterilized cotton wool, dry or squeezed out of peroxide of hydrogen, and packing again will suffice. As great attention should be given to the sterilization of the hands, instruments and dressings at each dressing as at the

actual operation. Iodoform gauze sometimes tends to the excessive formation of granulation tissue, when it may be well to substitute for it simple sterilized or double cyanide gauze. A very important point is to check local exuberance of granulation tissue, which is very apt to take place, even in spite of persistent packing, at the aditus and at the inner wall of the antrum, also at the flap incision within the meatus. If this is not kept down, not only is epidermization hindered, but pus-yielding recesses or spaces are apt to form, especially at the aditus, from the coalescence of opposite masses of granulation tissue leaving a narrow aperture discharging pus. Bridges or walls of fibrous tissue, partially or completely closing the opening to the antrum behind, may be the ultimate consequence. It is therefore generally necessary, from time to time, to cauterize or curette exuberant granulation tissue, followed by pretty firm packing with gauze. It is useful in these circumstances to soak the gauze used for packing in rectified spirit, or the same diluted with an equal portion of water, which tends to check the excessive growth of granulation tissue; or, as some prefer, to fill the cavities, for ten minutes before packing, with warm rectified spirit. When a satisfactory layer of granulation tissue has formed, and the time taken for this varies in different persons, epidermization (which springs from the skin lining the anterior and inferior walls of the meatus and the edges of the skin flaps) is more encouraged by ceasing to pack, or doing so very lightly with sterilized cotton wool tampons, and, instead, insufflating a small quantity of fine powder, such as zeroform, either simply mopping or syringing and mopping before the insufflation. Longer intervals between the dressings are now permissible if the moisture is slight and the epidermization going on well. There is in certain cases troublesome persistence of a discharge from the inner tympanic wall, after the other cavities have epidermized properly. There we may find localized purulent areas from which firm granulation tissue sprouts, recurring after removal; this is most frequent behind the promontory at the sinus tympani, or at the mouth of the Eustachian tube. Cauterization, curetting, peroxide of hydrogen and spirit instillations usually lead ultimately, although it may be after a very considerable time, to a good result. Probably in some of these cases there is a small carious erosion or minute sequestrum on the inner tympanic wall, on the disappearance of which the discharge dries up.

Objections to Packing. A serious objection to the treatment just described is the necessity for frequent and prolonged packing, involving much personal attention. A less troublesome method therefore is greatly to be desired in the interest both of the surgeon and the patient. Ballance's mode of epithelial grafting promised much

relief in this direction (see p. 137) but, besides involving two operations, most surgeons find the technique difficult and have not met with the success hoped for. Many surgeons have given up packing, unless at the operation. At the first dressing, 4 or 5 days after the operation, and twice a day afterwards, they simply syringe with normal saline solution and instil warm rectified spirit, allowing it to remain in the ear for 20 minutes. A firm plug of gauze is inserted into the meatal orifice in order to prevent contraction there. A nurse or a friend of the patient may be taught to carry out this treatment; the surgeon examining from time to time so that, if exuberant granulation tissue forms, it may be dealt with. It is alleged by excellent authorities that, by this method, excessive formation of granulation tissue is prevented, and that, as a rule, a satisfactory result is achieved. Other surgeons keep, in lieu of packing, a wide drainage tube in the meatus, employing also the spirit treatment. Others again simply mop out the cavities, or instruct the patient to do so, and insufflate a fine powder, such as boracic acid, zeroform, or aristol. The writer is bound to say that the spirit treatment, without prolonged packing, does very well in some cases, yet in others the absence of packing seemed to him responsible for unsatisfactory results, and he has had sometimes to resort to packing after trying the other method for weeks.

The Result to be Desired. The result aimed at is that the internal surfaces should gradually come to have a fine epidermic lining, pale pink, shining and non-secreting. Probably 85 per cent. end in satisfactory cicatrization, when the operation and the after-treatment are thoroughly carried out. If that condition has been attained in two months the result may be regarded as very satisfactory, more frequently three or four months are required, while, in certain cases, a year or more may elapse before after-treatment can be discontinued. While there may be slow healing and cicatrization, even when the operation has been thoroughly performed, the greatest delay is no doubt due to the incomplete removal of the disease, leaving carious areas, either from their inaccessibility or other causes. A moist area on the inner tympanic wall often persists for a long time. Labyrinthine or tuberculous complications will, of course, tend to delay the ultimate healing. In some cases the shining, smooth, dry surface remains permanent, but more frequently epidermic collections and crusts form in the recesses, with perhaps granulation tissue underneath, leading to a partial return of the suppuration. These should be removed by syringing with a normal saline solution, after saturation with peroxide of hydrogen. Forceps are often required to remove these collections. While this tendency continues to exist, the patient should be seen

at intervals, say every month or two, to ensure the thorough cleansing of the cavities.

Effects upon Hearing. In regard to the effects of the radical mastoid operation upon the hearing, the statistics of different operators vary greatly. Probably in the larger number the hearing remains unaltered; a considerable number show improvement, sometimes marked; only comparatively few are made worse. Quickness of healing is favourable to the hearing. Involvement of the labyrinth is very unfavourable to hearing, so likewise is luxation of the stapes caused by the operation. The binding down of the stapes with dense cicatricial tissue, which is sometimes apt to occur, gives rise to great deafness.

Permanent Opening Behind. When the post-auricular wound is to be kept open, packing from behind with careful and regular antiseptic cleansing may be required for weeks and even for months. So long as purulent secretion forms in any quantity, a 2 per cent. solution of carbolic acid is injected once a day through the mastoid opening, escaping through the external meatus, and *vice versa*. If exuberant granulation tissue sprouts up at the outer opening or in the cavity, it should be scraped away with the sharp spoon, or touched with chromic acid; this may require to be done several times. A spirituous solution of carbolic acid or boracic acid poured in after syringing, and allowed to remain in the ear for a few minutes, is often beneficial. After a sufficient lapse of time, when the cavities are dry and completely epidermized, the post-auricular opening, such as in Fig. 101, may be closed by a suitable plastic operation, if desired by the patient. The closure contributes to the cleanliness of the interior, especially amongst those who work in a dusty atmosphere, in whom the cavities are apt to become occupied by dust and dirt. We must be sure that the desquamative tendency has ceased before closing the opening.

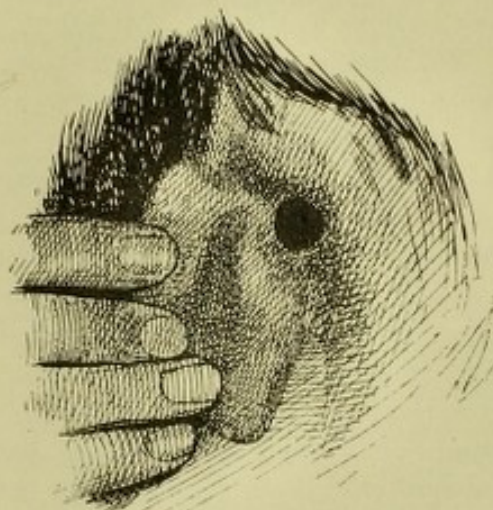


FIG. 101.—Permanent opening leading into antrum after operation.

THE TREATMENT BY MEANS OF EPITHELIAL GRAFTS.

This method of facilitating the healing of these cavities in the bone has been introduced by Mr. Charles A. Ballance. The object is to obviate, as Mr. Ballance says, "the painful, prolonged, and unsatis-

factory after-treatment" of the operation just described. By this method two operations, separated by an interval of a week, are required; 1st, for the removal of the disease, and 2nd, for the grafting of the cavities.

Ballance's First Operation. Mr. Ballance's mode of performing the first operation is exceedingly thorough, and pretty much on the lines just described, with important modifications. He makes a vertical incision close behind the pinna, and as a rule a second incision, an inch long, horizontally backwards from the middle of the vertical. The whole of the posterior wall of the bony meatus is removed, and the antrum, attic and bony meatus are very thoroughly exposed and cleared out. Ballance lays stress upon the complete removal of the outer wall of the attic and the efficient removal of the disease from the attic, antro-tympanic passage, and tegmen. The posterior wall of the osseous meatus being removed, the floor of the membranous meatus is divided vertically by means of a long and narrow knife, into the concha, when the incision is carried in a curved direction, upwards and backwards, to the level of the commencement of the helix. The flap, "concha-meatal," formed by the posterior wall of the meatus, is then raised upwards and backwards and sutured to the mastoid flap, raw surface to raw surface, by silk-worm gut threads. After packing the cavities with iodoform gauze the external wound behind the auricle is closed by sutures. In cases where the disease is limited and asepsis assured, the grafting may be done at the end of the first operation.

Ballance's Grafting Operation. The second or grafting operation is done at the end of a week. In the interval between the two operations, the cavities are irrigated two or three times daily with chlorine water or weak carbolic lotion. On the morning of the operation the cavities are washed out three or four times with warm sterile saline solution. The patient being again under a general anæsthetic, the external incision is opened with the handle of the knife, the cavities are exposed and further curetting employed if necessary. All oozing of blood should be carefully and thoroughly arrested by the use of hot saline solution and peroxide of hydrogen followed by the pressure of pieces of gauze. The graft is taken either from the inner surface of the thigh or arm by means of a large razor, the surface being first washed and then kept bathed in a normal saline solution. The thinner the epithelial layer removed the better, even thin to transparency, and it is more suitable to use one large graft than several small ones. The surfaces upon which it is specially important to lay the graft are the roofs of the tympanum and antrum and the inner surfaces of the antrum, attic and lower tympanum. A microscopic section lifter is used to carry the graft, and, beginning at the outer edge of the anterior wall of the cavity in the bone, the thin, almost transparent, graft is then insinuated inwards from the section lifter with the help of a probe. A steel probe with a pear-shaped head is used to press the graft into the recesses of the bone cavities; if possible, no space should be left between the bone and the graft, and, when successful, the definition of the surfaces should be quite clear. Drops of blood or bubbles of air may prevent the due approximation of the graft to the surface below. Suction with a glass pipette is very effective in withdrawing the drops of blood or bubbles; during the suction the graft falls accurately and smoothly upon the surface below. A graft or two grafts are placed on the inner surface of the outer wall of the cavity, one edge being drawn through the meatus so as also to cover the raw surface of the cut edge of the cartilage along the

posterior edge of the meatus. The grafts are kept in their places by small sterilized gauze tampons covered with aristol powder, which are carefully pressed upon the grafts. The wound behind is again sutured, and outside dressings applied. The tampons are removed on the fourth or fifth day and further tamponading is unnecessary, the cavities being simply irrigated daily with warm rectified spirit alone or with an equal quantity of peroxide of hydrogen. In this way the dead part of the graft separates gradually by molecular necrosis and comes away, not in one piece, but in fine fragments, and all tendency to granulation and suppuration of the ungrafted area is antagonised. This method of epithelializing these cavities has in Mr. Ballance's hands proved very successful. The after-treatment is reduced to a few weeks while the hearing is conserved and in many cases greatly improved.

Modified Grafting Operation. The following modification of Ballance's system of grafting has been practised by the writer for the last two years with considerable success. By this method the use of a general anæsthetic and the reopening of the post-auricular wound, the two great drawbacks to Ballance's method, are obviated. The graft is cut from the left forearm or thigh under local anæsthesia induced in the following manner:—A warm, sterilised, normal saline solution, to which has been added Parke Davis and Co.'s codrenine in the proportion of 1 ampulla (10 minims) to 6 drachms of the normal saline solution, is injected under the skin from which the graft is to be taken. An ordinary hypodermic syringe, with a needle at least two inches long, is required, and several syringefuls of the fluid are injected in various directions before withdrawing the needle. In this way it is quite easy to anæsthetise three to four square inches of skin sufficient to permit of the removal painlessly of a large Thiersch graft. The graft, which must be thin to transparency, is then introduced through the widened meatus during the second week after the operation by manipulating it over the end of a suitably bent glass tube, connected at the other end by rubber tubing having a glass mouth-piece or a small rubber bag. The graft at the end of the tube is passed through a wide speculum to the inner wall of the tympanum, when by blowing air through the tube, the graft is spread out over the inner surfaces, including the tympanic walls, the aditus, and the antrum. Or, one graft may be used for the tympanum and a second for the antrum. Before introducing the grafts the surfaces must be most carefully dried, and after their introduction zeroform powder is blown in so as to cover the grafts with a fine layer; afterwards small gauze tampons are carefully inserted into all the recesses. In a week the gauze packing can be removed, followed by gentle syringing with saline solution, drying, and a fresh insufflation of zeroform. In the course of a few days the spirit treatment may be commenced. By this modified grafting operation and the limited use of packing there is little doubt that the healing process is materially shortened.

INDICATIONS FOR THE RADICAL MASTOID OPERATION.

This operation is called for in cases of *chronic* middle ear suppuration presenting certain complications. The following are the chief indications for its performance:—(1) The first signs of an intra-cranial complication, such as sickness and vomiting, headache, rigors with violent oscillations of temperature (see Chapter XIV). The operation

is then usually preliminary to exposing the dura mater, brain or lateral sinus. (2) Stenosis of the external meatus, hindering the escape of purulent matter from the deep parts, and preventing effective treatment through the meatus. (3) The presence of epidermic and cholesteatomatous masses, with pain in the ear, vertigo and headache; or where, without these subjective symptoms, and after removal of the accessible masses, followed by suitable treatment, the purulent discharge persists. (4) When, after ossiculectomy, followed by attic syringing, a fetid discharge continues, with escape from time to time of epithelial masses; the hearing being very defective on the same side. (5) Carious or necrotic lesions of the mastoid, behind the auricle or on the posterior wall of the meatus (associated with *chronic* suppuration), with or without a sinus in the soft tissues. (6) Polypoid or granulation tissue *continuing to recur*, in spite of repeated removals and suitable treatment, especially if it springs from the upper and back part of the tympanum, or protrudes from the attic or aditus. (7) Acute mastoiditis, based on chronic suppuration, with abscess behind the auricle, on opening which a carious aperture in the mastoid is found. (8) A fetid discharge which continues offensive in spite of all remedies, probably indicating caries or cholesteatomatous disease in the invisible cavities. (9) Persistent or frequently recurring headache and earache with a sense of heaviness and pressure in the head, associated with chronic otorrhœa which has been unaffected by all ordinary remedies. (10) The presence of violent vertigo in a person with a chronic ear discharge having serious loss of hearing on the affected side and defective bone-conduction. In such a case the operator should, during the operation, look out for a carious aperture over the external semicircular canal, or on the inner wall of the tympanum (see p. 130). (11) The presence of diplococci, streptococci (pyogenes) or the tubercle bacillus strengthens the indications for the operation. So, likewise, does the presence in the discharge of lymphocytes, epithelioid cells and myelocytes, indicating bone disease; of lymphocytes and "acid fast" squames, indicating cholesteatomatous changes; of lymphocytes, epithelioid cells, myelocytes and giant cells, indicating tuberculous disease of the temporal bone. (12) Vascular changes in the optic disc, although short of optic neuritis, and distinct optic neuritis itself would also strengthen the other indications for the radical operation.

Considerations before deciding on Operation. When the otorrhœa continues or rapidly recurs in spite of all ordinary efforts of treatment, without there being any special local complication, or symptoms which might be regarded as urgent, the indications are less clear and the radical operation may not be called for in every case. The operation must not be lightly undertaken in every case

of purulent ear disease. Various considerations should be placed fairly and fully before the patient. There is the *possibly* injurious effect upon the hearing. If the hearing be fairly good in the affected ear, while very defective in the other, the patient should consider whether the possible injury to hearing, resulting from the operation, may not interfere seriously with his prospects in life, or imperil his means of living. Of course the possibility of improving the hearing by the operation should also be considered. It would not be surprising if, in some cases, the patient preferred rather to risk the dangers of the disease than the serious consequences of further loss of hearing. The patient's habits and his circumstances in life should influence the surgeon's decision. Do these admit of the proper carrying out of suitable treatment and the exercise of due care? Is the patient likely to continue residing in a place accessible to skilled surgical treatment and expert advice in the event of serious complications arising? The possibility of the ultimate success of conservative treatment should not be ignored. Cases are occasionally met with in which long-continued treatment, perhaps even for years, has permanently brought an end, without operation, to the chronic discharge. It is even occasionally observed that, *without any treatment*, a discharge, which has existed for years, ultimately ceases. Another point should not be forgotten, especially if the patient be a lady, namely, the possibility of permanent facial paresis or paralysis following operation, which, while comparatively rare, is far from being unknown. It is also to be remembered that we cannot, unfortunately, assure the patient that, after the operation, there will be no further trouble with the ear, because it has to be admitted that, in a certain number, the operation requires very prolonged after-treatment, and even then may not be followed by complete cure. Although the actual disease may be eradicated by the operation, experience shows that a considerable number need attention, such as more or less regular syringing and removal of epidermic collections at intervals, for months or even years. The surgeon may decide, after some such considerations, that at least delay is justifiable. Of course if the patient is anxious for the operation, and the danger of the disease greatly disturbs his mind, the operation should be carried out.

CHAPTER VI.

DISEASES OF THE NOSE AND THROAT IN RELATION TO THE EAR.

THE most important diseases of the upper respiratory tract which come under the notice of the aural surgeon, on account of their far reaching effects upon the ear, are those which lead to *nasal obstruction*. These are acute and chronic rhinitis (including the hypertrophic and atrophic varieties), nasal polypi and accessory sinus disease, spurs and deflections of the septum, and—most frequent of all—post-nasal adenoids. For methods of examination see p. 24.

Symptoms of Nasal Obstruction and its Consequences. The most prominent symptom of obstruction of the nasal passages is "mouth breathing," which in marked cases is constant day and night. In a large number of cases, where the obstruction is less pronounced, oral breathing is only observed during sleep, whilst in the waking hours fairly satisfactory nasal breathing is enjoyed. From time to time, however, even during the day, the nasal passages in these slighter cases are liable to become blocked. The changes produced in the physiognomy of a child constrained to breathe habitually through the open mouth are often characteristic (Fig. 102). The bridge of the nose becomes broadened and the *alæ nasi*



FIG. 102.—Facial aspect in deafness associated with post-nasal growths.

pinched in, the lower jaw hangs down and the lower lip droops, the facial aspect is dull and expressionless, and the eyes have a vacant look. Inattention at school and defective memory are often observed; but it should be remembered that impaired hearing, a common consequence of nasal obstruction, may to a great extent account for the

mental dulness (aproxia of Guye). The speaking voice also undergoes change; it loses its resonance and acquires the so-called nasal tone; whilst the singing voice is weak and muffled, and becomes hoarse or husky after slight exertion.

As a result of long continued oral breathing in early life and the attempts, especially during sleep, to breathe through the obstructed nasal passages, certain changes in the bony framework of the mouth, nose, and chest are frequently observed. The hard palate in many instances becomes high-arched, and the upper alveolus V-shaped, resulting in irregularity of the teeth, the premolars in not a few cases being displaced inwards and downwards, so that on clenching the teeth the incisors of the upper and lower jaws do not overlap or may even not meet,—the open bite (Lack, Parker). In the nose, the septum is frequently distorted and exhibits crests or spurs of cartilage or bone, or it may be deflected to one or both sides. In the thorax, pigeon chest or other deformity of the ribs is sometimes observed, more frequently if, in addition to the obstruction in the nasal passages, the faucial tonsils are hypertrophied. There are also symptoms arising from deficient aeration of the blood, such as nightmare, night terrors and broken sleep, anæmia and malnutrition; headaches and epileptiform convulsions during sleep are not infrequent and may be referred to the same cause. Dryness of the mouth in the morning, a tendency to chronic pharyngitis, laryngitis, bronchitis; and, in children, attacks of so-called "croup" are also observed, and are probably due to the filtering and warming function of the nasal passages being in abeyance. Disturbances of the digestive organs accompanied by a coated tongue are not infrequent, and are usually attributed to the swallowing of offensive secretion. As a result, the general health and nutrition tend to suffer; and a child, the subject of such a condition, is mentally and physically of stunted growth. Snoring is a very frequent symptom, and impairment or loss of the sense of smell (anosmia) is also not uncommon. Nasal discharge of a serous, mucous, or muco-purulent character often accompanies nasal obstruction. In the suckling infant, nasal obstruction may lead to refusal to take the breast and consequent serious effect on the health and nutrition of the child.

Certain reflex neuroses, such as asthma, hay fever, stammering, nocturnal enuresis, etc., may sometimes be attributable to nasal obstruction, especially that due to adenoid vegetations. Disease of the middle ear, manifesting itself by earache, disturbances of hearing, or purulent discharge, often arises out of the various forms of nasal obstruction. How the ear may be involved in these cases has been already described (p. 68).

ACUTE RHINITIS (COLD IN THE HEAD).

Causation. (1) Cold. Exposure to draughts, sudden change from a warm to a cold atmosphere, wet feet, etc., are common instances. The general health at the time of exposure is an important factor as a determining cause, and those whose occupation confines them to hot and ill-ventilated rooms are more liable to be affected. (2) Unhealthy conditions of the upper air passages, particularly those conditions which cause nasal obstruction. Children suffering from enlarged tonsils and adenoids are especially susceptible. (3) Infectious diseases, particularly measles, scarlatina, diphtheria and influenza. (4) Gout, rheumatism, and syphilis may be mentioned as predisposing causes, also the excessive use of alcohol and tobacco. (5) Traumatic causes, such as a foreign body, hot fluids, or irritating vapours. (6) Certain drugs, such as iodides, salts of mercury and antimony. An acute catarrhal attack frequently begins in the nose and spreads backwards into the naso-pharynx and downwards into the pharynx, larynx and trachea. Less often it originates primarily in the larynx or naso-pharynx. The infectivity of an acute catarrh seems to be fairly pronounced, its spread through a whole family being an everyday observation.

The symptoms of a cold in the head are unfortunately too well known from personal experience to require description. It is to be remembered, however, that, when headache is a prominent feature, the catarrh or inflammation has probably extended to one or more of the nasal accessory sinuses, and this is specially liable to occur in the catarrh accompanying influenza, where headache is often so troublesome. A similar extension along the Eustachian tube into the middle ear spaces is far from infrequent, and may lead to serious results.

The mucous membrane, especially of the inferior turbinal, will be found to be red and swollen and covered with muco-purulent secretion. The amount of swelling varies from time to time. It may be great at the first examination, while, shortly afterwards, the nasal passages may appear quite clear. The application of cocaine and adrenalin causes marked shrinking of the parts. In a few days the catarrh generally extends to the naso-pharynx, and it is when this has occurred that the ears are in most danger of being implicated. The mucous membrane of the naso-pharynx participates in the swelling and increased secretion, and the pharyngeal tonsil (post-nasal adenoid tissue) may become swollen and block the naso-pharynx. The symptoms of involvement of the naso-pharynx consist of a feeling of rawness at the back of the nose, accompanied by a constant desire to "hawk" or clear the throat. In the chronic

form (post-nasal catarrh) this is a common affection and forms a distinct menace to the ears.

When the catarrh spreads to the pharynx, the symptoms complained of are pain or stiffness on speaking or swallowing, and the voice is easily tired. At the commencement the throat feels dry, but later there is some thick viscid secretion, accompanied often by a sensation as if some foreign body such as a hair were in the throat. Occasionally the onset is marked by a slightly febrile state. The mucous membrane of the pharynx is swollen, with proliferation of its superficial layers; the fauces are reddened and the tonsils may be swollen and in some instances spotted with exudation. An attack of acute rhinitis generally passes off in from a few days to a few weeks, but, if frequently repeated, it may gradually merge into the chronic form.

CHRONIC RHINITIS.

The two chief varieties are (1) hypertrophic rhinitis, (2) atrophic rhinitis.

1. *HYPERTROPHIC RHINITIS.*

Pathology. Hypertrophic rhinitis is characterized by persistent swelling, and in many cases redness of the nasal mucous membrane. The swelling may be of the nature of (1) a true hypertrophy which involves the mucous membrane, its glandular structures, the sub-mucous connective tissue, and even the underlying bone itself; (2) an œdematous infiltration of the mucous membrane and the subjacent soft structures; (3) a vascular engorgement and dilatation of the venous channels in the deepest—viz., the cavernous—layer of the mucous membrane. It is important to know which of the above three conditions predominates in the causation of the swelling, as an accurate appreciation of this has an influence upon the mode of treatment. The œdematous infiltration and the venous engorgement disappear almost entirely on the application of cocaine and adrenalin, whilst the swelling due to a true hypertrophy is uninfluenced by such treatment.

Appearances on Examination. The colour of the mucous membrane is generally dark red, but in anæmic subjects may be pale, and in cases of long standing the tint may even be slightly yellow. The inferior turbinated bodies are most frequently involved and the hypertrophy is generally more pronounced at their posterior ends, which may be so greatly enlarged as to block completely the choanæ. By posterior rhinoscopy they appear as round, mulberry-like masses of a grey or reddish-blue tint according to the degree of their vascularity. After cocainizing the anterior regions of the

nasal passages, the posterior ends of the inferior turbinals may be observed by anterior rhinoscopy as pendulous swellings which are freely movable with a probe (Fig. 103). The lower free edge of the inferior turbinal may show irregular polypoid growths or fringe-like excrescences. The anterior ends are sometimes much swollen, and may impinge on the septum, completely shutting off a view of the deeper parts, or they may even appear externally. This

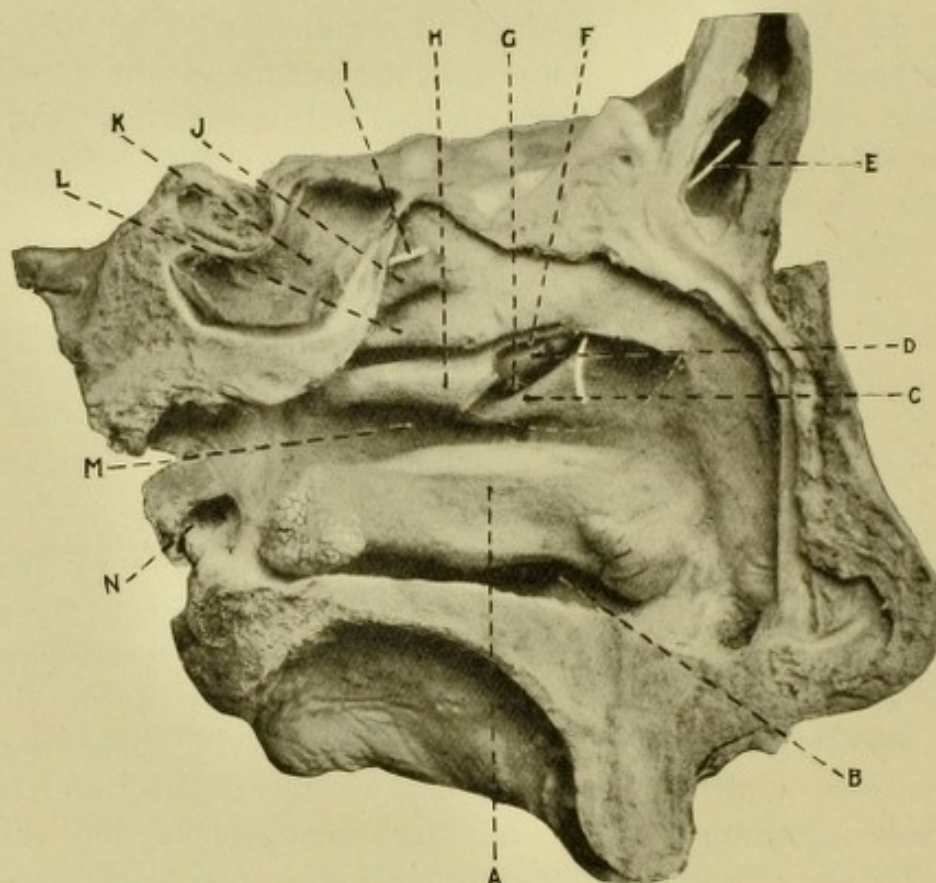


FIG. 103.—The outer wall of the nasal passages. The anterior half of the middle turbinal has been removed in order to expose the contents of the middle meatus. The dotted line indicates the outline of the portion of the middle turbinal which has been removed. A, inferior turbinal, showing hypertrophy of the anterior and posterior ends; B, inferior meatus of the nose; C, processus uncinatus; D, bulla ethmoidalis; E, bristle passed through the ostium frontale into the anterior end of the infundibulum; F, recess between bulla and middle turbinal where the principal opening into anterior ethmoidal cells lies; G, ostium maxillare; H, middle turbinal; I, bristle passed through ostium of sphenoidal sinus of left side; J, supernumerary superior turbinal; K, right sphenoidal sinus, unusually large; L, superior turbinal; M, middle meatus; N, pharyngeal orifice of Eustachian tube.

enlargement of the anterior ends is in many cases not a true hypertrophy but a transient engorgement, and disappears almost entirely on the application of cocaine. The middle turbinals may also participate in this hypertrophy. Marked localized enlargement of the anterior end of the middle turbinal, or the presence of hypertrophic tissue in the middle meatus of the nose, should arouse strong suspicion of disease in the accessory nasal sinuses, especially when the nasal discharge is of a purulent character. Occasionally the glandular elements in the mucous membrane of

the septum are involved. Not infrequently the whole mucous membrane of the nose is implicated in a general thickening without any specially localized hypertrophies. In such a case the amount of secretion is often great, and the entire nasal mucous membrane is unhealthy, flabby and sodden in appearance. Frequently associated with hypertrophic rhinitis are spurs or deflections of the septum.

Causation. A moist, raw climate, such as we have in the West of Scotland, is very conducive to rhinitis, both acute and chronic; and if, in addition, the atmosphere contains irritating vapours or gases, or is impregnated with solid particles, the tendency towards catarrh is still greater. Frequently recurring attacks of acute catarrh generally end in the establishment of chronic changes in the mucous membrane. The exanthemata are common causes. Post-nasal adenoids are frequently associated with hypertrophic rhinitis, and probably constitute an important causative factor. Disease of the nasal accessory sinuses may be regarded as the principal cause of localized hypertrophies of the middle turbinal and the structures in the middle meatus. General conditions, such as faulty digestion and hepatic disturbances, play an important role in the causation, as do also heart disease and other causes of venous engorgement. The rheumatic and gouty diatheses seem to be predisposing causes.

Symptoms. The most common complaint is nasal obstruction with all its train of symptoms (see p. 142). There may be copious serous discharge from the nose, or the discharge may be mucopurulent in character, having a tendency to the formation of crusts, especially upon the anterior regions of the septum nasi. Under these crusts ulceration may take place, and as a result attacks of bleeding from the nose may occur, or, though rarely, the ulcerative process may extend deeper, and eventually lead to small perforations of the septum, the so-called idiopathic perforation of the septum nasi. Patients frequently express their feelings by saying that they have "repeated colds in the head," the colds at first being of short duration, occurring generally during winter, but later on becoming more and more frequent until the intervals of relief are hardly noticeable. Hoarseness or weakness of voice is often complained of, and paroxysms of sneezing, with or without rhinorrhœa, may be so frequent and annoying as to overshadow all other symptoms. Loss of the sense of smell (anosmia) is not uncommon, and headache may be a troublesome symptom.

2. ATROPHIC RHINITIS (OZÆNA).

This condition is characterised by abnormal patency of the nasal passages caused by atrophy or defective development of the

turbinal bodies, especially of the inferior, and by muco-purulent discharge with extensive formation of yellowish green crusts of a very offensive and characteristic odour. The ciliated epithelium of the mucous membrane becomes replaced by squamous epithelium, the glands of the mucous membrane atrophy and decrease in number, whilst there is a round-celled infiltration and fibrous tissue formation, especially in the neighbourhood of vessels and glands. The middle turbinal frequently shows no evidence of atrophy, and it may even be hypertrophied. The disease generally commences in early life, and is more frequent amongst females. Its causation is still the subject of controversy.

On examination by anterior rhinoscopy the septum and the remnants of the inferior turbinals are generally observed to be covered with crusts, and, owing to the extreme patency of the nasal passages, the back wall of the naso-pharynx, frequently also showing crust formation, may be clearly seen. The atrophic changes and crusting may extend over the pharyngeal wall down into the larynx. The fœtor is extremely offensive to those around; but, owing to loss of the sense of smell, it is not always perceived by the patient.

Nasal obstruction due to the crust formation is not infrequent, and the general health, in many cases unaffected, may suffer from mental depression, septic absorption, digestive disturbances due to swallowing purulent material, or anaemia, which is frequently associated with this condition in young women. Infection of the middle ear through the Eustachian tube is far from rare, and results in acute non-purulent or purulent otitis media. Great care must be exercised, in douching the nose for cleansing purposes, to avoid forcing the fluid, so rich in organisms of all kinds, into the Eustachian tubes.

Syphilis or Tuberculosis may attack the nose or pharynx and lead to necrosis of bone, perforation of the septum or palate and offensive purulent nasal discharge with crust formation. As a result of syphilitic ulceration the Eustachian orifices may be obliterated by cicatricial tissue.

CHRONIC PHARYNGITIS.

This may take the form of a *general pharyngitis* or a *granular pharyngitis*; and, accompanying either, there may be an elongated condition of the uvula. The etiology is similar to that of chronic rhinitis (p. 147); but emphasis should be laid upon diseases of the nose and naso-pharynx as frequent and important elements in the causation, and also on over-use or faulty production of the speaking or singing voice.

In *general pharyngitis* the mucous membrane is congested and reddened and may show increased secretion of mucus, whilst in *granular pharyngitis* the back wall of the pharynx and often the naso-pharynx are studded with small elevations of glandular tissue of a pink or reddish colour. Either condition may be accompanied by enlargement of the uvula or dilatation of the veins over the pharyngeal wall.

The symptoms most frequently complained of are stiffness and dryness of the throat, a sensation as if a foreign body, such as a hair, were present, and a desire to hawk and cough. The singing voice loses its tone and becomes tired on slight exertion. In granular pharyngitis the lymphoid elevations can often be felt by the patient with the tongue.

Spurs and Deviations of the Septum. These occur in a large number of people—according to Mackenzie in over 75 per cent.—and in many cases do not give rise to any symptoms. When pronounced, nasal obstruction results, and as a consequence the hearing may be affected. Nasal obstruction with mouth breathing in early life, resulting in a high arched palate, probably accounts for the majority of cases of septal deformity, while injuries to the nose may be responsible for a small number. There are infinite varieties in the shape and size of spurs and deflections. They are chiefly located upon the cartilaginous portion of the septum, but they may, and not infrequently do, extend backwards to the vomer or perpendicular plate of the ethmoid. A single spur or ridge parallel to the floor of the nose may be the only septal deformity; but more often there is a combination of spur and deflection. Spurs and ridges should perhaps be regarded simply as angular deviations.

From an otologist's point of view such changes in the septum are interesting for two reasons. (1) They may cause nasal obstruction, and therefore constitute a menace to the ears. (2) Their presence may prevent the passage of the Eustachian catheter and in this way hinder the efficient treatment of an existing ear affection. Septal spurs and deflections are frequently associated with hypertrophic rhinitis, and may require to be dealt with before proper surgical measures for relieving the rhinitis can be carried out.

Nasal Polypi. On inspection of the nasal passages by anterior rhinoscopy nasal polypi appear as smooth, rounded masses of a blue-grey or slightly pinkish colour (oyster-like) and they are freely movable, having generally a narrow base. They may be single; but are more often found in clusters and frequently completely occlude the nasal chambers. They may be visible on posterior rhinoscopy. Microscopically they consist of a loose stroma of connective tissue, the meshes of which are filled with serous fluid. The glandular

constituents vary in amount, but are always more abundant towards the base. Cystic and myxomatous changes are frequently observed. Nasal polypi are uncommon in early life. There is generally an accompanying copious muco-purulent or purulent discharge from the nostrils. Recently many investigators have been working upon the subject of the etiology of nasal polypi; and, while unanimity has not yet been reached, it may be stated that probably the great majority of cases of nasal polypi are caused by disease—past or present—of bone, and particularly of the ethmoid bone. They most commonly grow from the middle turbinal and middle meatus, especially from the neighbourhood of the ostia of the accessory sinuses, and they are frequent accompaniments of suppurative disease of these cavities, particularly of the ethmoidal labyrinth.

The symptoms complained of are (1) nasal obstruction; (2) rhinorrhœa, generally purulent in character; (3) frequent bleeding from the nose; and (4) headaches or neuralgic pains over the bridge of the nose, the forehead, or round the eyes. Affections of the ear are not rare, and generally assume the type of purulent middle ear disease.

POST-NASAL ADENOID GROWTHS.

The discovery of these growths and their bearing upon disease of the middle ear by William Meyer in 1860, marks an epoch in the history of otology and rhinology. Meyer's discovery was first introduced to the medical profession in

a paper read before the Royal Medical and Chirurgical Society in 1869. It was not, however, until 1881, when the subject was discussed fully at the International Medical Congress in London, that the importance of this discovery received its proper recognition.

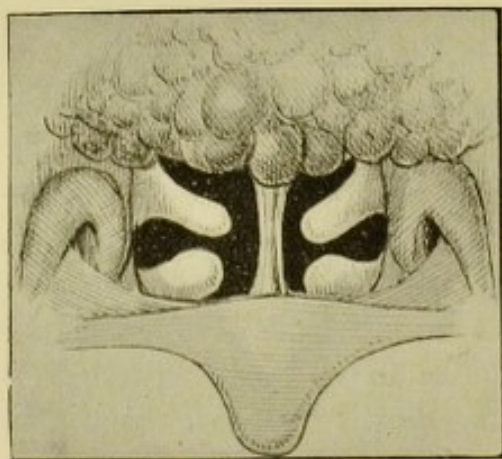


FIG. 104.—Post-nasal growths as seen by posterior rhinoscopy.

Pathology of Post-nasal Growths.

They appear as irregular, lobulated masses growing from the roof and back wall of the naso-pharynx (Fig. 104). In some cases the growth is soft, friable and easily detached: in other cases, especially in young adults,

it forms a smooth rounded pad of denser structure. The hypertrophy may involve the adenoid tissue in the fossae of Rosenmüller and round the pharyngeal orifices of the Eustachian tubes, or it may even implicate the lymphoid elements surrounding the membranous portion of the tube, a factor of importance in connection with the subject

of Eustachian patency. The amount of hypertrophy varies, but what may appear to be an insignificant amount may give rise to middle ear disease. The capacity of the naso-pharynx is to be taken into consideration in forming an estimate of the degree of obstruction. In the crypts and recesses of the adenoid mass are constantly to be found strepto- and staphylo-cocci (Moritz Schmidt) and not infrequently the tubercle bacillus. The lymphoid tissue of the naso-pharynx drains into the deep cervical glands, via the internal maxillary glands, a fact to be remembered when dealing with enlarged glands in the neck.

Etiology. Post-nasal adenoids are essentially a disease of early life, probably from the third to the tenth year being the most common period for their appearance. They very rarely if ever commence after the twentieth year, and they tend to atrophy and disappear spontaneously when adult age is reached. Traces, however, may remain for some years. Acute and chronic catarrhs of the nose and naso-pharynx, the infectious fevers such as measles, scarlet fever and diphtheria, and a cold, damp, changeable climate are the most frequent exciting causes. Heredity and race play an important part as predisposing causes. The prevalence of this affection amongst the Jews and narrow-faced races is a frequent observation, and it is an almost every day occurrence to find several children of the same family affected, whilst the parents may show evidences of nasal obstruction in early life.

Symptoms of Post-nasal Growths. The most prominent symptoms are those due to nasal obstruction, with consequent mouth breathing (see p. 142). The mouth is in most cases habitually open at night and often at other times. Noisy breathing, especially when eating, is frequently observed, while snoring is common during sleep. Nasal discharge, generally muco-purulent in character, is frequently complained of, and may lead to redness and excoriation of the nostrils and upper lip, while the irritation of the naso-pharyngeal discharge, which is almost constantly present, not infrequently causes flat elongated elevations of lymphoid tissue upon the back wall of the pharynx. Owing to the variations in size from vaso-motor or catarrhal disturbances, to which the adenoid mass is subject from time to time, the amount of nasal stenosis is correspondingly increased or lessened. Accompanying turgescence or hypertrophy of the turbinates, which is a common associate of the adenoid condition, may aggravate the impeded nasal breathing. It is to be noted that adenoid growths may exist and cause middle ear disease without much, if any, nasal obstruction. On the other hand, there may be very marked nasal obstruction with pronounced growths in the naso-pharynx and no affection of the

hearing. In the former condition the explanation will probably be found in the position of the growth being more upon the lateral walls and round the Eustachian orifices, whilst in the latter case the glandular enlargement will be confined to the roof and back wall of the naso-pharynx. Children suffering from post-nasal growths probably show greater susceptibility to the infection of measles, scarlatina and diphtheria; and these diseases are also apt to assume a more severe form.

Diagnosis of Post-nasal Growths. In the large majority of cases a diagnosis of post-nasal adenoids can be readily made from the typical physiognomy and the history of mouth breathing, etc. (see p. 142). It is advisable, however, to make sure before operating that the growths have not already been dealt with, as in some instances the symptoms may persist after the curetting of the naso-pharynx. The presence of hypertrophied faucial tonsils in a child are almost certain indications of accompanying post-nasal adenoids; and if, in addition, there is muco-purulent discharge from the naso-pharynx with small elevations of lymphoid tissue upon the back wall of the oro-pharynx, a positive diagnosis can be confidently made (Parker). Frequent attacks of earache and dulness of hearing in early life are also strongly suggestive of such growths. The presence of a small area of swollen mucous membrane on the floor of the anterior part of the nose is regarded by some (Lennox Browne, Sprague) as diagnostic of the presence of adenoids. In only a few cases is it necessary to resort to a digital examination of the naso-pharynx; and, when possible, posterior rhinoscopy should be substituted for this unpleasant and dreaded method.

Hypertrophy of the Faucial Tonsils. This is most frequently met with in children in association with post-nasal adenoid enlargement, and consists usually of a hyperplasia of the lymphoid tissue. In adults, however, the whole gland may be involved and may show considerable development of fibrous tissue. The hearing may be affected through pressure of the tonsillar mass upon the floor of the Eustachian tube, or by the spread of an acute inflammation, to which chronically enlarged tonsils are prone, along the Eustachian tube. Inflammation of a tonsil may give rise to reflex pain in the ear.

The crypts of the tonsils are sometimes the seat of inflammation and may become filled with white or yellowish plugs of pus and epithelial debris. In this condition of lacunar or follicular tonsillitis the tonsils are generally swollen and studded with white spots, and there is considerable discomfort and pain on swallowing, accompanied by fever. It may pass off entirely or become chronic.

CHAPTER VII.

TREATMENT OF THE NOSE AND THROAT IN RELATION TO THE EAR.

ACUTE RHINITIS (COLD IN THE HEAD).

(1) **General Treatment.** If taken in hand at the commencement much can be done to abate an attack. A ten grain Dover's powder, or 15 grs. of phenacetin, or 20 grs. of sodium salicylate taken before going to bed preceded by a Turkish, Russian, hot air, or ordinary hot bath, followed in the morning by a smart saline purgative, often successfully cuts short an attack. In the early stages laudanum in 5 min. doses three or four times daily, or large doses of quinine or quinine and salicin have been recommended. If the attack be severe, or the patient delicate, or if he be professionally engaged as a singer or speaker, confinement to a room having an equable temperature with the use of steam inhalations through the nose three or four times daily, may be added to the above treatment. Bier's treatment carried out by means of an elastic band applied round the neck has been warmly advocated at the commencement of an attack by some authorities, particularly by Professor Henle, who has reported several consecutive cases cured by this means in less than twenty-four hours. The writer has not had sufficient experience of this method of treatment to give an opinion as to its merits, but he has himself gained much relief from all the distressing symptoms of a cold in the head by wearing during the night a broad elastic band lightly stretched round the neck.

Local Treatment of Acute Rhinitis. During the first forty-eight hours of a cold in the head local medication in the form of steam or dry nasal inhalations, sprays, paints, ointments, or snuffs are beneficial in relieving the more distressing symptoms. Of these, inhalations of steam impregnated with benzoin, menthol or camphor (Formulæ 1 to 4), repeated three or four times daily give relief, especially to the unpleasant sensation of dryness. The application

to the nasal mucosa of a 10 per cent. solution of cocaine, either as a spray or paint, reduces the swelling temporarily, and may by clearing the nose allow the patient to fall asleep. The addition of a few drops of 1-1000 adrenalin solution increases and prolongs the astringent action upon the vessels, but the subsequent swelling from vaso-motor paralysis is more pronounced. Dry inhalations of the fumes of menthol, ammonia, camphor, carbolic acid, or ammonium chloride (Formulæ 5 to 8), the latter used with an inhaler, of which Godfrey's is a good example, are also helpful in reducing the congestive swelling. Ointments such as cocaine and vaseline or menthol and camphor ointment (Formulæ 23 and 24) give in some cases the best results. Some of the inhalants introduced by Parke, Davis & Co. form pleasant and soothing applications, and of these the chloretone and adrenalin inhalants, used with their glaseptic nebulizer (Fig. 109), may be mentioned as probably the most efficacious. Snuffs, of which menthol and Ferrier's are the best known (Formulæ 28 to 30), may be prescribed with advantage. In the later stages, when the nasal discharge is considerable, washing out of the nose twice or thrice daily either by means of a coarse spray, a nasal irrigator (Fig. 105), or by simply sniffing the fluid up from the hollow of the hand or from a tablespoon is indicated (see p. 155). The solution used should be at first a weak alkalo-saline (Formula 15), but later a more stimulating or astringent one (Formula 19) may be employed. The use of the chloretone or acetozone inhalant with a nebulizer after the douching is of value. Tonics such as iron, iron and arsenic, or quinine (see Formulæ) are beneficial at this stage, but a few days' sojourn in the country forms, probably, the best tonic treatment, and will generally complete the cure.

Preventive Treatment. When there is a tendency to frequent attacks of acute rhinitis, especially if these are accompanied by disturbance in the ear, preventive measures should be used, such as the avoidance of sudden and extreme changes of temperature, of exposing the uncovered head to the cold open air, or of excessive indulgence in alcohol or tobacco. The growth of a moustache has sometimes a good prophylactic effect. Sponging the body with cold or tepid salt water followed by brisk friction; plenty of fresh open air during mild and dry weather; residence in the country, especially in a mountainous region or in a wooded district; these tend to invigorate the general health, and probably lessen the liability to attacks of catarrh. If the tendency is based upon the gouty or rheumatic diathesis, appropriate remedies may be required, such as a course of Carlsbad salts, or of sodium salicylate. *The treatment of chronic conditions in the nose* (see p. 155), if such exist, should never be omitted.

TREATMENT OF CHRONIC RHINITIS.

General Treatment. Our aim should be to establish the highest degree of bodily health, to keep the excretory functions in good working order, and, if possible, to introduce into the daily life of the patient some hardening influence such as a daily cold or tepid bath, outdoor exercise, open window at night, etc. The gouty, rheumatic, or plethoric habit should be corrected by diet, avoidance of alcoholic stimulants or excess in tea or coffee, along with careful regulation of the bowels by means of Carlsbad salts or other saline aperient. Daily exercise should be prescribed, preferably in the open air, but, if that is impossible, the window should be opened during the exercises, which are followed with advantage by cold or tepid sponging. In thin anæmic persons tonics of iron and arsenic or strychnine with a generous diet, and open air exercise should be ordered. Oatmeal porridge with cream, being rich in fats and oils and at the same time nourishing, is to be recommended.

Local Treatment. In the local treatment of chronic rhinitis three objects must be kept in view: (1) to remove the abnormal secretions, crusts, etc., and disinfect the parts; (2) to check the hypersecretion and reduce the chronic swelling and hypertrophy; and (3) to place the nasal passages in a position to perform satisfactorily their normal functions. In the furtherance of these aims various measures are brought into application. These may be divided into (A) simple medicated applications (solutions, vapours, powders and ointments); (B) cauterization of the nose; and (C) operative treatment, including removal or partial removal of enlarged turbinals, corrections of deviations, removal of spurs or polypi.

(A) *MEDICATED APPLICATIONS.*

Methods of Application. Irrigation of the nasal passages with suitable solutions is a valuable therapeutic measure. The simplest method of carrying this out is by sniffing a small quantity of the solution (tepid) from the hollow of the hand, a tablespoon, a saucer, or a small measure glass, through the nasal passages into the pharynx and then expelling it through the mouth. From a wineglassful to a teacupful may be used in this way at one sitting. With most people this method is very successful; but, with a few, headaches or retching may be excited or there may be failure through nervousness. The pouring of liquid into the nostril from a spoon or measure glass, while the head is inclined backwards, and, when the fluid reaches the naso-pharynx, tilting the head quickly forwards so as to

allow the solution to flow out of the opposite nostril is a good plan. Glass irrigators, such as that depicted in Fig. 105, are now widely used. The irrigator is filled with the solution, and, while a

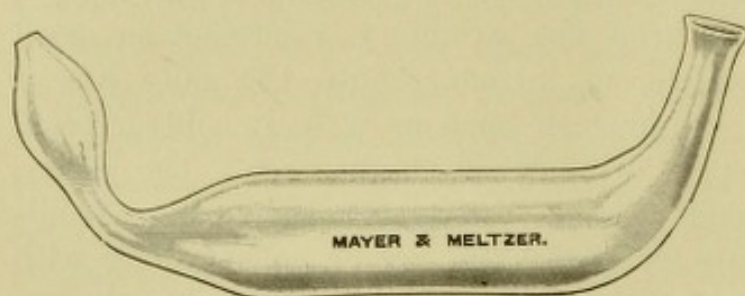


FIG. 105.—Glass nasal irrigator.

finger closes the aperture at one end, the other end is inserted into the nostril, while the head is inclined backwards; the finger is then removed, when the fluid will flow into the nasal passage until

it reaches the naso-pharynx. The head is then tilted quickly forward to allow the fluid to escape by the other nostril. Syphon nasal douches are now seldom used owing to the danger of forcing some of the fluid into the Eustachian tube, and setting up inflammation in the middle ear.

Syringing the nose, either by means of a rubber-ball syringe (Fig. 106) or an ordinary glass ear syringe, the nozzle of which is covered with india-rubber tubing, may be necessary when the secretions are very abundant or viscid, or when there is much crust

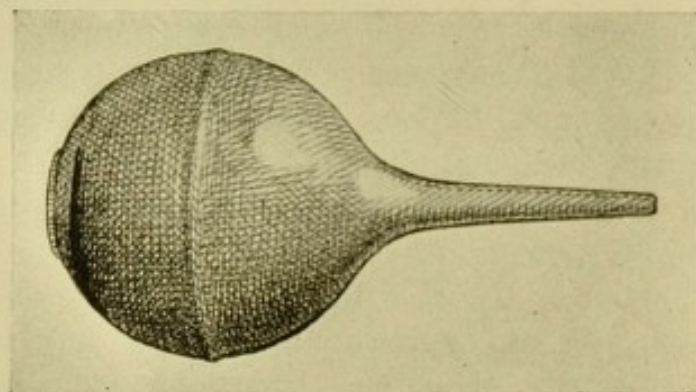


FIG. 106.—Nasal ball syringe.

formation. The stream of fluid should be directed straight backwards along the *narrower* of the two nostrils while the patient breathes through the open mouth. The glass syringe possesses the advantage over the rubber one in that it can be more easily sterilized. Although syringing through the anterior nares is usually sufficient to act



FIG. 107.—Posterior nasal syringe.

upon the walls of the naso-pharynx, it is sometimes desirable to inject fluid directly into that cavity. For this purpose the posterior nasal syringe (Fig. 107) is useful, or, a straight tube, with lateral perforations at its inner end, may be passed along the cocainezied inferior meatus of the nose, and fluid sprayed directly over the naso-pharyngeal mucosa. Another efficient and useful method of applying

solutions to the interior of the nasal chambers is by means of a coarse spray (Fig. 108). Children take more kindly to this method of nasal irrigation than to any of those already mentioned. It is often advantageous to follow douching of the nasal passages by the application of some soothing, stimulating antiseptic or oleaginous preparation. This can be done by means of a fine spray from an atomizer, or nebulizer, if oily substances are employed, by a ball insufflator if powder is used, or by painting or brushing the nasal mucosa with solutions or ointments, using a cotton mop or a camel's hair brush.

Nasal Solutions. In these various ways many kinds of solutions are applied to the naso-pharyngeal mucous membrane in chronic rhinitis. Alkalo-saline

solutions are probably the most frequently employed, and have the effect not only of cleansing the mucous membrane but also of reducing catarrhal swelling. The following give a sufficient variety (1) equal parts of sodium bicarbonate and sodium chloride; (2) equal parts of sodium bicarbonate, sodium chloride and sodium bichlorate; (3) equal parts of potassium chlorate and potassium

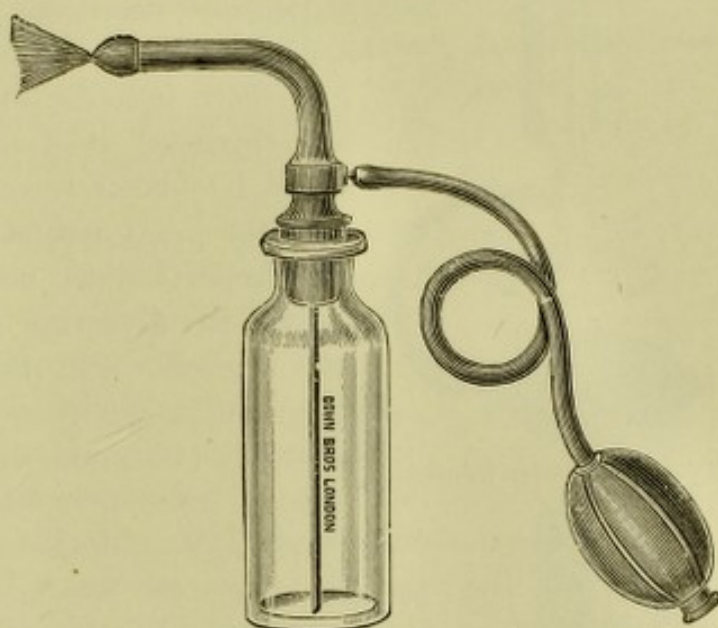


FIG. 108.—Spray producer for anterior nares.

bicarbonate; (4) equal parts of sodium chloride, sodium bicarbonate and ammonium chloride. In all of these a drachm of the powder to a pint of tepid water is the usual strength prescribed, but for different persons this may require to be modified (see Formulæ 16 to 18, also Formulæ 14 and 15). These and other medicaments are prepared in the form of tabloids by Burroughs, Wellcome & Co. for convenience of patients when travelling. The addition of hazeline (Formula 19) imparts a useful astringency. More aromatic solutions, such as glyco-thymoline, are also widely used. More powerful antiseptics for conditions such as are found in ozæna may be used with advantage—*e.g.* solutions containing permanganate of potassium, carbolic acid, sanitas or boracic acid (Formulæ 20 to 22). When these solutions are employed for ozæna, a nasal ball syringe is required, and at least half a pint should be employed on each occasion, twice daily. In other conditions they are introduced as a spray, or by means of a glass irrigator or hand douche (sniffing).

Paroleine and fluid vaseline, bland and tasteless products of petroleum, are often used, and apparently with advantage, by means of an atomizer or nebulizer (Fig. 109), in both acute and chronic rhinitis. They have a soothing effect, and soften crusts, but they are most useful as forming excellent media for many other medicaments, such as menthol, eucalyptus, camphor, thymol and adrenalin (Formulæ 9 to 12). The combination of menthol and

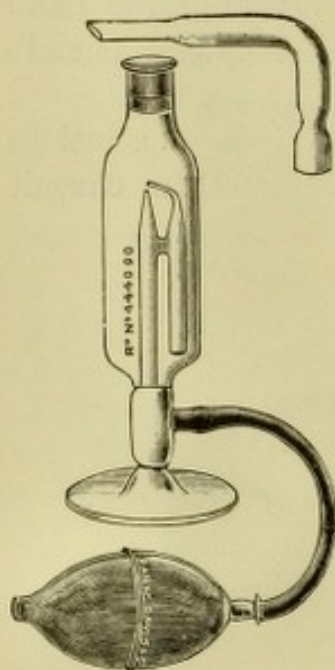


FIG. 109.—Glaseptic nebulizer.

camphor is much employed to diminish the turgidity of the turbinated bodies which so often exists in chronic rhinitis. Menthol combines the properties of an anæsthetic with an antiseptic (Formulæ 9 and 11). Solutions of chloretone, acetozone and adrenalin (P. D. & Co.) are now extensively used in a very fine nebulized form both in acute and chronic rhinitis. Rectified spirit—1 to 4 of water—in the form of a spray has been recommended by Baber for the roots of nasal polypi after operation, as well as for hypertrophic conditions. A solution of iodine in glycerine with iodide of potassium and carbolic acid is employed with advantage in granular conditions of the pharynx and nasopharynx (Formula 36). Cocaine and adrenalin are in constant use by the rhinologist. A

10 per cent. solution of hydrochloride of cocaine is applied, by means of the spray or cotton swab, in small quantity before examination, or as an anæsthetic before the use of the cautery, and other operations; it is often combined with adrenalin for its ischæmic effect (Formula 13). The "neboline" compounds of Oppenheimer, Son & Co. are much used in the form of a very fine nebulized vapour introduced into the nasal passages by their "Aeriser." Their list of Formulæ includes solutions of such substances as menthol, cocaine, extract of suprarenal gland, eucalyptus, iodine, oil of cassia, formaline, atropine, etc. They form elegant and useful remedies, with great variety of combinations, some of which are specially useful in hay fever and nasal asthma.

Precautionary Suggestions. The following precautions should be kept in view when applying solutions to the nasal passages and naso-pharynx, in order to avoid or diminish the risk of exciting inflammation in the middle ear. (1) Patients, before using the nasal syringe, syphon douche, glass irrigator, or the hand douche, should be carefully instructed by the surgeon in their proper and safe use. (2) Previous to injecting fluids by the syringe or syphon douche into the nose, or prescribing such, the nasal passages should be carefully examined, and if one should be found obstructed, the fluid should be injected into the obstructed passage. (3) The nozzle of the syringe should not tightly close the nostril, and

during the injection of the fluid, the stream should be interrupted. (4) If a syringe is employed, too great force must not be used, especially if there is resistance to the flow of the fluid from one nostril to the other; if a syphon douche is employed the fall must not be too great—not more than 2 feet. (5) The fluid injected should always be comfortably warmed—say 80° to 90° F.—and it should hold in solution a saline, such as a 1 per cent. solution of common salt or bicarbonate of sodium, while in ozæna or other bacterial diseases a definite antiseptic should be employed. (6) The act of swallowing, being attended by the opening of the Eustachian tube, must be carefully avoided during the douche; this is aided by breathing through the mouth. Eitelberg suggests that the patient should protrude the tongue so as effectually to prevent the act of swallowing. (7) In the case of infants or very young children, or in adults whose Eustachian tubes are abnormally permeable, the syringe or syphon douche should not be employed. The liquid should in these cases be poured into the nasal passages with a spoon or other suitable appliance, while the patient (if old enough) should sound the syllable “ah.” (8) The patient should not blow his nose or, if possible, sneeze, for at least fifteen minutes afterwards. (9) He should be instructed that, in the event of the liquid entering the ear, he must swallow several times with the nostrils closed.

Vapours—Powders—Ointments. Vapours are most useful in acute rhinitis or in an acute exacerbation of the chronic form (see p. 153). Powders may be applied to the nasal passages or naso-pharynx for the reduction of swollen mucous membrane and hyper-secretion, or they may be used as sedative applications. It is generally necessary first to cleanse thoroughly the nasal passages. By simple sniffing, the powder may be brought into contact with the anterior parts of the nasal chambers; but some form of insufflator is usually required to distribute the powder on the deeper parts, and that described for the ear (Fig. 110) is very suitable. For applying powder to the naso-pharyngeal mucous membrane a suitably bent nozzle may be attached to the ball. A variety of substances are used in the form of powder. Menthol alone or combined with boracic acid is antiseptic and relieves the sense of stuffiness, cocaine may be added to increase the ischæmic effect (Formulæ 29 and 30). Orthoform is useful as an analgesic and Ferrier’s snuff (Formula 28) is sometimes beneficial in an acute exacerbation, especially with serous exudation. *Ointments* are often serviceable, and are more generally used than powders. Menthol and camphor ointment, to which cocaine may be added (Formulæ 23 and 24) is a very popular application both in acute and chronic rhinitis. Zinc ointment or a mild mercurial is beneficial in eczematous conditions of the nostrils, which are common in children.

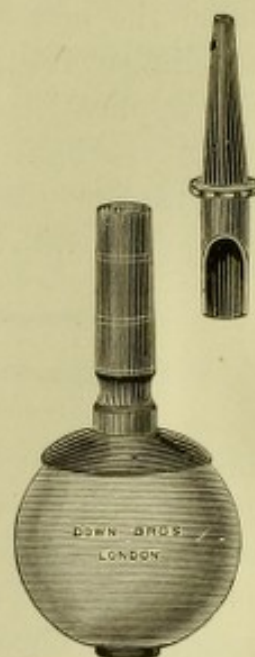


FIG. 110.—Ball insufflator.

(B) CAUTERIZATION.

Chemical Cauterization. The nasal passages should first of all be cleansed of secretion, if such be present, and then cocainized in order to give as much space as possible. *Nitrate of Silver* solution (40 grs. to the ounce) may be applied to the tumid nasal mucosa with a brush or cotton wool on the end of a cotton wool carrier until the parts become whitened, when they should be swabbed over with a weak saline solution. This method of treatment is efficacious in chronic congestion of the mucous membrane, and it should be repeated at frequent intervals, in some cases daily, for ten days or a fortnight. The naso-pharynx and the Eustachian orifices may be subjected to this treatment by passing a long cotton holder, tipped with cotton wool soaked in the solution, through the inferior meatus of the nose, which has been previously cocainized. Hajek recommends this method in preference to using a bent holder passed up behind the soft palate. Nitrate of silver may be fused into a bead upon the end of a silver probe and applied to limited areas of mucous membrane. *Chromic Acid* is best applied fused into a bead upon the end of a probe. Owing to the tendency of chromic acid to diffuse itself over surrounding parts it should be restricted in its application to limited areas, such as to the roots of polypi after snaring, to localized hypertrophies, or to small masses of granulation tissue. Used in this manner it is often very beneficial. A concentrated solution may be applied upon cotton wool or by

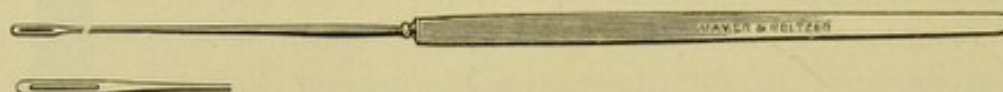


FIG. 111.—Woakes' chromic acid carrier.

means of a chromic acid carrier (Fig. 111). If too freely used it may produce excessive irritation or even general toxic effects. The local irritation may be relieved by swabbing with a solution of sodium bicarbonate. For a few days following the application the nose should not be douched and the patient should avoid exposure to cold. A case is known to the writer in which severe purulent disease of the middle ear, including the mastoid cells, was excited by the patient travelling from London to Glasgow the night after such a cauterization. *Trichloracetic Acid* used on a chromic acid carrier is preferred by some to chromic acid. Lambert Lack considers *Nitric Acid* as probably the best of the chemical caustics. It should be applied with a small wooden stick or glass brush, followed by mopping with cotton wool soaked in a weak solution of sodium bicarbonate.

The Galvano-cautery. This is a most effective means of reducing chronic congestion or slight hypertrophy of the inferior turbinals, but it

is not applicable to the middle turbinal. A platinum burner, attached to a suitable handle (Fig. 112), and connected by insulated wires to an accumulator, battery or transformer, yielding a current strong enough to render the platinum point red hot, is required for employing this method of treatment. Careful preliminary cocainizing of the nasal

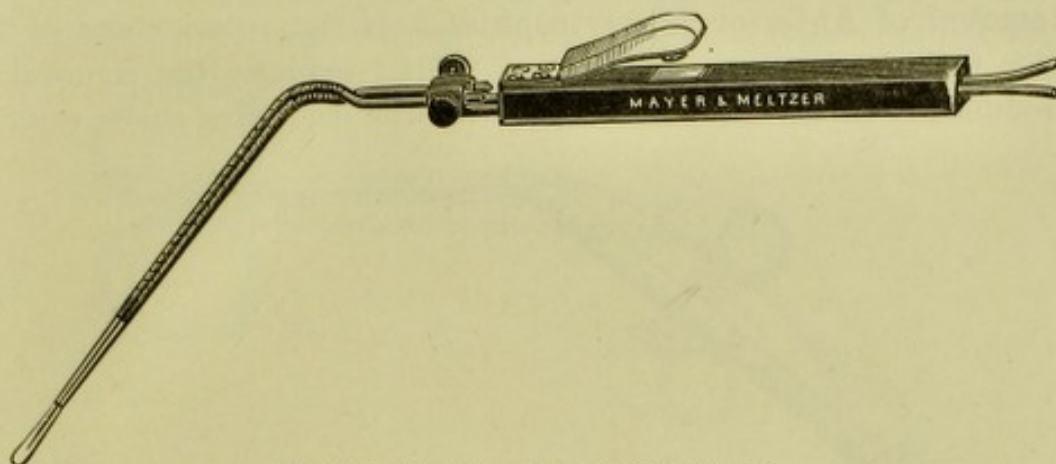


FIG. 112.—Hovell's cautery, handle and point.

mucous membrane is necessary. Cauterization may be carried out either superficially or by the sub-mucous method. In the former—the superficial—the cautery point heated to redness is drawn from the posterior end of the swollen inferior turbinal to the anterior end two or three times, making in this way a series of parallel furrows. Marked shrinking of the turbinal in many instances follows, but two or even three applications, at intervals of ten days or a fortnight, may be necessary. The consequent reactionary swelling is generally slight, and may be relieved by the use of either the menthol and cocaine ointment, or a weak nitrate of mercury pigment (Formula 12). A fibrinous deposit generally forms, but usually separates in a week or ten days. In the second—the sub-mucous method—a sharper platinum point (Fig. 113) is employed. It is plunged into the swollen tissue and allowed to remain in for a couple of seconds. This may be repeated at other spots two or three times at one sitting. The amount of mucous surface destroyed is less than by the other method, but the reactionary swelling is greater and it is doubtful if it is as efficacious. The results of careful cauterization in suitable cases are often very good; there should be little or no pain, either at the time of operation or afterwards, and healing, when the slough has separated, is rapid. The best results are obtained in those cases in which the amount of actual hypertrophy is slight, but where the swelling is chiefly due to serous infiltration of the soft parts or chronic engorgement of the cavernous layer of the mucous membrane.



FIG. 113.—
Pointed burner.

(C) OPERATIVE TREATMENT.

When the hypertrophy is so great that the foregoing methods are insufficient, operative removal is called for. The inferior turbinal is most often the seat of hypertrophy.

Removal of Anterior Hypertrophies. If the anterior end of the inferior turbinal be the main seat of the hyperplasia the removal of the redundant tissue may be effected with the cold wire snare, such as

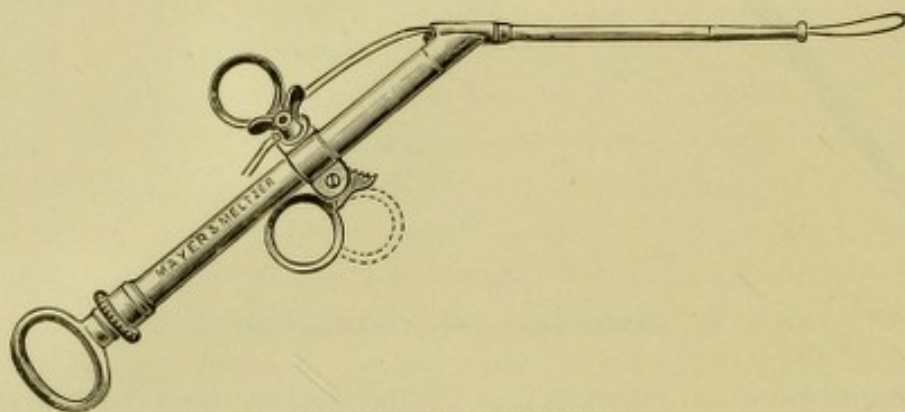


FIG. 114.—Lack's nasal snare.

that depicted in Fig. 114, after the design of Lambert Lack. He recommends that the loop of wire should be quickly tightened round the growth, and then by means of the ratchet arrangement the mass is slowly strangled until it is detached, in this way ensuring a minimum

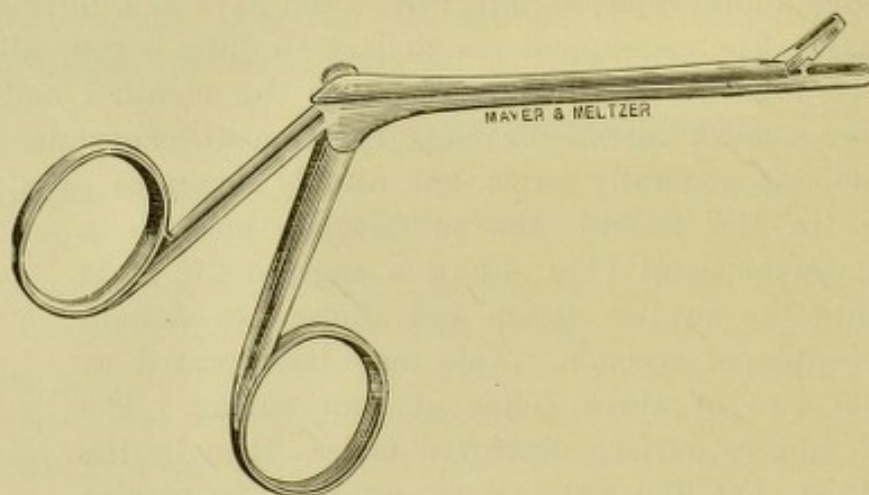


FIG. 115.—Grünwald's forceps.

of bleeding. Grünwald's forceps (Fig 115) may be requisitioned to snip away the growth should any difficulty be met with in snaring it. This operation is usually performed almost painlessly under cocaine and adrenalin anæsthesia. Krause's snare has also been found by the writer to be satisfactory, and Baber's is also a good pattern.

Removal of Posterior Hypertrophies. This is usually done through the anterior nares with one or other of the snares mentioned above. The nasal passage is first of all treated with cocaine and

adrenalin, and the loop of the snare bent outwards is passed along the floor of the inferior meatus into the naso-pharynx. On withdrawal, the loop, owing to its inclination outwards, generally catches upon the posterior enlargement; it is then quickly tightened until it grips, when, by screwing, the wire is pulled slowly home through the mass. The injection of a few minims of Schleich's solution (normal saline)

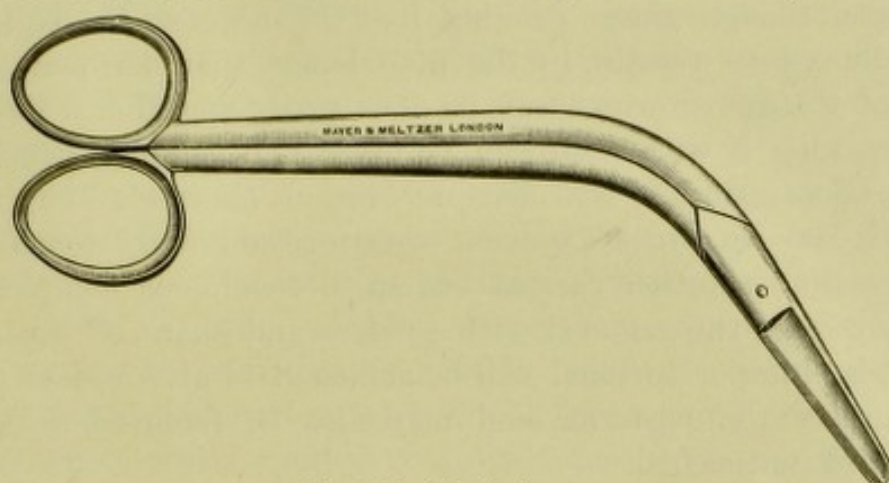


FIG. 116.—Nasal scissors.

into the part to be removed is sometimes practised by the writer, and facilitates the operation, producing a more complete anæsthesia. It may be necessary in some cases to pass the finger into the naso-pharynx, and coax the wire round the mass. For this a general anæsthetic is advisable. Fringe-like masses of redundant mucous membrane springing from the free border of the inferior turbinal may be snipped off with nasal scissors (Fig. 116 or Fig. 118), or Grünwald's forceps.

Turbinectomy. In some cases simple removal of hypertrophied tissue is insufficient for our purpose. It will then be necessary to include the turbinal bone in our operation (partial or complete turbinectomy). Removal of the whole of the inferior turbinal may be effected in one of two ways. (1) By dividing with scissors (Fig. 116) the outer attachment of the inferior turbinal as far back as possible and then encircling the posterior attached part with a wire loop and snaring it off. (2) By Carmalt Jones' spoke-shave (Fig. 117). This instrument is passed along the inferior meatus of the nose, hooked round the posterior end of the turbinal, and rapidly pulled forwards through the outer attachment of the turbinal. General anæsthesia is usually necessary for this operation. The first method

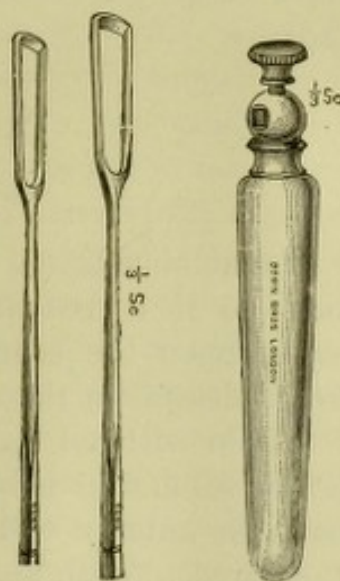


FIG. 117.—Carmalt Jones' spoke-shave.

is preferred by the writer as enabling him to regulate the amount of tissue removed. With the spoke-shave removal is often too drastic, and may be followed by disagreeable consequences, such as dry pharynx, or rhinitis sicca. Complete turbinectomy should be reserved for very marked cases, or when the nasal passage is greatly narrowed. In these operations on the inferior turbinal hæmorrhage is seldom troublesome, though gauze packing may be necessary. This should not be allowed to remain in the nose longer than 48 hours. After removal of the gauze, which can be done easily and almost bloodlessly by first soaking it with hydrogen peroxide (10 volumes strength), an ointment (Formula 24) or oily preparation (Formula 12) may be used for a day or two to prevent crusting, and daily douching with an alkalo-saline solution carried out until healing is complete.

In many cases the removal with scissors and snare of the anterior third of the inferior turbinal will be sufficient to give a clear passage; in other cases the posterior end may also be removed, leaving the middle third untouched.

Operations upon the Middle Turbinal. The anterior end of the middle turbinal may require to be removed, (1) to allow of free access to the anterior end of the infundibulum (for exploring or washing out

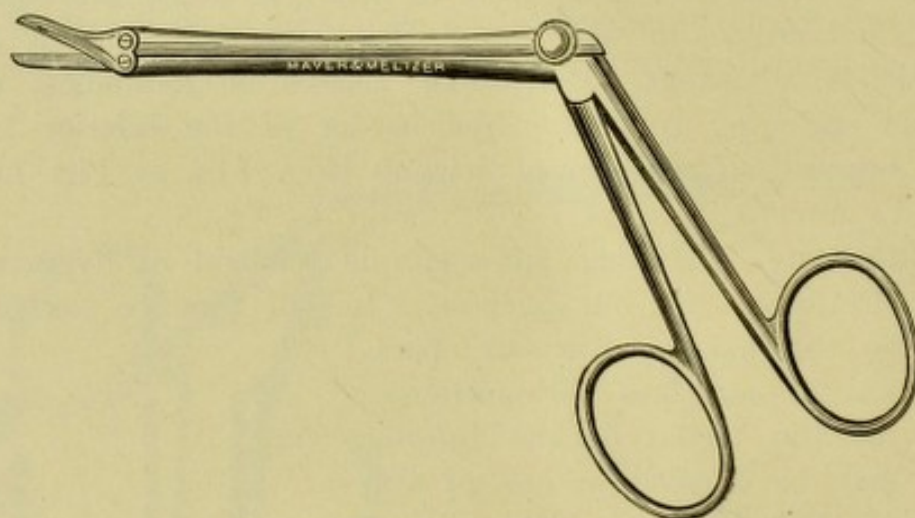


FIG. 118.—Walsham's intra-nasal scissors.

the frontal sinus); (2) to give free exit to discharge from the frontal sinus; (3) if it be much hypertrophied or cystic, when, owing to pressure upon the septum, headache is frequently excited; (4) when there is disease in the anterior ethmoidal cells. Complete removal of the middle turbinal may be necessary to allow of free access to the posterior ethmoidal labyrinth or to the sphenoidal sinus. In order to remove the anterior end, suitable scissors (Fig. 118), and a wire snare are required. With the scissors the outer attachment of the turbinal is cut through as far back as is necessary; the wire loop of the snare is passed along to the end of this incision and tightened. The amount

of the turbinal removed can be regulated by the length of the incision with the scissors. In complete removal, the outer attachment is divided with the scissors as far back as possible, the loop of wire is slipped behind the posterior end of the turbinal, the barrel of the snare being pushed along the track made by the scissors, and the wire is drawn through what remains of the outer attachment.

Removal of Nasal Polypi. For this purpose a cold wire snare, suitable examples of which have already been mentioned (see p. 162), is the instrument preferred by most operators, though forceps are recommended by a few. The wire loop (No. 5 piano wire) is made to encircle the growth, and is pushed up as near the base as possible. It is then tightened sufficiently so as to give a firm hold, and the mass is torn away by pulling, not by cutting through. In this way the so-called root, or even a small piece of bone, may be extracted. Several sittings are sometimes necessary before the nose can be cleared owing to bleeding obscuring the parts. Cocaine and adrenalin should of course be carefully applied some minutes before operating. Some authorities recommend the application of chromic acid or the galvano-cautery to the stumps to prevent recurrence. The use of a spirit spray or douche after the removal of polypi tends, it is said, to shrivel up any roots which may remain. If recurrence takes place, as it often does after simple removal, it will generally be found that the ethmoidal cells are filled with polypoid tissue from which fresh crops of the growths spring. Hence our aim should be to curette thoroughly the ethmoidal cells. In extensive cases the best and most lasting results are got by anæsthetizing the patient, and radically scraping out the whole ethmoidal labyrinth with Meyer's ring knife supplemented by forceps. In cases where a polypus hangs down into the naso-pharynx, it may be necessary to introduce the finger into the naso-pharynx in order to guide the loop over the growth. Apart from ethmoidal disease, suppuration in the other accessory sinuses (frontal, maxillary, sphenoidal) is frequently responsible for polypoid growths. Simple removal of these growths is generally insufficient, unless the diseased cavity or cavities are concurrently and successfully treated.

Operations upon the Septum. Ridges or spurs, if small and confined chiefly to the cartilaginous septum, may be removed by means of a saw (Fig. 119) or Jones' spoke-shave. It is advisable, for purposes of rapid healing, to preserve the mucous membrane as far as possible. This can be done by making a longitudinal incision with a narrow bladed knife along the summit of the crest or ridge through the muco-perichondrium, which is raised from the cartilage by a small elevator. The saw is then applied to the base of the upper surface of the crest, already denuded of its soft covering, and the projecting cartilage sawn through. If the spoke-shave be the instrument selected,

it is passed behind the crest and, with a quick forward pull, the projecting part is cut through. The elevated mucous membrane is then folded down over the broad stump, in this way covering to a large extent the raw surface. The nostril should be lightly packed with gauze for twenty-four hours; the subsequent treatment consists in simple cleansing or, if crusts form, an oleaginous paint or spray may be used. This operation can, as a rule, be painlessly and bloodlessly performed under cocaine and adrenalin anæsthesia.

Extensive deformities, such as marked deflections, combined deflection and spur, or a much thickened and distorted septum, are best treated by the sub-mucous resection operation elaborated by Killian and

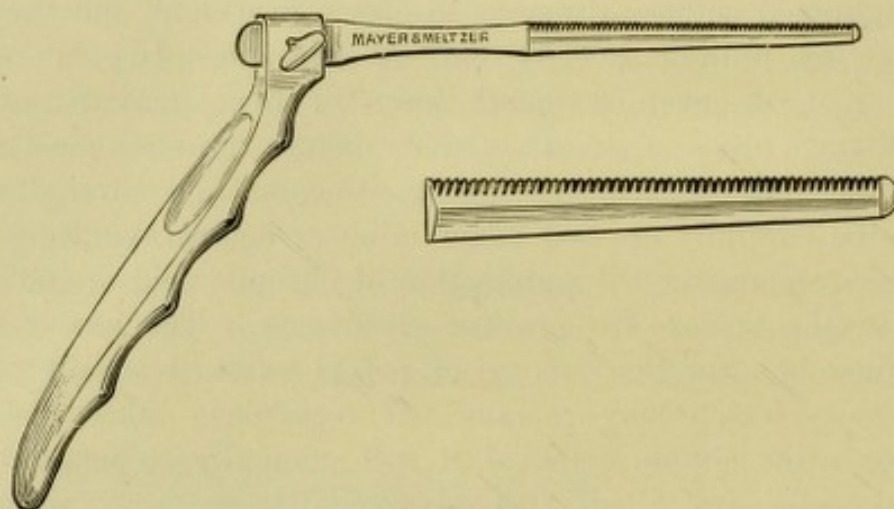


FIG. 119.—Nasal saw.

Freer. Shortly stated, the object of this operation is to remove the cartilaginous and bony deformities without the loss of any mucous membrane. A (or L-shaped cut is made through muco-perichondrium just within the nares upon the convex side of the septum, the muco-perichondrium and muco-periosteum are raised from the septum by a small elevator as far back as the deformity extends, the original incision in the mucous membrane is deepened through the cartilage, the soft coverings of the concave side are similarly elevated, and the cartilage and bone, divested on both sides of mucous membrane, are then removed by Ballenger's knife, forceps, cutting forceps, saw and chisel. The edges of the incision are drawn together by a couple of horse-hair sutures, and the two curtains of muco-perichondrium are pressed together, raw surface to raw surface, by gauze packing inserted into both nostrils. If, from the type of deformity, much chiselling is anticipated, a general anæsthetic should be employed. Otherwise local anæsthesia, by means of cocaine and adrenalin applied to the mucous membrane, is sufficient. More complete anæsthesia and a bloodless field are obtained if normal saline solution, containing one-tenth per cent. cocaine, and a few drops of the solution of adrenalin is injected under the mucous membrane, to the extent of from 40 to 60

minims for each side of the septum. This type of operation, which has many modifications, is gradually ousting all the older methods (Asch, Moure, Gleason's, etc.) from the field of operative treatment of septal deformities. The results are usually excellent and, although the technique is difficult, practice soon gives speed and dexterity. The packing should at latest be removed in 48 hours and the stitches in three or four days. A saline douche may be ordered and used for a week or ten days, when, in an average case, healing should be complete.

Treatment of Ozæna. In the treatment of this intractable disease our object should be (1) to remove the crusts and prevent their reforming as far as possible; (2) to reduce the patency of the nasal passages; and (3) to establish the highest degree of bodily health. (1) In order to remove the crusts, hydrogen peroxide, 6 volumes strength, may be applied to the nasal passages either as a coarse spray or by cotton wool on a cotton wool carrier, followed by copious irrigation with an alkalo-saline solution, and by more definite antiseptics (p. 157) in a few weeks. Sniffing of the solution up the nostrils rarely suffices to dislodge the crusts; a stronger stream from a 3 oz. rubber ball or Higginson's syringe with a suitable nose-piece being generally required. At first great caution should be exercised by the patient to avoid forcing fluid into the Eustachian tubes; but after some practice he acquires greater dexterity and also tolerance. After the crusts have been removed our next aim is to prevent their reforming. In some cases nasal douching, carried out thoroughly twice daily, using at least a pint of fluid on each occasion, is sufficient. The application to the nasal mucosa of an oleaginous solution such as Formula 12 after douching is sometimes beneficial. This cleansing treatment, while not curative, gives great relief. A method which has met with a considerable measure of success in the hands of some surgeons is to pack the nasal passages after cleansing with a long strip of cyanide gauze. The patient soon learns to carry out this treatment himself. The gauze must of course be removed daily, and after thorough douching a fresh strip is inserted. The nasal chambers should at first be completely filled with the gauze, but afterwards a passage for air may be left by confining the packing to the upper two-thirds of the nasal passages. By this means the odour is abolished and crust formation prevented. It is even claimed that in time the packing may be dispensed with, although daily douching, followed by an oily spray, must still be carried out. (2) To reduce the patency of the passages, vaseline or paraffin has been injected by means of a special syringe into the inferior turbinal or into the septum. Small quantities should be injected at a time, and if carried out according to Gersuny's instructions the operation is practically without danger. The writer has seen considerable relief follow this method.

(3) General treatment should never be omitted. Anæmia is treated in the usual way with iron tonics, plenty of nourishment and fresh air. Sea air is supposed to be peculiarly beneficial in ozæna.

TREATMENT OF POST-NASAL ADENOIDS.

Importance of Early Removal. As already stated adenoid vegetations tend to atrophy and disappear when adult age is reached, but meanwhile irreparable damage may have been done to the physical and mental development and to the hearing. It is of great importance, therefore, to diagnose and treat this condition at as early an age, within limits, as possible, in order (1) to prevent those deformities of the face, jaws, teeth, chest, etc., which have been shown to result from prolonged nasal obstruction in early life; (2) to place the child in as favourable a position as possible, mentally as well as physically, for benefiting from schooling; (3) to diminish the risk of attacks of middle ear inflammation, which so often lay the foundation of permanent defects of the hearing; and (4) to remove the greater liability to infectious fevers. It is not advisable to operate upon very young infants, owing to the increased risk from hæmorrhage and the greater difficulty in performing the operation; but, when the nasal obstruction is so great as to interfere with sleep or the taking of sufficient nourishment, or when laryngismus stridulus or other spasmodic affections of the upper respiratory track are endangering life or interfering with the well-being of the child, the removal of adenoids should unhesitatingly be undertaken even in the very young child. Apart from these considerations, between the fourth and sixth year of life is a favourable time for operation. The tendency for the growths to recur is slight, although perhaps greater the earlier the removal; this slight disadvantage of early operation is far outbalanced by the risks run by delay.

Modes of Operating. The question of choice of anæsthetic has already been discussed (p. 100). Of the many methods of operating

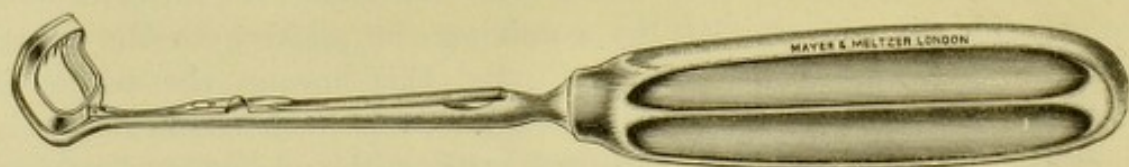


FIG. 120. —St. Clair Thomson's curette, with cage.

for the removal of these growths, that with Gottstein's curette, or one of its modifications, is probably the most generally employed. The curette used by the writer is a modified Beckmann (Fig. 120) having a cage fitted to the back for catching and retaining the growth, thereby preventing it slipping off into the pharynx. An additional curette,

smaller and unguarded, should be kept in reserve for scraping off any smaller projections which may be left after the main mass has been removed. A pair of forceps such as Löwenberg's, or preferably St. Clair Thomson's (Fig. 121) should also be at hand to lay hold of tags or larger portions of adenoid tissue which may have become detached from the guarded curette. A front gag (Doyen's improved model) is used to widely separate the jaws, but some surgeons prefer a side gag; if tonsils as well as adenoids require removal the former is more convenient.

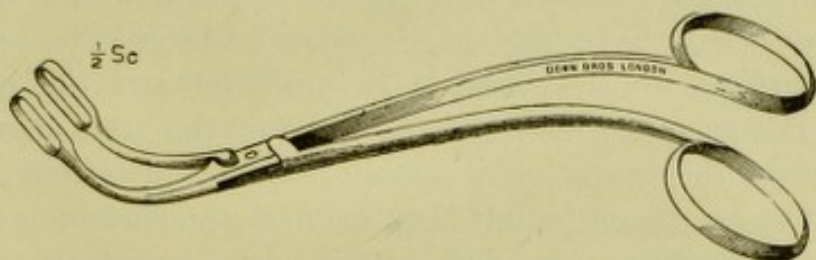


FIG. 121.—St. Clair Thomson's forceps.

Tracheotomy instruments should always be ready to hand for an emergency. The patient's head should be covered with a sterilized towel or waterproof bathing cap, and the clothing should be stripped from the upper part of the body and a warm, clean towel wrapped round the chest. The hands of the operator and all who are assisting must be carefully cleansed, and the instruments thoroughly sterilized.

(1) **Operation under Chloroform or Ether Anæsthesia.** Whilst in the recumbent position the patient is first put under the influence of the anæsthetic (see p. 100). The gag is then inserted between the teeth, which have been previously examined to exclude the risk of a loose stump being detached and gaining entrance to the larynx during

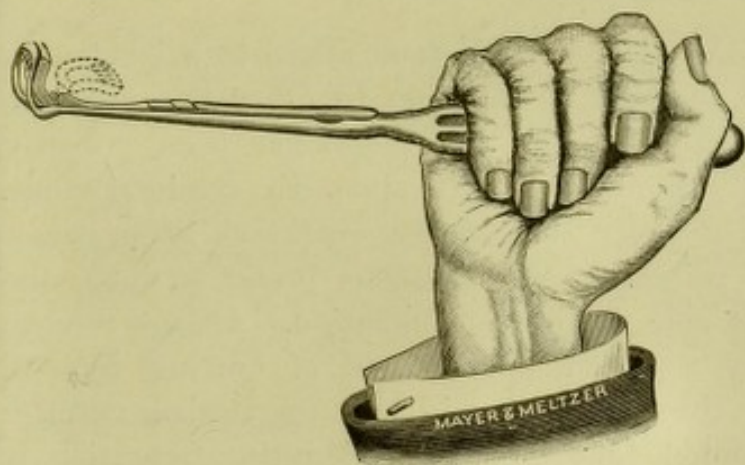


FIG. 122.—Method of holding the curette.

the course of the operation, and the mouth widely opened. The pharynx is examined by reflected light, and the finger is passed rapidly into the naso-pharynx to ascertain the amount and distribution of the adenoid tissue, as well as the depth of anæsthesia as indicated by the presence or absence

of a pharyngeal reflex. The head is then lowered by allowing it to hang, supported by an assistant, over the end of the table, or better, by having an arrangement for elevating or lowering the end of the operating table. The surgeon stands upon the patient's right hand, and, holding the guarded curette dagger-wise (Fig. 122), introduces it into the naso-pharynx (the tongue meanwhile being

depressed by the first finger of the left hand) and passes it upwards and a little forwards until the back of the blade of the curette impinges on the posterior border of the septum. By a bold, firm, sweeping movement of the curette upwards, backwards, and downwards, the growth is shaved off, and should be found caught in the cage on withdrawal of the instrument. The left fore-finger is then introduced behind the palate to examine for any fragments of the growth which may have escaped the curette, special attention being directed to the fossæ of Rosenmüller and the neighbourhoods of the Eustachian orifices; if the walls of the naso-pharynx feel smooth and firm the operation is to all intents and purposes completed. Should any remnants be felt they may be removed by a few final scrapes with the smaller unguarded curette, with Löwenberg's or St. Clair Thomson's forceps, with Meyer's ring knife inserted through the nostril if the lateral wall is not clean, or gauze applied with friction by the finger (Walker Downie). If tags of tissue are seen hanging down from the posterior pharyngeal wall, or if, as sometimes happens, the mass of tissue at the first application of the curette escapes from the cage and is suspended in the pharynx by a fringe of mucous membrane, they may be removed by one or other of the forceps mentioned. The blood which gathers in a pool in the pharynx can be mopped away from time to time with sterile sponges or pieces of sterilized gauze firmly attached

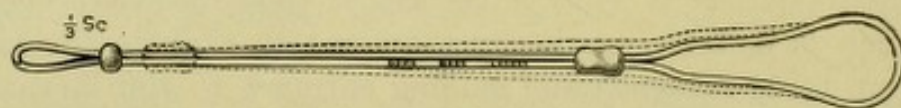


FIG. 123.—Sponge holders for naso-pharynx.

to metal holders (Fig. 123). The head is then raised to a level with the rest of the body, and inclined to the side to allow the blood to pass freely out of the mouth. If the anæsthetic has been properly administered the patient should by this time be semi-conscious. Bleeding, which is usually sharp during the operation, soon ceases after the head has been raised. Some surgeons prefer to have the patient lying on the right side during the operation. Others remove the growth piecemeal by repeated applications of cutting forceps, concluding with two or three scrapes with an unguarded curette. When this method is adopted, lowering the head during operation is inadvisable.

(2) **Under Ethyl Chloride Anæsthesia.** With this anæsthetic the time available for the operation is much shorter than with chloroform or ether. Certain modifications in technique may therefore be indicated which facilitate speedy operating. The teeth, if possible, during the induction of anæsthesia, should be kept apart by a dentist's rubber prop, thus allowing the gag to be slipped in when the patient

is anæsthetized without losing time in the effort to force the clenched jaws asunder, and the preliminary examination of the pharynx should if possible be carried out before the patient is placed on the table. Of most importance, however, is the possession of skilled assistance from those accustomed to this method of operating. Owing to the short time at the operator's disposal, sponging is next to impossible; the surgeon should therefore learn to rely largely upon the sense of touch in manipulating his instruments. At the conclusion of the operation the patient should be quickly turned face downwards and the blood allowed to flow into a basin, the face being meanwhile sponged with cold water. Some authorities adopt this method in preference to using throat swabs, even when chloroform or ether is the anæsthetic selected. With ethyl chloride anæsthesia the operation may be performed with the patient sitting in a chair, but the recumbent position is more convenient, and in the writer's opinion safer. When nitrous oxide gas is administered the sitting posture is always adopted. This anæsthetic is now much less in vogue for this operation than formerly.

Dangers of the Operation for Removal of Post-nasal Adenoids.

(1) *The risk of the anæsthetic.* In regard to this it should be said that the desirability of having a skilful and experienced anæsthetist is perhaps greater for this operation than for almost any other performed upon the human body. With a skilful anæsthetist experienced in this special operation the risk is reduced to a minimum. (2) *The risk of asphyxia* from blood or blood clot, detached pieces of adenoid tissue or tonsils, sponges, teeth or a fragment of a broken instrument. (3) *Dangerous hæmorrhage* is rare, troublesome hæmorrhage is sometimes due to incomplete removal of the growth. As rare sequelæ of this operation may be mentioned (*a*) pneumonia consequent upon the inhalation of blood or mucus into the air passages; (*b*) general sepsis (very rare); and (*c*) acute otitis media purulenta, which occurs more frequently than the other two and is generally attributable to an incomplete operation, injury to the Eustachian orifices, exposure to draughts or cold during or after the operation, or to syringing the nose. An ear already damaged by a past suppuration is more susceptible to this.

After-Treatment. The parents or nurse should be warned about sickness which, owing to the large quantity of blood swallowed, almost invariably occurs shortly after getting the patient back to bed. During the act of vomiting the head should be inclined to one side. For the first few hours, only sips of cold water or pieces of ice to suck should be given, and, for a couple of days, the diet should be semi-solid (milk, custard, porridge, etc.). The patient may be allowed to rise from bed in two or three days, and in a week may be permitted to go into the open air. Syringing or douching the nose is not desirable.

Mouth Breathing after Operation. If mouth breathing continues in spite of the operation, and we are confident that the post-nasal growths have been thoroughly eradicated, we should carefully examine the nasal passages in order to make sure that no obstruction exists there. If the inferior turbinal is found to be enlarged or hypertrophied, cauterization with the galvanic cautery or chromic acid, or even operative removal may be required. In mild forms of obstruction a prolonged and careful use of an alkalo-saline solution with a spray apparatus or a suitable syringe may prove sufficient. This should not be begun for two or three weeks after the operation. If the obstruction be due to spurs upon the septum or to deflections, these may require operation; but such forms of obstruction are not common in childhood. If, after the mechanical impediment to free nasal breathing has been removed, the mouth breathing still continues, means should be adopted to help the person to overcome this habit. The simple plan is first tried of causing the patient to sit still for fifteen minutes, twice or thrice daily, during which he studiously keeps the mouth closed and breathes through the nose alone. If after a time this proves insufficient, an appliance should be provided consisting of a small india-rubber cup, on which the chin rests, the cup being kept in position by means of bands secured round the head. This should be worn for a time at night, so as to keep the lower jaw from falling. Or we may use an india-rubber band with a mouth-piece of soft leather secured round the head during sleep, so that the leather mouth-piece covers the mouth and compels nasal breathing. Another plan, which the writer has known a female patient to adopt, is to retain the lips in contact during sleep by means of long strips of sticking plaster. Some writers ridicule the use of these aids to nose breathing, alleging that, if the nose and naso-pharynx are really free from obstruction, the breathing will naturally become nasal without any such contrivances, and that, if there is defective nasal breathing, we shall find a mechanical cause in the nasal cavities, which must be removed by suitable treatment. Undoubtedly, however, mouth breathing has been remedied by these artificial helps, when it had persisted after ample breathing space had been secured in the nose and naso-pharynx.

OPERATION FOR ENLARGED FAUCIAL TONSILS.

In children enlarged faucial tonsils, being almost invariably associated with post-nasal adenoids, may be and generally are removed either directly before or after the naso-pharynx is curetted. It is, however, advised by some to remove the tonsils without a general anæsthetic a week or so before the adenoids are dealt with, and in adults, where hypertrophied tonsils may be present without post-nasal adenoids, their removal under the local application of cocaine is frequently necessitated. The tonsillotome is the instrument which most rapidly and thoroughly effects this. The instrument (Fig. 124), a modification of Mackenzie's tonsillotome devised by Heath, is the one which the writer favours as being simple, *strong* and effective. Matthieu's (Fig. 125) or Behag's are also widely used, but, owing to their slim and complicated construction, are not so reliable.

Method of Operating without a General Anæsthetic. Five or ten minutes before operating the tonsils are freely brushed or sprayed with a 10 per cent. solution of cocaine. The patient is seated with an assistant supporting the head, light is reflected into the throat and the tongue is depressed. The ring of the tonsillotome is made to

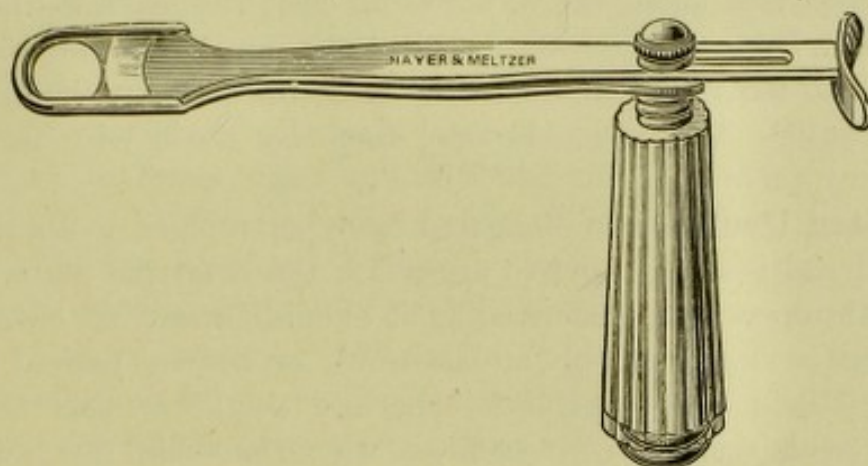


FIG. 124.—Heath's tonsillotome.

encircle the enlarged tonsil, and is pressed strongly outwards so as to enclose as large a portion as possible, at the same time the assistant makes counter pressure inwards with his finger just below and behind the angle of the jaw. If Heath's tonsillotome is the instrument used it is held in the right hand when the left tonsil is to be removed, and in the left hand when the right tonsil is to be dealt with; the blade being pushed home with the thumb of the disengaged hand. If Matthieu's or Behag's be selected only one hand is required, the right for the left tonsil, and the left for the right tonsil, and the fork helps

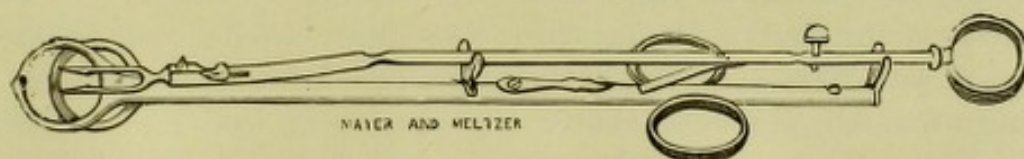


FIG. 125.—Matthieu's tonsillotome.

to pull the tonsil out of its niche before the knife comes into action. Rarely is there much bleeding following this operation. The after-treatment consists in rest in the house for a day or two, with cooling drinks or ice to suck, and the diet may be pultaceous in character for a couple of days. When adenoids coexist it is now the general custom to remove both tonsils and adenoids at the same operation. Some surgeons prefer to curette the naso-pharynx, removing the tonsils immediately afterwards; but the majority deal with the tonsils first. The writer invariably adopts the latter plan.

Method of Performing the Operation with a General Anæsthetic. The mouth is held widely open with a front gag, the tonsillotome (Heath's) is grasped in the left hand and the ring passed round the right

tonsil and pressed into position with the right index finger, counter pressure being meanwhile exercised behind the angle of the jaw by the assistant. The blade is then pushed home somewhat slowly at first until it bites, then more quickly until the tonsil is divided. The severed mass is prevented from falling into the pharynx by the knife carrying with it a small tag of tissue as it is pushed into the groove in the ring. After removal of the right tonsil the instrument is transferred to the right hand, and the same procedure carried out upon the left tonsil. The adenoids may then be dealt with as already described.

Elongated Uvula. An elongated or hypertrophied uvula may be a source of irritation, and tend to aggravate the catarrhal state, and the simple little operation of shortening it should be carried out. While the tongue is depressed by an assistant, or by the patient himself, the uvula is held with suitable forceps, and the lower part is snipped off with uvula scissors in such a way that the raw surface is situated behind. This slight operation may be performed while the patient is anæsthetized for the removal of tonsils and adenoids. The treatment afterwards is similar to that following the removal of enlarged tonsils.

MEDICAL TREATMENT OF THE THROAT.

The mucous membrane lining the throat frequently requires treatment in connection with ear disease.

Treatment of Acute Conditions. The acute forms of sore throat—such as acute pharyngitis or acute tonsillitis—are not such important causes of ear disease as the chronic forms. In the acute cases the sucking of small pieces of ice, or the sipping of iced and sweetened barley water flavoured with lemon, does good in many cases; while in others the inhalation of the vapour of hot water from a narrow-mouthed jug, either simple or medicated with benzoin or oil of pine (Formula 1), suits better. Painting or spraying with menthol (Formula 9) or cocaine (Formula 13) soothes the pain of swallowing. Dissolving tabloids of chlorate of potassium slowly in the mouth, or gargling with a solution of the same (Formula 34) is often very beneficial. Formamint tablets are said to be germicidal when dissolved slowly in the mouth. Guaiacum lozenges internally are useful in the rheumatic form, for which also 10 to 20 grains of salicylate of sodium or aspirin every few hours, or 15 grains of salol four times daily, are given. If the inflammatory process is chiefly in the interstices of the tonsils and suppuration takes place, the inhalation of steam and the application of poultices

outside soothe the pain, and tend to bring forward the abscess, which, when fully matured, should be opened with a knife, the edge of which is directed towards the middle line of the pharynx, and is protected with sticking plaster to within half an inch of the point.

Treatment of Chronic Conditions. Much more frequently, however, ear affections are associated with *chronic* affections of the throat. When the throat is simply relaxed, soft and swollen, the use of gargles (Formulæ 31 to 34), or sprays (Formulæ 15 and 33), or medicated lozenges (Formula 39) are recommended. Gargles should be employed at least night and morning, and in many cases three or four times a day. The ingredients of gargles are very various. Many patients are benefited by simply using a glass of fresh water morning and evening, or half a teaspoonful of common salt dissolved in half a pint of water. Chlorate of potassium, borax, tannin and alum gargles are all employed (Formulæ 31 to 34). While the solution of alum may be beneficial to the mucous membrane, it is injurious to the dentine. The same solutions are also usefully applied in the form of sprays. When there is dryness of the throat the inhalation of the vapour of eucalyptus (Formula 4) is useful. Suitable sedative and astringent lozenges are given under the Formulæ 39 to 43. Menthol pastilles with cocaine are antiseptic and anæsthetic. While lozenges are a very convenient and pleasant mode of applying medicaments to the pharyngeal mucous membrane, care must be taken not to injure the digestion by their too frequent use. When the congestive swelling or thickening is more pronounced, stronger stimulation is essential, and the applications must then be made by means of a brush or cotton on a cotton-holder. Glycerine of tannin, glycerine of carbolic acid, glycerine of tannin and carbolic acid, a solution of perchloride of iron, and a solution of iodine (Formulæ 37 and 38) are probably those from which most benefit is derived. A solution of iodine, iodide of potassium, and carbolic acid in oil of peppermint and glycerine (Formula 36) is probably one of the most useful, employed once or twice daily for several weeks. The others may be used daily, and they should, in most cases, be continued for several weeks.

Granular or Hypertrophic Pharyngitis. When there is localized thickening of the mucous membrane, the solution of iodine (Formula 36) will be found an excellent application. But in the treatment of this condition, cauterization with the galvano-cautery of the particular hypertrophied parts is undoubtedly the most efficient mode of treatment. A small flat burner (Fig. 61b) should be employed to each individual reddish elevation or enlarged follicle on the posterior wall of the pharynx, or laterally if there is hypertrophy of the lateral bands. A sore throat may be the result for a few days, during which the voice is rested, exposure to cold avoided, and an antiseptic gargle

or spray used. An alkalo-saline spray is useful for a few weeks afterwards. It has to be mentioned that attention to the general health is requisite in the treatment of granular pharyngitis. Gouty, rheumatic, dyspeptic and anaemic conditions or nervous exhaustion must be properly treated. Attention must be paid to any source of irritation in the nose such as hypertrophic rhinitis, polypi, etc.

CHAPTER VIII.

DISEASES OF THE AURICLE AND EXTERNAL MEATUS.

I. THE AURICLE.

ANATOMICAL AND PHYSIOLOGICAL DESCRIPTION.

Structure. The *auricle* or *pinna* (Fig. 126) is that part of the ear which projects from the side of the head. It covers a considerable area of the mastoid and squamous parts of the temporal bone. The middle segment of the concha extends 15 to 20 mm. backwards on the mastoid area, a fact which should be kept in view in operating on the mastoid. The auricle is composed of a framework of yellow elastic fibro-cartilage covered with perichondrium and skin. In the lower or most dependent portion—the lobule—the cartilaginous tissue is absent, there being here fat and connective tissue in its place. The auricle becomes much more soft and flaccid in advanced years. The skin, especially in the concavities, is richly supplied with sebaceous glands and hair follicles.

Various Parts of the Auricle. The outer or anterior aspect presents concavities and eminences which have received distinctive names. The posterior and upper edge folded inwards is termed the *helix*, but in many persons, instead of being folded, it is partially or wholly flat. The ridge, forked at the upper end, in front of the helix, is named the *antihelix*. Between these two is the fossa of the helix or *fossa navicularis*. The concave space enclosed by the forked upper terminations of the antihelix is termed the fossa of the antihelix or *fossa triangularis*. The lower prominent extremity of the antihelix is called the *antitragus*. The large deep concavity in front of the ridge of the antihelix is the *concha*, divided into two parts by the commencement of the ridge of the helix. The concha passes into the external canal of the ear. In front of and overlapping the external opening of the ear is the nipple-shaped projection of the *tragus*, whose inner surface is often the seat, especially in elderly men, of a tuft of bristly, stiff hair. The notch between the tragus and the antitragus is termed the *incisura intertragica*.

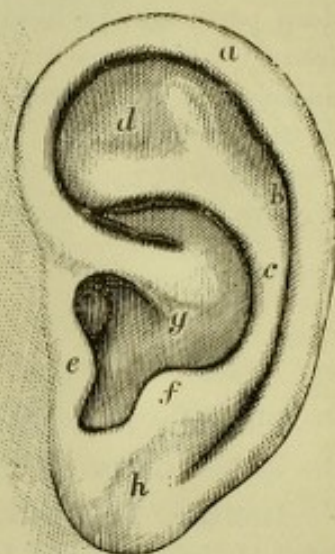


FIG. 126.—Auricle—*a*, helix; *b*, fossa of the helix; *c*, antihelix; *d*, fossa of the antihelix; *e*, tragus; *f*, antitragus; *g*, concha; *h*, lobule.

Varieties of Auricles. The auricle presents great varieties in length and breadth, as well as in the inequalities on its surface and in the size of its angle of attachment to the head. These varieties are connected partly with family peculiarities, partly with peculiarities of race, partly with habits of dress, and partly with the effects of disease. In women, for example, who have for years worn caps closely applied over the ears, the auricle may often be seen lying flat against the head. Intertrigo of the back of the ear in childhood may produce the same abnormally close application of the auricle to the side of the head. Again, the marked projection of the ear from the side of the head, so striking a peculiarity in some men, is occasionally due to, or at least aggravated by, the common habit of boys wearing their caps closely pulled down between the auricle and the head. The form of the lobule of the ear may be sadly marred by the constant traction exercised by heavy ornaments suspended from this part of the ear.

Muscles. The auricle is furnished with so-called extrinsic and intrinsic muscles—three of the former and six of the latter; but these are extremely rudimentary in man, and hence the auricle is usually capable of only a very limited amount of voluntary movement.

Function of the Auricle. This part of the ear does not seem to contribute materially to the power of hearing. It has been repeatedly observed that the loss of an auricle had little if any effect upon the acuteness of hearing, and we may therefore look upon it chiefly as the homologue of the more highly developed and more useful organ of the lower animals. Probably, however, the different concavities, especially the concha, by collecting the waves of sound and reflecting them into the external auditory canal, aid somewhat in the transmission of sound to the deep parts and in increasing the perception of it. The fact that deaf persons frequently improve their hearing by pressing the auricle forwards shows that it exercises some influence on the hearing. The hollow formed by the inner surface of the tragus is of use in guiding the waves of sound, which have been collected and reflected by the concha, into the external auditory canal (Politzer). By some writers the auricle is thought to act as a resonator for high tones.

INJURIES OF THE AURICLE.

The auricle from its exposed situation is liable to injuries, which may be of the nature of incised wounds or contusions.

Incised Wounds, on account of the irregularity of the surface of the auricle, should be brought together by means of sutures. If the auricle is permanently severed, an artificial one may be substituted. A gap in the lobule—cleft lobule—is not unfrequently seen as a result of the wearing of ear-rings. Either by the mere weight of a heavy ornament, or by violence, the lobule is torn through; and, when the two separated edges of the wound have cicatrized, a cleft remains. This deformity is easily rectified by carefully paring the edges, and accurately bringing them together by sutures.

Traumatic Hæmatoma Auris. Contusions often lead to important results, especially if, in consequence of previous disease, the cartilaginous tissue has been weakened and has on that account been

ruptured by the injury. In this way the condition named "Hæmatoma auris" or "Othæmatoma" may have a traumatic origin. The blood effused into the tissue, usually between the perichondrium and the cartilage, which in some cases is fractured, forms a sanguineous swelling at the upper and anterior part. At first this swelling (Fig. 127) has generally a dark reddish-blue appearance, but it may have the natural colour of the skin, and there is considerable pain and a feeling of tension. After a time, the contents may consist of straw-coloured fluid owing to the deposition of the colouring matter of the blood upon the walls of the cavity. If the effused blood is imperfectly absorbed, organization of the contents of the swelling takes place with

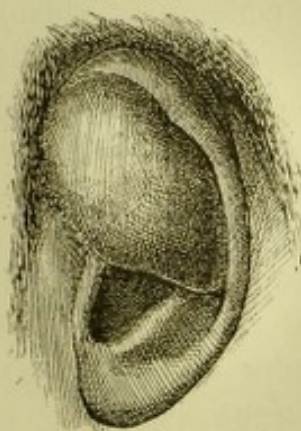


FIG. 127.—Traumatic hæmatoma auris, due to the pressure of a heavy sack of grain carried on the shoulder.

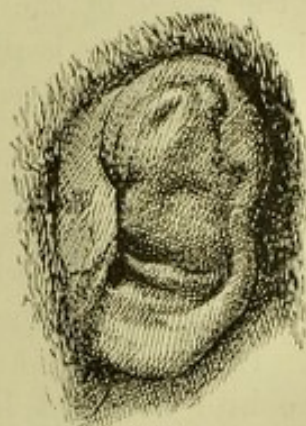


FIG. 128.—The shrunken ear after hæmatoma auris in an insane patient.

thickening of the surrounding tissues, followed ultimately by contraction. The normal ridges and concavities become in this way partially or wholly effaced, and in the course of time the auricle may be converted into a shrunken, shapeless mass—the so-called shrunken ear (Fig. 128). The most serious deformity ensues when the cartilage has been torn by the injury. This deformity is not unfrequently seen in professional boxers. The swelling may be due to perichondritis with serous effusion. It then appears as a fluctuating swelling, containing serous or sometimes purulent fluid, generally occupying the fossæ of the concha and helix.

SPONTANEOUS HÆMATOMA AURIS.

Hæmatoma auris may also arise without a traumatic cause. The swelling may be developed spontaneously and very quickly, so that in a few hours it may attain the size of a walnut. Here there is less pain and less tendency to serious deformity than in those cases which have a traumatic origin.

Frequency in the Insane. The insane seem specially liable to this sanguineous swelling, although it may also occur spontaneously in persons of sound mind. By some it is contended that even in the insane its origin is always traumatic. Its association chiefly with such forms of insanity as acute mania and general paralysis, where there is greater liability to injury, inflicted either by the patients themselves or by attendants, and its preference for the left ear, are the most important facts adduced in favour of this view. Specialists on insanity are now, however, pretty generally agreed that, while hæmatoma auris in the insane may arise from an injury, and that a slight one, its occurrence without any traumatic cause is indisputable. There seems to be therefore in the insane a special tendency to this effusion of blood in the tissue of the auricle, with the consequent shrinking, and the predisposing cause is probably some morbid change in the cartilaginous tissue and blood-vessels; the former having previously become softened or degenerated. In the ear not affected with the tumour we sometimes find nodulated, thickened portions of cartilage. The walls of the vessels have also become weaker from the softening process in the cartilage, so that slight causes, such as a gentle blow, pressure, or even the hyperæmia of mental emotion, may produce a rupture. If the "shrunk ear" come under observation, it is well to inquire into the past history of the patient, especially as to the question of insanity or injury.

Treatment of Hæmatoma Auris. When traumatic in origin, this should consist, at the early stage, in the use of cold, moist applications or the lead lotion (Formula 93), with moderate pressure. Afterwards we should employ remedies to promote absorption or to counteract inflammatory reaction, such as the application of blistering fluid. If pain be very severe and the swelling remain undiminished after some time, the fluid should be evacuated by aspiration, which, if it re-accumulates, may have to be repeated. If this fails, free incision may be required, with removal of the contents and stuffing with iodoform gauze. When it is due to perichondritis and the contents are serous, Pritchard recommends the repeated injection of tincture of iodine after aspiration, and this was employed with success by the writer in the case figured 127.

CUTANEOUS AFFECTIONS.

Eczema of the Auricle. This is the most frequent affection of the auricle which comes before the surgeon. As in other parts of the body, it may occur in the *acute* or in the *chronic* form.

Acute eczema manifests itself by great redness and swelling, with a sense of heat and tension. The irritation of a discharge from the ear

or of an application, such as iodoform or a poultice, may excite it. The disease may at this stage be mistaken for erysipelas. After a short time a more or less extensive crop of vesicles appears, from which there soon begins to exude a reddish-yellow fluid, sometimes containing blood; or the exudation may take place without the formation of vesicles. This fluid, by drying, forms crusts or scabs, which cover the cutis now denuded of its epidermis. The disease may be attended by more or less febrile disturbance.

Chronic eczema is met with much more frequently than acute. It is often a part of an eczematous condition affecting the face and scalp. It may be limited to a part of the auricle, such as the lobule, originating perhaps from "boring the ear," or more frequently from the irritation of discharge from the ear. At the attachment of the auricle to the head, is also a common situation for the disease to appear, either as a red moistened surface or as a fissure having a red and moist base denuded of epidermis. It is also frequently met with in the fossa of the helix. In the most chronic form there is usually very considerable infiltration of the skin, which is yellowish-brown, reddened, and covered either with inspissated secretion or with numerous epidermic scales. There are also frequently fissures, out of which fluid exudes, and which are apt to bleed. When chronic eczema is allowed to go on without treatment, or is of the nature of eczema impetiginosum, the auricle may be transformed into a thick brownish-red mass covered with offensive crusts and scabs or marked with fissures. Great itchiness is the predominant feeling in chronic eczema. Acute exacerbations, however, may take place, when besides the itchiness there is a painful sense of heat and tension. There is frequently also considerable loss of hearing from the induration and thickening of the skin at the outer opening of the external auditory canal.

Treatment of Eczema of the Auricle. In the *acute* form this consists in protecting the ear against pressure, and at the same time excluding the atmosphere by dusting the part with a fine powder, such as finely powdered starch (Formula 78). A solution of subacetate of lead is also very useful, alleviating the sense of heat and probably shortening the acute stage (Formula 93). A zinc and calamine lotion (Formula 94) is an efficient application in an acute moist eczema. The diachylon ointment is also a very useful application after the first few days (Formula 81). A purgative may be prescribed, and only light diet should be permitted. In the local treatment of *chronic* eczema we should be careful to treat the neighbouring parts of the head if they are also affected, and we must prevent hairs getting into the moist cracks, and so irritating them. The auricle should be protected by a light and soft covering made for the purpose, so as to avoid the contact of dirt or exposure to injurious pressure. When

there is a great tendency to the formation of crusts, the milder stimulating and astringent applications are to be used, such as the diachylon ointment (Formula 81), benzoated oxide of zinc (Formula 82), boracic acid in vaseline (Formula 86), or subnitrate or oleate of bismuth with benzoated lard and vaseline (Formula 85). The ointment should not only be applied over the diseased surface, but also smeared thickly over narrow strips of soft linen and laid into the various depressions of the auricle. The ointment should be wiped, not washed, off. It is useful also occasionally to bathe the parts with the solution of subacetate of lead. If the scabs are very difficult to remove, they should be frequently saturated with weak carbolized oil or vaseline, and then starch poultices applied. If there be great induration, infiltration, or epidermic formation, applications of a more distinctly stimulating character must be used; and for this purpose tarry and mercurial preparations are most useful. Formulæ 79 and 80 are mild stimulating ointments, with which we may begin. When there are great scaliness and dryness with itchiness, either of the Formulæ 80, 83, or 84 may be employed. The use of super-fatted tarry soap would be suitable for this condition. In scaly eczema of a very chronic character, mainly affecting the entrance to the external auditory canal, painting with a strong solution of nitrate of silver (Formula 68) two or three times, at intervals of three or four days, is very beneficial. The same application is also suitable for chronic fissures.

Internal remedies are frequently necessary in the treatment of chronic eczema, especially of the scaly variety. Arsenic and iron are the most important of these, and their use should be continued for a considerable time (see Formulæ). If we have to deal with a scrofulous patient, cod liver oil should be given in addition to the iron or arsenic. The fresh open air of the country and nutritious food are here, as in all chronic diseases, very helpful in bringing about a cure. In gouty subjects the use of alkalies or Carlsbad salts is indicated.

Herpes Zoster occasionally affects the auricle. In its distribution the eruption corresponds either with the auriculo-temporal branch of the trigeminus or with the great auricular branch of the first cervical nerve. It is usually attended with severe neuralgic pains and rarely with facial paralysis. Temporary labyrinthine deafness is sometimes associated with it. The recurrent forms are usually of the nature of herpes simplex.

Erysipelas frequently extends from the face to the auricle, although it rarely affects this part primarily; it has been known, however, to originate in the external meatus during the existence of a purulent affection of the middle ear. The swollen œdematous and reddened appearance may possibly be mistaken for the early stage of acute eczema, especially as vesication may appear in erysipelas. The nature of the case is clear when we find, as is usually the case, that it simply forms a part of erysipelas of the face and head and is associated with marked constitutional disturbance.

Lupus occasionally attacks the auricle, more frequently in the form of lupus erythematodes than of lupus vulgaris. The latter may produce serious deformity and partial adhesion of the auricle to the side of the head. In the symptoms and treatment there is no essential difference between this disease when it affects the auricle and when it attacks other parts of the body. The student is therefore referred to works on dermatology for further information.

Chilblains and Frost-bite. Under the influence of intense cold, especially in persons having a feeble circulation, the auricle may be frost-bitten, and in this way even completely destroyed by gangrene. In milder cases a local dermatitis is produced, the part affected simply appearing red and inflamed; in more severe forms there may be small livid nodules which become pale on pressure with the finger, and may lead to excoriations. Vesicles or ulcerations are occasionally seen. The treatment of frost-bite consists at first in the local application of iced water or in gentle friction so as to restore the circulation. Afterwards the lead and opium lotion and frequent bathing with hot water do good. The nodules should be painted either with tincture of iodine, collodion, or equal parts of the liniments of camphor and belladonna. If there is excoriation, an ointment, such as boracic acid with vaseline, should be applied. The results of the inflammation must be treated on ordinary surgical principles.

Diffused or Furuncular Inflammation of the skin of the auricle, or abscess, may occur either as part of a like process in the external auditory canal or as the result of improper poulticing of the ear. The lead lotion should be employed for the diffuse form; and for the furuncular variety the applications to be described for the same disease, when occurring in the external auditory canal, will suffice.

Erythema, Seborrhœa, Comedones, and other skin affections are sometimes found on the auricle, but their situation here invests them with no special claim for further consideration.

Leprosy. In almost every case of leontiasis the auricles are affected.

MORBID GROWTHS.

Various kinds of morbid growths, simple and malignant, are occasionally met with on the auricle. *Epithelioma* and *sarcoma* are very rare affections. *Fibrous growths* and *hypertrophy* of the lobule, when they do occur, have probably in most cases their origin in the irritation produced by the insertion or wearing of ear-rings. A tuberculous origin of these keloidal growths has been demonstrated by inoculation of the guinea-pig (Sabouraud). Vascular tumours, as *angioma* and *nævus*, are rarely met with. The writer has seen a case in which the dilated pulsating vessels were also on the neighbouring parts of the mastoid and head. *Sebaceous cysts* have occasionally their seat on this part of the body. *Gouty deposits*, in the form of sodium biurate, are sometimes met with, especially in the upper part of the helix or in the fossa of the helix. Morbid growths are to be dealt with, when they occur on the auricle, in the same way as on other accessible parts of the body.

CONGENITAL MALFORMATIONS OF THE AURICLE.

The auricle may suffer congenitally from *excess* or *defect* of formation or from *abnormal position*. Complete supernumerary auricles—polyotia—have been only very rarely met with. Not unfrequently, however, one or two cartilaginous or cutaneous protuberances are seen in front of the tragus, and these appendages are looked upon as very rudimentary additional auricles—the auricular appendages of Virchow (Fig. 129).

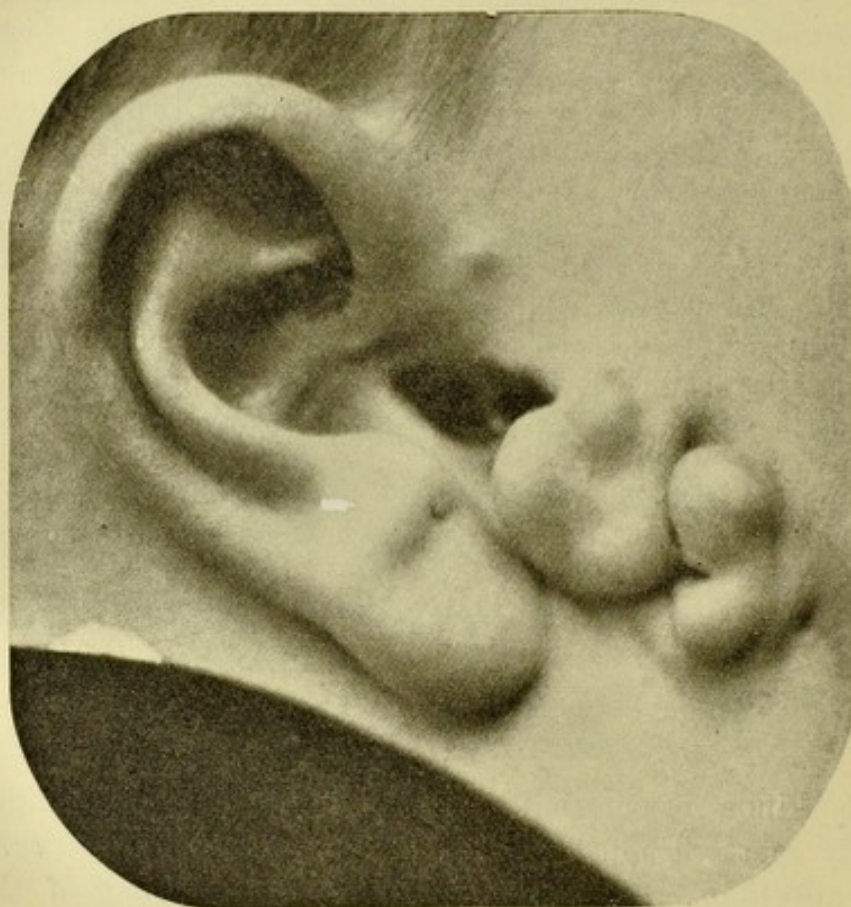


FIG. 129.—Auricular appendages (from photograph by Hartmann).

Defective Formation of the Auricle. Defective formation or development—microtia—has more important consequences. Complete absence of the auricle is very rare, for there usually exists some rudiment of the organ, however imperfect in size or formation. Sometimes it is represented by a cartilaginous ridge, at other times by a small cartilaginous or cutaneous projection, often situated further forward and lower down. In the marked forms the arrested development of the auricle is generally associated with a defective condition of the external auditory meatus, which may consist of a fine canal terminating in a blind extremity. The tympanic ring is usually absent, while the whole middle ear, including in some cases the canal

for the facial nerve, with facial paralysis, frequently shares in the malformation. Cases are, however, known where an extremely rudimentary condition of the auricle existed with quite a normal state of the other parts of the organ. Anomalies of formation of the auricle seem to be often attended by some abnormal state of the

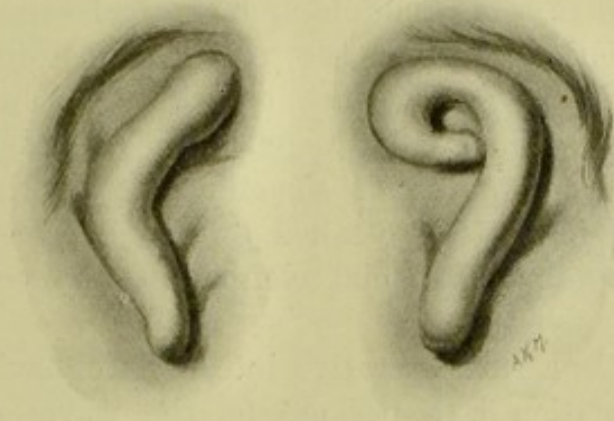


FIG. 130.—Malformations of auricles in infant who had also cleft palate.

palate and maxillary bones. The writer has recently seen a child whose auricles were represented by small cartilaginous ridges with no auditory meatus, in whom there was also marked cleft palate (Fig. 130). He has also seen an infant having a naevus on the forehead, associated with defective auricle and absence of the external meatus. If

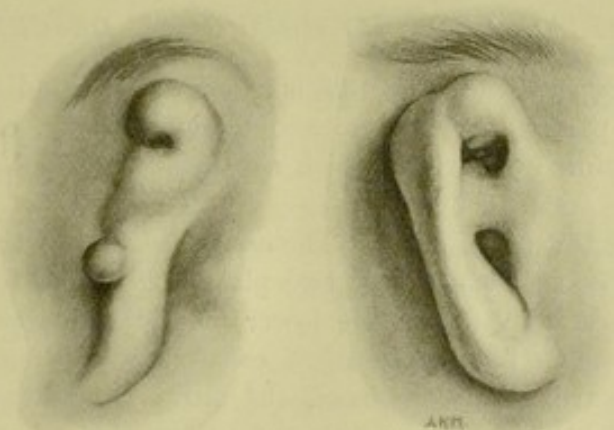


FIG. 131.—Malformations of auricles in child who had a very appreciable amount of hearing although there was no external meatus on either side.

the sentient part of the ear is not seriously involved, a certain amount of hearing is compatible with defective formation of the auricle and of the external auditory canal. The writer has had an opportunity of making an examination of a child in whom there were only rudimentary auricles (Fig. 131), with complete absence of the external auditory canals, and he was convinced, both from his own observation and the statements of the mother, that a very appreciable

amount of hearing was possessed by the child. The late Prof. Allen Thomson described the cases of several persons with congenital closure of the external auditory canals, who were capable of hearing speech in a moderately loud voice. The possession of partial hearing in such cases is probably due to the fact that the labyrinth, which has an entirely distinct mode of development, is frequently quite normal in formation. The middle and external ears are remnants of the first branchial cleft, from the posterior margin of which the auricle is developed. The labyrinth, on the other hand, arises from an invagination of the primordial integument. An indentation or short canal ending in a *cul de sac* is sometimes met with in front of the tragus or on the helix, the so-called *fistula auris congenita*, a partial persistence of the first branchial cleft, frequently containing milky-looking material.

Treatment. As a rule, operative interference, having for its object the artificial formation of a passage for the waves of sound, is not attended by any benefit. In cutting down into the small *cul de sac* representing the external auditory canal we usually come upon bone showing an osseous closure farther in. An exploratory incision, however, might be tried and could do no harm. If one auricle be rudimentary an artificial one to match the normal one can be applied.

II. THE EXTERNAL AUDITORY MEATUS.

ANATOMICAL AND PHYSIOLOGICAL DESCRIPTION.

The *external auditory canal* (Fig. 132) is a somewhat winding tube consisting partly of bone and partly of cartilage, about an inch long, extending from the auricle to the tympanic membrane, which separates the canal from the cavity of the tympanum.

Walls of the External Meatus. The *osseous* section of the canal forms the inner two-thirds. The roof consists of two plates, the upper forming part of the floor of the middle cranial fossa; the lower plate terminates internally at the margo tympanicus. The floor presents a convexity in the central part, and extends further inwards than the roof, the latter reaching further outwards. The posterior wall extends further outwards than the others, and forms the anterior wall of, and is in close relation to, the antrum mastoideum and mastoid cells. The anterior bony wall forms the posterior wall of the glenoid fossa. The *cartilaginous* section is continuous with the cartilage of the auricle; but at the upper and back part the tube is formed by membrane. The cartilaginous part contains several transverse clefts, *incisuræ Santorini*, which are filled up with fibrous membrane, while it is fixed to the bone by means of fibrous tissue, thus allowing movement of the walls of the canal when the auricle is stretched. The movements of the lower jaw are communicated to the cartilaginous meatus.

Curvature of the Canal. The curvature in the course of the canal is caused mainly by a rounded angle, usually well marked, at the junction of the cartilage and bone in the antero-inferior wall. From this projection the cartilaginous

part slopes in an outward direction pretty abruptly downwards and forwards, while the osseous portion slopes more gradually downwards, inwards, and slightly forwards to the tympanic membrane. Near the membrane the sinking of the floor is sometimes very considerable, this depression being called the *sinus* of the external auditory canal. In consequence of this depression it is often difficult to see the antero-inferior part of the tympanic membrane, while here also small foreign bodies may escape detection, and larger bodies may become very firmly fixed, so to render their removal difficult. The upper and back walls of the canal are comparatively straight. Two practical considerations follow from the curved direction of the canal. (1) In introducing the aural speculum, or when syringing the ear, the auricle should be drawn upwards and backwards, so that the angle at the antero-inferior part of the canal may be partially removed. (2) In syringing the ear, the point of the instrument should be placed on the upper wall, for, if it be placed on the lower or anterior wall, the stream will probably rebound from the angular projection, and the deep parts may remain untouched. The width and course of the canal present many varieties. In some persons it is wide and straight, while in others it is narrow and curved.

Lumen and Length. The lumen of the canal is usually oval in shape. The long diameter has a vertical direction at the entrance, while further in it becomes horizontal, and nearer to the membrane it has an oblique direction. The narrowest part, the *isthmus*, is about the middle of the osseous portion. When foreign bodies are forced beyond this, the difficulty in their extraction is much increased. Although the *axis* of the canal is about an inch in length, the anterior and inferior walls are longer than the posterior and superior. This inequality in length is due to the oblique position of the membrane, which will be afterwards described.

Meatus in Infancy. At birth the walls of the external auditory canal consist only of membranous tissue attached to the annulus tympanicus. After birth the osseous canal gradually develops, and the membranous part gives place in course of time to bone. Behind and above, the osseous canal is formed by the gradual development outwards of the mastoid and squamous sections of the temporal bone; while in front and below, termed the tympanic plate, it is formed by new deposition of bone at the annulus tympanicus, which, at birth, is a separate bone to which the tympanic membrane is attached. A gap in the ossification of this wall is found during the first few years of life and occasionally in the adult. In infancy there is very little bulging of the antero-inferior wall of the canal, while at that time of life the lower and front walls are twice as long as the upper and back walls. This is due to the more horizontal position of the membrane in early childhood, when it is almost parallel with the floor of the canal, from which it is separated by an extremely narrow space. This space is

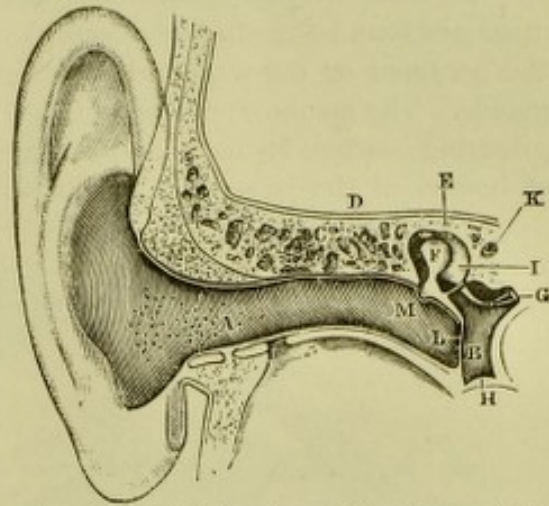


FIG. 132.—Vertical section of the external auditory canal, tympanic membrane, and tympanic cavity (right ear). A, Ceruminous glands in the external auditory canal; B, tympanic cavity; C, cellular spaces in the roof of the canal; D, dura mater lining upper surface of roof of canal; E, roof of tympanic cavity; F, head of the malleus; G, foot-piece of stapes; H, floor of tympanic cavity; I, body of incus; K, Fallopian canal; L, tympanic membrane; M, short process of malleus.

filled at birth with epidermic debris, the so-called *vernix caseosa*. It has been suggested that the infant for a few weeks after birth does not hear (von Tröltsch).

Lining of the Canal. The external auditory canal is lined by a continuation of the general cutaneous covering of the body. The skin lining the cartilaginous portion of the canal and a part of the roof of the osseous canal is fairly thick, and contains all the elements of skin. At the inner part of the cartilaginous canal are found the *glandulæ ceruminosæ*, seen as small dark points, which secrete the cerumen or ear-wax, and which are similar in structure to the sudoriparous glands. The cerumen, which in the normal condition consists chiefly of fatty and colouring matter, forms a circular yellowish white layer, having the consistence of honey, at the inner end of the cartilaginous part of the canal; it is forced

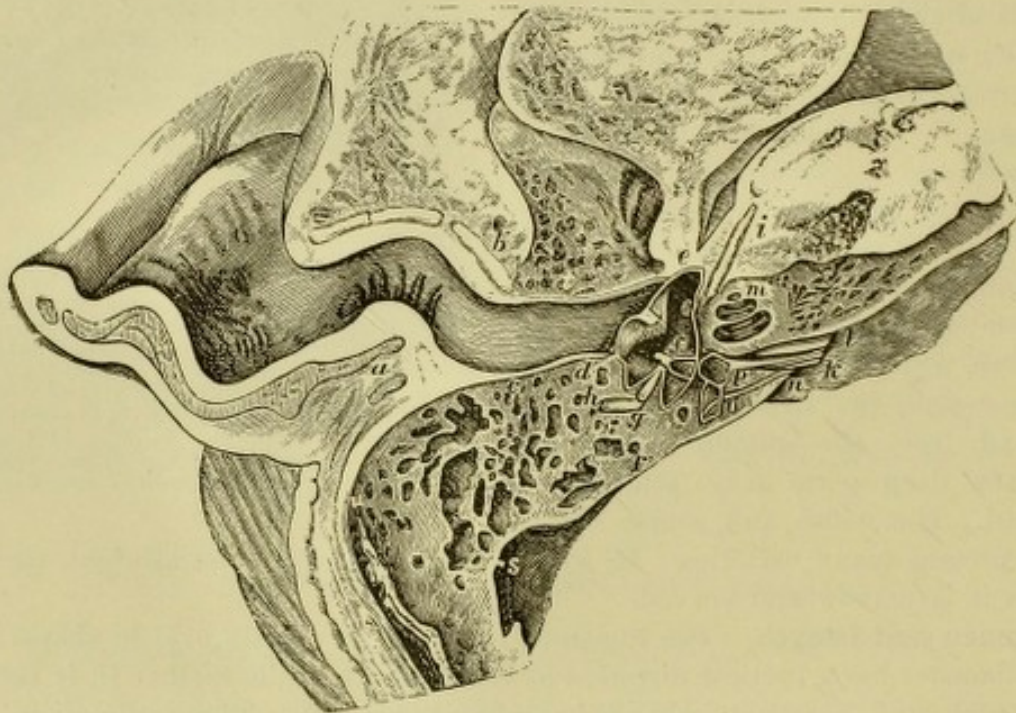


FIG. 133.—Horizontal section through the left organ of hearing, showing the curvature of external canal as seen from above, and its relations to neighbouring parts (Rüdinger): *a*, posterior wall of the cartilaginous part of the external canal; *b*, anterior cartilaginous wall corresponding with situation of parotid gland; *c*, the posterior wall of the osseous part of the canal with the mastoid cells behind; *d*, near to the insertion of the tympanic membrane; *t*, anterior osseous wall or tympanic plate; *s*, sigmoid sinus. For complete description see Anatomical Description of the Internal Ear.

outwards normally by the motions of the lower jaw acting on the cartilaginous meatus. Over the osseous portion of the canal, except at the roof where a triangular prolongation of thicker skin extends to the membrane, the skin is very much thinner, and is destitute of glandular elements, but still it has fine hairs. It is very firmly adherent to the periosteum, which really constitutes its deep layer and is almost inseparable from it. Inflammation of the cutaneous covering of the osseous part of the external auditory canal is therefore more of the nature of a periostitis, and is usually attended by much pain. Hence also inflammatory affections of this part are attended by risk of caries, necrosis, or hyperostosis in the subjacent bone. It is also to be observed that the lining of the external auditory canal, not being of the nature of a mucous membrane, cannot secrete mucus, and it is not correct to speak of catarrh of this canal. If flakes of mucus are found here, they must have come from the mucous lining of the middle ear, either through a perforation in the membrane or through a fistulous opening in the osseous wall communicating with the mastoid cells.

Relations to Neighbouring Parts. The external auditory canal has important relations to neighbouring parts (Fig. 133). (1) The parotid gland is situated in front of and below the cartilaginous part of the canal. In abscess of the parotid gland the pus sometimes makes its way through the *incisura Santorini* into the canal of the ear. Tumours or enlargements also of the gland may close or contract the canal by pressure on the anterior and inferior walls. (2) The anterior wall of the osseous part of the canal—the tympanic plate—forms the posterior wall of the articular fossa of the jaw. In injuries to the head, due to a fall from a height, this tympanic plate may be fractured from force applied to the chin. Bleeding from the ear would, in such a case, ensue; but, when due to this cause, it would not have the grave meaning usually attached to bleeding from the ear after head injuries. (3) In the young child, the tympanic plate being defective, inflammation of the external auditory meatus is apt to pass into the articulation of the jaw and the parotid gland. (4) The posterior and, to a less extent, the superior wall of the osseous meatus have a close relation to the antrum mastoideum and mastoid cells

(Fig. 134). These are separated from the external canal usually by only a thin plate of bone. Collections of matter in the mastoid cells make their way not unfrequently through this layer of bone by ulceration, and either burrow underneath the cutaneous lining or burst through it into the meatus. A fistulous passage may be formed in this way, and over such an opening exuberant granulations or even polypi may spring up. (5) The upper surface of the roof of the

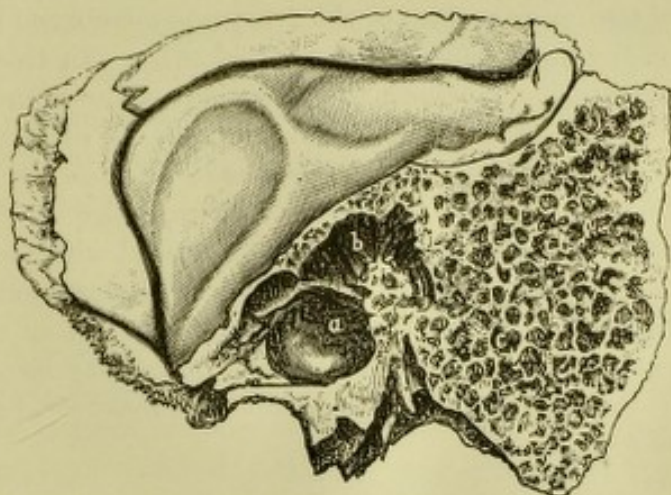


FIG. 134.—Vertical section of right external auditory canal and mastoid process seen from within: *a*, lumen of canal; *b*, antrum mastoideum; *c*, mastoid cells.

osseous canal forms a part of the floor of the middle fossa of the skull and is covered by dura mater, on which rests the brain. There are records of cases of disease of the external auditory canal proving fatal by extension to these vital parts through the roof. The posterior osseous wall has a relation to the sigmoid sinus, which is important in operations on the mastoid. While the anterior knee of this sinus is frequently at a distance of not less than 20 mm. from this wall of the meatus, it may be much nearer, and has been found by the writer as near as 5 mm.

Function. The waves of sound, collected and reflected by the auricle, or entering directly into the canal of the ear, are conducted by the column of air to the tympanic membrane. The reflection of the waves of sound from the curved walls of the meatus probably weakens, in some degree, their strength before they reach the membrane. It is found that there may be great contraction of the lumen of the canal without interfering with the hearing power.

EXCESS OF CERUMEN—CERUMINOUS OBSTRUCTION.

Composition of Ceruminous Masses. These vary in composition, consistence, and colour. They consist not only of cerumen, but also of sebaceous matter,

epidermic scales and hair, as well as foreign substances deposited from the atmosphere, such as coal-dust, etc. Not unfrequently a small ball of cotton or some other foreign body occupies the centre of the mass. Their colour and consistence depend very much on the relative proportion of the several constituents. If they are composed to a great extent of laminated masses of epidermis with an admixture of cerumen and other matters, they have a yellowish or yellowish-brown colour. When, on the other hand, they consist mainly of the products of the ceruminous glands with some sebaceous matter, the colour is a darker brown, which may sometimes become deep black when there is an admixture of coal-dust or other black substance from the atmosphere. The presence of plates of cholesterine imparts at times a shining appearance to the surface of the plug. The consistence of the masses presents great varieties; they may be semi-fluid or soft and doughy, or of an almost stony consistence from the complete evaporation of the watery constituents. When the plugs are very old, they often appear as gray, dry masses. Sometimes we find the plug covered with a dirty white membrane formed of exfoliated epidermis, while an accurate mould of the outer surface of the tympanic membrane may occasionally be seen impressed on the inner end of the expelled mass. In this case we may trace an elongated indentation marking the situation of the manubrium, while a slight bulging on each side of the indentation indicates the niche on each side of the manubrium.

In some cases the plug seems to be more the result of a pathological desquamation (keratosis); epidermic masses, hairs and cerumen closely adhering to the walls of the meatus, and being removed with much difficulty and pain.

These accumulations may fill the whole external meatus from the tympanic membrane to the outer orifice of the ear, or they may be limited to particular parts of the canal. Occasionally there may be only a thin partition at some point in the course of the canal, sufficient, however, to impede the transmission of waves of sound.

Causes of Ceruminous Obstruction. Excess of cerumen may be due (1) to an over-active state of the ceruminous glands, or to the secretion being abnormally dry and tenacious, or (2) to some defect in the natural means of escape of the cerumen from the canal of the ear. All of these factors may co-exist.

Increased secretion of cerumen is often found in persons who perspire readily, and who have a plentiful sebaceous secretion, the glands of the cutaneous lining of the ear participating in the peculiarities of the glands of the whole integument. Furuncular inflammations and eczematous conditions of the canal of the ear are apt to be followed by excessive formation of cerumen. Mechanical irritation, such as is produced by the frequent use of the point of a pen or toothpick, with the object of relieving a sense of itchiness, or of removing particles of cerumen, has a similar effect. Diseases of the middle ear, and even of the labyrinth, are frequently found associated with excessive formation and inspissation of cerumen; hence, in most cases, the removal of the accumulation is not followed by complete restoration of the hearing power. It seems that catarrhal processes in the middle ear have an influence upon the secretion of the ceruminous glands;

but why in some cases this influence should produce increase and inspissation of the cerumen, while in others it should act in the direction of diminishing or abolishing the secretion, is not yet clearly understood.

Hindrance to the natural escape of the cerumen from the ear may be the cause of the accumulation, although there may be no actual increase in the secretion of the glands. Thus its natural exit may be impeded by epidermic exfoliation, by a congenitally narrow canal, or, in old persons, by a collapsed condition of the cartilaginous walls reducing the lumen to a mere slit, or by the presence of abundant bristly hairs at the entrance to the ear. Exostosis, hyperostosis, and eczematous or inflammatory thickening of the walls of the canal also offer hindrances to the escape of the cerumen, while in these conditions small quantities of cerumen suffice to occlude it.

The efforts employed to remove the cerumen from the ear are often responsible for bringing about the very condition which they are employed to avoid. In some, these efforts are limited to the use of a towel every morning after washing, and are sometimes excited by the sense of a drop or two of water getting into the ear. A corner of the towel is screwed into a cylindrical form and pressed into the ear, pushing before it the cerumen, which is forced into the deep part of the canal. Others use a special instrument, the "aurilave," consisting of a piece of sponge fixed to the end of a small handle. These efforts to clean the ear are unnecessary as well as futile. They generally result in the formation of hard balls of cerumen in the osseous meatus, or even in the packing of the secretion upon the tympanic membrane. Ordinary washing of the visible parts of the ear with the fingers will suffice to cause a clean condition in adults whose ears are healthy. If, as is sometimes necessary in young children, the outer part of the canal of the ear requires special cleansing, this should be carefully done by the mother or nurse, while the part is clearly exposed to view, with the corner of a soft towel or sponge which must be so small as to get behind the material to be wiped away.

Symptoms of Ceruminous Obstruction. These masses may go on accumulating during a long period of time, and may have formed in considerable quantities without causing any inconvenience to the patient, or even without his knowledge of their presence, provided that a gap, however slight, exists in the mass, or that no pressure is exercised upon the membrane. On the other hand, as soon as the lumen of the canal is completely occluded, although only by a thin partition, or when even a comparatively small quantity of cerumen has come to press on the tympanic membrane, deafness, frequently accompanied by other unpleasant symptoms, are manifested.

Defective hearing may come on quite suddenly, and the patient on that account frequently considers that some disease has just affected his ear. The collection of cerumen has increased, unknown to the patient, till only a slight cleft remains, when, owing to the entrance of moisture during washing or in the bath, some swelling of the mass takes place, and the patient is suddenly, and to his dismay, affected with deafness. The degree of deafness depends upon the quantity and position of the accumulation, as well as upon the presence or absence of other disease in the ear. It may be such as only slightly to interfere with the hearing of conversation, or it may be so great that if both ears are affected loud conversation cannot be heard.

For a time the degree of deafness may fluctuate considerably owing to changes in the size and position of the plug. Movements of the jaw, sudden shaking of the head, and the introduction of the finger or some instrument to allay the sense of itchiness may disturb the position of the plug. While at other times the entrance of moisture, or the drying again of previously moist cerumen, may change the size of the obstructing mass, and so account for sudden fluctuations in the hearing. Ultimately, however, when the impaction and the hardening process have been completed, the deafness becomes uniformly severe.

Subjective sounds of various kinds and degrees may also be experienced by the patient. The most disagreeable buzzing, singing, or rushing noises are complained of, and are sometimes much more annoying than the dulness of hearing. These sounds are also apt to fluctuate in intensity from the same causes as modify the degree of deafness. They are due either (1) to pressure upon the membrane, and thence through the chain of ossicles upon the labyrinthine fluid; or (2) to reflex action upon the auditory nerve from the irritation caused by pressure upon those branches of the trigeminus and pneumogastric nerves which impart sensation to the skin of the external auditory canal.

Giddiness, even of a severe kind, may also result from the pressure of the ceruminous masses. This symptom is produced in the same way as subjective sounds, that is, either by pressure on the labyrinthine fluid, or reflexly through pressure on the nerves of the canal.

Pain is complained of in only a small number of cases. Occasionally, however, intense pain is felt, radiating from the inside of the ear along the side of the head. Probably, in these cases, the pressure of the hard mass has set up inflammation of the lining of the canal, or even of the membrane. A sense of *itchiness*, with a feeling of fulness or "stopping up," in the canal of the ear is more frequently present than actual pain.

Consequences. As already mentioned, there are, in many of the cases of accumulated cerumen, other pathological changes in the

ear, such as chronic catarrh of the middle ear or disease of the labyrinth. The lining of the walls of the canal may be found inflamed and softened, while the tympanic membrane may be thickened, pressed inwards, and even perforated.

Diagnosis. The diagnosis of ceruminous obstruction is generally very easy. By the use of the speculum and reflecting mirror, or even by the unaided vision, the mass is seen completely or partially to occupy the external meatus. It is to be noted that the mass may be so packed in upon the membrane as to form a layer on its outer surface which may, if not carefully inspected, be taken for the tympanic membrane itself. Collections of dried purulent or desquamative masses, coloured with blood or cerumen, or masses of fungi may also be confounded with accumulations of cerumen.

Prognosis. In only about a third of the cases of deafness associated with plugs of cerumen in the ear is their removal followed by complete recovery of hearing; in another third we find more or less improvement; while in the remaining third the removal of the plugs has no effect whatever. If a deaf patient, therefore, presents himself for treatment, having his ears plugged with ceruminous masses, we must not at once rashly promise a cure. If the deafness came on suddenly, after washing or after a bath, and if good hearing was enjoyed before, the likelihood is that the excessive secretion is the primary and only affection, and that its removal will completely restore the hearing. If, on the other hand, the deafness has come on more slowly, and if the vibrating tuning-fork, applied to the middle line of the head, is heard most distinctly on the unaffected or better side, the probability is that there is another deep-seated and more serious affection, and that the removal of the cerumen will not be followed by restoration or even by improvement of the hearing. The removal of the obstructing masses is, however, the only sure way of solving the question. In many persons these obstructing masses tend regularly to return after months or years, and often prove the precursors of other forms of deafness.

Treatment of Ceruminous Obstruction. In the removal of ceruminous masses we must trust mainly to the syringe and warm water, which may be employed at once if they are soft. If the mass is very hard, or firmly adhering to the walls of the canal, or if we suspect a perforation in the tympanic membrane, it is necessary to use preliminary softening measures before employing the syringe. A solution, consisting of 6 grs. of bicarbonate of sodium, 6 grs. of carbolic acid, 2 drachms of glycerine, and 2 drachms of water, is more effective than the application of oils. A small quantity of this solution, after being warmed, is poured into the ear, and allowed to remain for from five to ten minutes, this process being repeated

twice during twenty-four hours. In cases of extreme hardness of the mass, or when epidermic in character, more than one sitting may be necessary before we are able, with the syringe and warm water, aided by forceps, to dislodge and completely remove the accumulation. It is well to point out to the patient that the preliminary process of softening may for the time aggravate the deafness and the noises in the ear, owing to the swelling of the mass from absorption of fluid.

Removal with the Syringe. After the softening process the masses should be removed with the syringe and sterilized warm water (Fig. 50). If we suspect a perforation in the tympanic membrane we should take special care, as violent pain and middle ear inflammation may be excited by forcible syringing. For a description of the mode of syringing the ear, the student is referred to p. 79. While it is important that all the cerumen should be removed, we must not continue the syringing after the canal of the ear has been emptied. We should therefore examine the interior of the ear in the course of our syringing, so as to stop the operation as soon as we have washed away the whole of the mass.

After the cerumen has been wholly removed, the water should be drained out of the ear, and the canal dried with cotton wool; the tympanic membrane should also be examined and the hearing tested. For a day afterwards, a plug of cotton wool should be worn in the ear, so as to avoid the evil effects of cold air upon the newly exposed canal and membrane, as well as to protect the organ from the sudden and strong effects of sound, which may for a time be very unpleasant to the patient.

Syringing produces some injection of the blood-vessels of the membrane and of the inner part of the canal, which, however, passes off in a few hours.

Deficiency of Cerumen. This is often found in persons whose skin is dry and hard—the *glandulæ ceruminosæ* sharing in the inactive condition of the sudoriparous glands of the general cutaneous covering. We meet with deficiency of cerumen most frequently in elderly persons who suffer from sclerosis of the middle ear. The canal of the ear is then found to be dry, destitute of this natural emollient, and also abnormally wide. In these cases the ceruminous glands after a time become atrophied, or they even disappear altogether. It must be remembered, however, that the cerumen may be deficient simply because it is being constantly washed away by purulent discharge, or being removed by the efforts of the patient in picking the ear, or by frequent syringing.

Symptoms.—The only symptom of deficiency of cerumen is a feeling of uncomfortable dryness in the ear. As has been said, it often co-exists with impairment of hearing; this, however, is not the *result* of the absence of cerumen, which may rather be looked upon as an *indication* of disease in the middle ear.

Treatment.—The sense of dryness in the ear may be relieved by painting the walls with vaseline or a slightly stimulating ointment. This has, of course, no effect upon the hearing. The treatment of the associated disease in the

middle ear is sometimes followed by increase in the secretion of cerumen, which may happen even when no beneficial effect is produced in the hearing power of the patient.

FURUNCULI OR CIRCUMSCRIBED INFLAMMATION OF THE EXTERNAL MEATUS.

SYN.—OTITIS EXTERNA CIRCUMSCRIPTA ; BOILS IN THE EAR.

Pathology. This painful and troublesome affection has its origin and seat in a gland or hair follicle in the subcutaneous tissue of the external meatus. Like furuncular inflammation in any other part of the body, a boil in the ear is attended by the formation of a core, composed of sloughed connective tissue or of a necrosed follicle or gland, around which there is usually more or less purulent formation. In this way an abscess may form in the subcutaneous tissue of the external auditory canal.

The disease does not often terminate with a single boil ; we generally find that there is a succession of them, and that, while one is passing away, another begins to manifest itself. We may find at the same time boils on other parts of the body, especially on the scalp, eyelids, and face.

Causes. Boils in the ear are found most frequently in adults. While the disease often affects persons who are otherwise healthy, being due to an entirely local cause, it may be associated with defective states of the health. Diabetes is in some cases a predisposing cause.

Local causes, however, play the most important part in the etiology of the disease. Mechanical irritation, as the use of pointed substances to relieve a feeling of itchiness, may excite the disease. Hence boils are often found where chronic scaly eczema already exists in the cutaneous lining of the external meatus. The prolonged action of pus or other fluid, such as ear lotions, upon the skin of the canal, is a frequent exciting cause of the disease. For this reason, boils in the ear are a common complication of purulent diseases of the middle ear. The action of cold air or cold water, or of chemical irritants, may also produce furuncular inflammation.

The *microbic origin* of furunculi is now generally admitted, the disease being due to the invasion and multiplication of a special microbe, the staphylococcus pyogenes, aureus or albus (see p. 72). It is probably often inoculated by scratching, or introduced by some slight abrasion of the skin. The parasite enters a hair follicle, where it excites the intense inflammation characteristic of a boil. This view of the disease has modified and guided the course of treatment.

Subjective Symptoms. The symptoms experienced by the patient are usually pain, impairment of hearing, and subjective sounds in the ear. The degree of their severity depends upon the intensity of the inflammatory process, and upon its situation in the canal of the ear.

Pain in the ear may, if the inflammatory process be superficial and at the outer entrance of the ear, amount to only a sense of warmth and fulness, or "stopping up." If, on the other hand, the inflammation be deeper, and especially if it be situated in the bony part of the canal, so that the inflammatory area has an osseous basis, the pain is usually intensely acute. Patients often describe it as that of a painful sense of stretching, and a distracting beating or "hammering in the ear," worse at night, with occasional intermissions of an hour or two. A sharp pain also frequently radiates over the side of the head. It is aggravated during chewing or speaking, or any other movement of the lower jaw, this being due to the close relationship between the canal of the ear and the articulation of the lower jaw. Pulling the auricle of the affected side, or lying upon it, also aggravates the pain, while incautious attempts to introduce a speculum cause severe suffering. The tragus is often especially tender to touch or pressure when the furunculus is on the anterior wall.

In some cases, and particularly when the furunculus is situated on the posterior wall of the meatus, the mastoid process may be very painful on pressure, with considerable œdema and even jutting out of the auricle, thus *simulating periostitis* of the mastoid process.

Defective hearing is commonly present, and depends upon the extent of the occlusion of the canal by the disease, or upon the amount of concomitant hyperæmia of the middle and even of the inner ear.

Tinnitus aurium, when present, is usually of a humming or buzzing character, and is due either to the causes mentioned as producing the deafness, or to the sympathetic relations between the canal of the ear and the labyrinth.

Febrile disturbance, especially at night, may be experienced in irritable systems, or in very severe cases.

Objective Symptoms. In examining the canal of the ear, we must use caution and gentleness, employing only the reflecting mirror until we ascertain the position of the boil; we may then introduce a speculum very gently for a short distance. The attempt to push a speculum into the external meatus when a boil is at its entrance will cause the most acute pain. If the furunculi be connected with middle ear suppuration, the ear should first be gently syringed and dried.

The most frequent position for the furunculus is the cartilaginous section of the canal, where it usually forms a distinct rounded bulging, unless at the very early stage when the pain excited by the pressure of a probe is the only indication of its presence. We may also find at the early stage the colour of the bulging little changed from that of the normal skin, the inflammation being then mainly in the tissue under the skin. At a more advanced stage, however, the skin over the

furunculus is usually distinctly red, and the central part is very sensitive when touched with the point of a probe. There may be two, or even three furunculi found at the same time closing the meatus, one of them being usually more acute than the others.

Course and Consequences. The disease sometimes passes off without suppuration or rupture. Much more frequently, however, after from three to five days a reddish, seldom yellowish, spot appears on the surface of the boil, where it bursts, giving exit to some drops of thick pus and to a small flaky mass of sloughed tissue. This latter may require to be helped out by gentle pressure on each side with a probe. Immediate relief usually follows the rupture of the boil. The purulent discharge is generally small in quantity and short in duration, but in certain dyscrasiæ, or where there has been defective treatment, especially the want of proper cleansing, the disease may take a more chronic course. The edges of the opening may then become covered with granulation tissue and exude a thin sanious matter. It is frequently found that increased formation of epidermic scales and cerumen follows an attack, producing deafness. Hence it is well that the patient should return for examination a month or two after an attack, so that such an accumulation, if present, may be removed.

Diagnosis and Prognosis. It is known by the localized character of the swelling and by the pain, as tested by the probe, being limited to a spot at the centre of the swelling. In the diffuse form of inflammation the swelling is uniform, while there is also usually much more secretion or epidermic exfoliation than in the circumscribed variety. It must not be confounded with the sagging of the roof of the meatus at its inner end which attends acute mastoiditis, or with a swelling in the upper and back part of the osseous canal, due to a collection of pus which may have made its way through the bone from the mastoid cells. It is sometimes simulated by an exostosis. The history of the case and careful examination enable us to avoid any error of diagnosis. When there is œdema and pain over the mastoid, the condition may be mistaken for periostitis.

The *prognosis* of this disease is very favourable if properly treated. It is, however, advisable to warn the patient that several successive boils may form, one immediately after the other, with recurrence, on each occasion, of the painful symptoms, before the disease fully disappears. It is also to be noted that certain persons have regular and periodic recurrence of boils in the ear from fresh infections at intervals of weeks or months; in such cases the urine should be examined for sugar.

Treatment of Boils in the Ear. We shall consider this under the three heads of (1) preventive measures; (2) remedies to cut short or to mitigate the inflammatory process; (3) constitutional treatment,

(1) Causes which are known to excite boils in the ear should, if possible, be removed. If a patient is suffering from a purulent disease of the middle ear, we must see to it that proper treatment is employed for this, so as to avoid the action of organisms in the discharge upon the follicles of the external meatus. Chronic eczema, or pruritus, of the external canal of the ear, if found to exist, should always be removed by appropriate treatment. Indiscriminate poulticing or the pouring of oils into the ear should be forbidden, syringing, unless followed by careful drying, is also to be avoided—these often account for the persistence of the disease.

(2) If the pain be intense and persistent, *incision of the inflamed tissue* is an effective means of cutting short the inflammatory process. We need not wait till we are sure of suppuration, as, before that stage has been reached, the relief of tension and the free depletion have an excellent effect in allaying the painful symptoms and in cutting short the inflammatory process. A local anæsthetic, such as Formula 65, may be applied. The incision should be deep and free, as the chief seat of the inflammation is underneath the skin. A knife with a slender and sharp-pointed blade, such as a fine tenotomy knife, is best suited for making the incision. We should not cut *down* upon the inflamed tissue, but from below upwards, as this is less painful. Afterwards gentle pressure should be used on each side of the incision with a probe, in order to press out the contents of the boil from the opening, and then the ear should be syringed with a warm solution of boracic acid and carefully dried with cotton. Warm applications may be used for a few hours after the incision, but it is to be noted that the sooner we stop the application of moisture to the canal of the ear the less likelihood will there be of a succession of fresh furunculi. The writer has found great benefit from an ointment of 2 grains of iodoform or boracic acid, and 2 grains of menthol in a drachm of vaseline, thoroughly smeared on cotton plugs introduced into the canal of the ear, and changed every few hours. Some prefer carbolic acid and vaseline or glycerine (1 in 50). These plugs should be made so as to occupy the canal of the ear but not to press unduly upon its walls; if they prove uncomfortable, the lining of the meatus should, instead, be frequently painted with the ointment. The instillation of antiseptic solutions, in the recurrent form, is preferred by some—such as boracic acid and alcohol (1 in 20), or bichloride of mercury (1 in 2000).

If the treatment by incision cannot be carried out, owing to the aversion of the patient to the operation, or if it is not deemed necessary, we may employ other remedies to relieve the symptoms. Warmth and moisture are extremely useful in relieving the pain and in hastening the process of softening. These may be applied by means of warm linseed meal poultices, or hot fomentations, which should cover the ear

and should be frequently renewed, *at the same time* the canal of the ear should be occupied by the antiseptic plugs; the moist applications should be stopped with the subsidence of the pain.

If the opening made by the rupture or the incision assumes an unhealthy tendency, it should be kept free from secretion by drying with cotton wool, and insufflating finely powdered boracic acid. If granulations arise, they should be removed with forceps or cauterized with chromic acid.

(3) *The general treatment* of the patient, especially in the recurrent form of the disease, is of importance. If any general disease or evidence of malnutrition exists, such as anæmia on the one hand or plethora on the other, we must employ appropriate medicinal and hygienic treatment. In all cases we should inquire after and regulate the diet, the hours of rest, the use of stimulants, exercise, baths, etc. The digestive functions are frequently found to be at fault, and are, as a rule, to be corrected by careful attention to regimen as well as by the judicious administration of medicines. Liquor arsenicalis has been recommended as a specific remedy in persistently and periodically recurrent furunculi in the ear. Sulphide of calcium is said to limit or cut short the disease. Of course, if glycosuria exists appropriate treatment must be instituted.

DIFFUSE INFLAMMATION OF THE EXTERNAL AUDITORY CANAL—OTITIS EXTERNA DIFFUSA.

Pathology. The inflammatory process is most frequently of the eczematous variety and extends over the greater part of the cutaneous lining of the canal, generally, indeed, over its whole extent. It usually involves the outer layer of the tympanic membrane, while there may be also some hyperæmia of the middle ear. In the severe forms the periosteum lining the osseous part of the canal participates in the morbid process, and in the *hæmorrhagic* form there are bluish swellings in the osseous meatus, which are elevations of the epidermis containing blood. The initial stage of hyperæmia commonly advances to exudation on the surface, and to *abundant epidermic exfoliation*. *Croupous* and *diphtheritic* forms have been observed during epidemics of these diseases. In these cases a dirty greyish membrane is seen adhering to the osseous meatus, very difficult of separation, especially in the diphtheritic form, when a bleeding surface is exposed.

Causes. (1) The worst forms of the disease are the results of injury, especially the introduction of irritating substances, the unskilful use of injections, the presence of foreign bodies in the ear, or improper or violent attempts to remove them. (2) Probably most cases are of the nature of *eczematous inflammation* with copious serous exudation. These may be acute exacerbations of chronic eczema, perhaps excited by the use of hard substances to relieve the itchiness attendant upon scaly eczema of the external meatus. The squamous variety of eczema

limited to the external auditory meatus is usually regarded as seborrhœic in origin, accompanied with seborrhœic manifestations elsewhere. (3) It often arises from disease in the middle ear, especially in the mastoid cells, when, from great swelling and thickening of the lining of the canal, the latter may be almost closed. Extensive caries or necrosis may affect the osseous meatus, originating in the mastoid antrum or cells. When affecting the inner section of the canal, it is often a part of an acute otitis media. *Syphilis* and *fungi* excite special forms, which will be afterwards separately considered. The diphtheritic is the rarest form of the disease.

Subjective Symptoms. The sensations experienced by the patient vary much in different cases.

The painful sensations are in some very slight, being limited, as in the eczematous variety, to more or less itchiness, heat and fulness in the ear. In other cases the symptoms advance to a dull aching in the ear, which in severe forms, and especially when the osseous part of the canal and the membrane are involved, becomes of an intense and penetrating character, radiating from the interior of the ear over the side of the head. The pain is usually aggravated at night, and may be increased by movements of the jaw or by shaking the head as in coughing, as well as by pressing or pulling upon the auricle. Incautious attempts to introduce a speculum are also attended by acute pain.

The hearing is impaired in proportion to the amount of swelling of the walls of the canal, the quantity of inflammatory products contained in the canal, and the degree in which the tympanic membrane and cavity of the tympanum participate in the inflammation.

Subjective sounds, particularly a sense of pulsation or buzzing, are generally experienced by the patient, and depend on the same causes as produce the impairment of hearing.

General malaise, associated sometimes with distinct feverishness, may be present in the more severe forms.

Objective Symptoms. In the early stage the walls of the canal are seen to be hyperæmic and swollen. The hyperæmia is observed chiefly on the osseous walls of the canal adjoining the membrane. In rare cases hæmorrhagic elevations of the epidermis are seen on the floor of the osseous portion of the canal (*otitis externa hæmorrhagica*). A discharge from the ear appears in two or three days, serous in the case of eczema; and, if the process goes on, we find the canal occupied either with serous or purulent secretion, which may be partially dried in the form of scabs, or with laminated masses of sodden epidermis mixed with purulent or serous fluid. These laminated masses are thrown off partly from the skin of the canal and partly from the outer layer of the membrane; they sometimes form almost complete casts of

the canal and membrane. On account of them and of the swollen condition of the lining of the canal, there is considerable difficulty in getting a view of the deep part of the canal and of the membrane. We should endeavour to remove these accumulations, which is not always easily done, by cautious and gentle syringing with a solution of boric acid and careful drying. If we succeed in doing so, the walls of the canal, and generally the membrane also, will be found reddened, swollen and spongy, while the normal boundary between the walls of the canal and the membrane will not be distinguished. The cutis, where exposed by recent loss of epidermis, presents a reddish, granular, moist surface.

In the later and *chronic stages* the secretion has usually a very disagreeable smell, and has also an irritating effect on the skin of the auricle. There is more or less congestion, with swelling or thickening of the lining of the external auditory canal, which, especially at its upper and back part, is often covered with brownish crusts emitting a bad smell. Granulations are sometimes seen springing from the diseased skin. The tympanic membrane is generally thickened, especially in its outer or cutaneous layer, the vessels of which are often injected, particularly at the upper part. There is in some cases excoriation, or even perforation of the tympanic membrane. We may find glandular enlargements in the neck below the ear, and there may also be more or less swelling of the parotid gland.

Course and Consequences. In very slight cases, or when prompt treatment is employed, the inflammatory process may end in resolution before the stage of exudation. Generally, however, it passes on to exudation and exfoliation, after which the morbid process begins to abate; and the discharge from the ear may come to an end in from one to two weeks, or it may go on to the chronic form. When the disease occurs in a person of unhealthy constitution, or when treatment is neglected or of an improper kind, the disease lapses into the chronic form, and, as one form of otorrhœa, may continue for months, or, with occasional remissions or interruptions, for years. When long continued it may bring about such consequences as the following:—(1) Stenosis of the canal from hypertrophy of the cutaneous lining or from hyperostosis of the osseous walls; (2) caries or necrosis of the osseous part of the canal; this is, however, much more commonly the result of middle ear disease; (3) opacity and thickening, or ulceration and perforation, of the tympanic membrane, with propagation of the disease to the middle ear; (4) extension to the articulation of the lower jaw, especially if gaps exist in the anterior wall, as they do in children, or to the parotid gland through the clefts in the cartilaginous meatus; (5) fatal implication of the meninges, brain, or lateral sinus by extension through the roof or back wall. Fatal

extension from the middle ear spaces is, however, very much more common. Some of these consequences will be presently described more fully, while others will be discussed under the head of "Consequences of Purulent Inflammation of the Middle Ear."

Diagnosis and Prognosis. The points which distinguish the diffuse form of inflammation from the furuncular have already been noticed (see p. 197). In some cases it is very difficult to distinguish it from inflammation of the middle ear, when the latter is attended by swelling of the lining of the inner end of the canal. Further, if a perforation exists in the tympanic membrane, and the middle ear be also involved in the chronic purulent disease, it may be impossible to say whether the disease has primarily affected the middle ear or the external meatus.

With proper treatment the prospects of early and complete recovery are very favourable, if the middle ear or bony walls be not involved; even when perforation of the membrane has taken place, it may, under judicious treatment, be quickly healed. The eczematous form is sometimes obstinate and tends to recur. Even in the chronic state, if the disease be limited to the cutaneous lining of the canal, careful and persevering treatment will in most cases be crowned with success.

Treatment of Diffuse Inflammation of the External Meatus. In the acute stage associated with severe pain, the treatment described in Chapter XII. for the early stage of purulent inflammation of the middle ear is suitable.

When the stage of secretion and epidermic exfoliation has been reached, the inflammatory products contained in the canal of the ear should be removed by cautious and gentle syringing with a hot solution of boracic acid or a two per cent. solution of carbolic acid. This is very soothing to the patient; but forcible syringing will excite pain, and may cause perforation of the membrane. After syringing, the interior of the ear should be carefully dried by means of absorbent cotton on a cotton-holder, and a small quantity of finely powdered boracic acid blown in. This is to be removed by syringing when it becomes saturated with the secretion, and a fresh application made. As soon as the secretion has ceased to form, the ear should be finally syringed and the parts simply kept dry. In the exudative stage of the eczematous form the application of an absorbent powder such as Formula 78 is useful, or of an ointment (Formula 82). When the lining of the walls of the canal is much thickened the introduction of elongated cotton plugs smeared with an ointment (Formula 79) into the meatus is very useful. In persistent forms a strong solution of nitrate of silver (forty grains to the ounce of water) should be painted over the walls of the canal by the surgeon several times, at intervals of three or

four days; this has a very beneficial influence upon the thickened cutaneous tissue. After the use of nitrate of silver, a ball of cotton soaked in a solution of common salt should be inserted in the orifice of the ear for a minute to prevent blackening. In the dry scaly form with troublesome itchiness the use of Formula 72 is indicated; in the seborrhœic variety a spirituous solution of salicylic acid is very useful (Formula 73). Granulations are most efficiently and quickly treated by removing them with Wilde's snare or with forceps, and afterwards employing the spirit treatment. The treatment of the other complications and consequences of chronic otitis externa will be found under their own proper headings.

Constitutional treatment is useful when the disease occurs in weakly persons, although local treatment is always of the first importance. Iron, cod liver oil, nutritious and digestible food, plenty of fresh open air, etc., have often a determining influence upon the favourable issue of the disease; alkalies and aperients should be given, if the eczematous inflammation be gouty.

STRICTURES OF THE EXTERNAL MEATUS DUE TO INFLAMMATORY AFFECTIONS.

Varieties of Stricture of the External Meatus. (1) *Swelling or thickening of the cutaneous lining* may so contract the canal of the ear as scarcely to allow of the admission of an ordinary probe. Its most frequent causes are (a) chronic eczematous inflammation, when it mainly affects the outer part of the canal, or (b) chronic otitis externa, either primary or arising from purulent inflammation of the middle ear; the latter is more frequent, and hence there is usually discharge from the middle ear. The cautious use of the probe will show the degree and length of the narrowing.

(2) *Septa or adhesions* may be due (a) to the coalescence of granulation or polypoid tissue, (b) to the long-continued contact of abraded surfaces which have been brought into apposition by thickening of the cutaneous lining, or (c) to ulceration from the effects of burns, caustic substances, syphilis, etc. There may be a complete membranous partition, which, if situated far in, may be mistaken for an altered tympanic membrane; or a septum in the form of a ring with a central aperture may be found. A considerable extent of surface may be adherent, and the closure may even become bony. The degree of deafness varies according to the thickness of the septum or the breadth of the adhesions. The probe should be employed to determine the situation and nature of the closure.

(3) *Hyperostosis of the meatus* consists of a diffused thickening of the whole extent, or of a considerable portion, of the osseous part of the

external canal, producing a uniform contraction of its lumen. The bony surface may be smooth, but more frequently it presents small rough elevations. The skin of the canal is generally reddish and swollen or even thickened. It may usually be looked upon as a chronic periostitis, with increased formation of osseous tissue; and it is *very frequently associated with chronic purulent disease of the middle ear*. After the removal of a sequestrum from the posterior wall of the canal, thickening and hypertrophy of the osseous tissue sometimes take place, which may almost totally close the canal. A similar condition of osseous hypertrophy may exist at the same time in the walls of the tympanum and of the mastoid cells adjacent to the external canal of the ear. Hyperostosis is sometimes, however, found in connection with non-purulent catarrh of the middle ear. The defective hearing, which generally exists, is due rather to the presence of secretion in the canal, or to concomitant disease of the middle ear, than to the mere thickening of the walls. The contraction of the lumen of the canal, caused by the uniform thickening of the osseous walls, may lead to serious consequences in cases where purulent disease of the middle ear co-exists with it.

Hyperostosis is distinguished from exostosis by the distinctly circumscribed form of the latter as compared with the diffused uniform thickening of the former.

Treatment of Strictures of the External Meatus. When due to cutaneous swelling or thickening, in the event of there being a discharge from the middle ear, gentle syringing with a warm solution of boracic acid, with subsequent careful drying of the walls of the canal and the introduction of diluted spirit, should be carried out. After each application a long cylindrical plug of cotton wool, smeared with an ointment composed of 4 grains of iodoform to a drachm of vaseline, is inserted by means of a cotton-holder and is changed morning and evening. Along with the treatment of the middle ear, comparatively slight and gradual pressure with the cotton plug often effects great improvement. If the canal is not sufficiently widened in this way, a thin compressed sponge tent should be used. The tent must not be allowed at first to remain in the ear more than two hours, during which the patient should be close at hand, so that the surgeon may himself remove it. At intervals of two or three days such tents may be introduced with good effect. Severe and rapid dilatation must be avoided. In cases of purulent secretion retained in the deep parts, after dilatation with the tent a small conically-shaped vulcanite or soft rubber tube may be inserted and kept in; this maintains the dilatation, allows escape of the secretion, and permits of syringing the ear. In these cases of retention, however, the radical mastoid operation is usually required (see p. 126). In the dry scaly thickening of eczematous

conditions, a plug of cotton wool, saturated with a solution of nitrate of silver (40 grs. to the ounce), should be inserted for a few seconds and then neutralized by a solution of common salt. A plug of cotton smeared with a slightly stimulating mercurial ointment (see *Ointments* in list of Formulæ), should afterwards be worn in the ear.

If a *septum* be found in the meatus, it should be removed by a circular incision, after which the ear should be kept packed with strips of gauze for some time. If there be *adhesions* of surfaces, careful separation with a fine-bladed knife may be attempted, followed by the use of a strip of gauze.

In an *elongated osseous stricture* good may be done by removing epidermic or ceruminous accumulations, which are liable to form. If a purulent discharge exists, whether its source be in the middle ear or in the external auditory canal, this must be carefully treated. Thickening of the cutaneous lining of the canal is to be dealt with as already described. The cautious use of sponge or laminaria tents, in order to produce a gradual mechanical pressure upon the osseous growths, may be followed by an increase in the width of the canal, and then treatment directed to the removal of the disease in the middle ear can be more effectively employed. The sponge tent is to be preferred on account of its being more gradual in its action; excessive and rapid pressure on the walls may do much harm. If symptoms of retention of pus in the middle ear show themselves, we must not hesitate to perform the radical mastoid operation (see p. 126).

Congenital Contraction. The canal of the ear may be altogether absent, or it may be so narrow that the most slender probe cannot be introduced. In these cases there is usually also a congenital defect of the auricle, as well as of the middle ear and sometimes of the labyrinth, so that an endeavour to form an artificial canal is rarely successful in giving better hearing. If, as in some cases, there is simply great contraction of the cartilaginous part of the canal from congenital causes, persevering efforts to dilate this portion by laminaria or sponge tents may have good results.

In some persons we find that the antero-inferior wall of the middle part of the osseous canal projects so much towards the lumen, that only the upper and back part of the membrane is visible. The only inconvenience of this abnormality is the hindrance which it presents to examination of the membrane or to operations upon it.

Collapse of the Meatus. This is found chiefly in persons of advanced age and is caused by the approximation of the posterior to the anterior wall at the entrance to the ear. This approximation is probably due to an over-flaccid condition of the fibrous tissue and skin which form the upper and back walls of the cartilaginous canal. The entrance to the ear may in this way be reduced to a mere slit. This rarely interferes with the acuteness of hearing; but, if it does so, the patient should employ a small silver tube of the same shape as, but rather smaller than, an ear speculum. This is to be kept in the ear only on

occasions when it is important that the patient should hear. As has been already mentioned, accumulation of cerumen is likely to take place in this condition, owing to the hindrance to its normal removal from the ear.

EXOSTOSES OR OSSEOUS TUMOURS IN THE EXTERNAL MEATUS.

These, while not common, are met with now and again. They appear as hard, rounded tumours of very various sizes, with circumscribed bases, projecting from the osseous walls of the canal of the ear (Coloured Plate No. I., Figs. 14 and 15). They are of two kinds, namely, those which have a pedunculated attachment, and those which are sessile and attached by a broad base. The latter are often multiple, very hard, and terminate in apices which may meet in the centre of the canal. These tumours are generally composed either of compact or of spongy bone, but occasionally they are hollow.

Causes. Exostosis is met with more frequently in men of middle age who eat and drink generously; and Toynbee believed the disease to be connected with the gouty or rheumatic diathesis. Heredity has also probably a predisposing influence in the causation. Those which are found in both ears, in the inner end of the osseous meatus, and which rarely go on to closure, probably originate in the process of ossification. The growths may be found associated with chronic non-purulent catarrh of the middle ear; but there is no doubt that a considerable number originate in irritative or inflammatory processes in the external auditory canal, usually secondary to chronic purulent inflammation of the middle ear. In such cases it is supposed that there is first of all periosteal thickening, or a small abscess in the external auditory canal, with granulation tissue; and that the granulation tissue is gradually converted into bone by a process of ossification extending from the base. It is significant that a large proportion of cases have their origin in the posterior or mastoid wall of the canal—a situation more prone than any other, owing to its relation to the mastoid cells, to inflammatory and purulent processes. That the frequent entrance of water into the canal of the ear is an important factor in the causation of these growths is pretty well established.

As bearing upon the etiology of these bony growths in the canal of the ear, we may refer to the remarkable observations by Blake, of America, upon the crania of the mound builders of the Cumberland valley of Tennessee, and of Seligmann, in regard to the crania of the Titicacas. Out of 195 crania of the mound builders examined by Blake, an exostosis in one or both canals was found in 18 per cent., and these were in most cases on the posterior walls. The most likely explanation of this remarkable prevalence is that these aboriginal inhabitants of America, living as they did on river banks, were frequently in the water, the irritation caused by the entrance of water being probably the exciting cause. Aural exostoses are very common among the South Sea Islanders who

are, in many cases, almost amphibious in their habits, and are notable divers, remaining under water for prolonged periods. Their ears are thus frequently full of sea water at varying degrees of temperature and pressure. The observations as to this frequency of aural exostoses include chiefly the Fijian and Hawaiian Islanders.

Symptoms and Course of Exostoses. These growths are usually very tender when touched with a probe. If the lumen of the canal be completely blocked there may be intense pain, due to the pressure of the expanding growth on the walls of the canal. If they have not developed to so great an extent as to close the canal, the patient has rarely a feeling of anything being wrong, and the presence of an exostosis may be first ascertained, when deafness, produced by epidermic or ceruminous accumulations, brings the patient to the surgeon for advice. Or he may first ask the aid of the surgeon in consequence of the symptoms produced by a co-existing middle ear disease. When the exostosis has completely closed the canal, the deafness is, of course, very considerable or even complete.

We may find several of these growths in the same ear, and not unfrequently they are present in both ears of the same person. They appear as knob-like projections, often of ivory hardness when touched with the probe, generally of a pale colour, but sometimes slightly red. If they be large, so as almost to close the passage of the ear, the skin over them may be thickened and spongy, and of a reddish colour. The surface is generally quite smooth. They may appear at any part of the canal; but the pedunculated variety is more frequently met with coming from the back wall, especially at the junction of the cartilaginous and osseous portions of the meatus. In that situation also they generally lack the ivory hardness of the multiple ones situated in the deeper parts of the meatus. We sometimes see two or three conical growths springing from opposite walls with only a fine opening between their apices.

The growth of these tumours usually extends over a long period of time. They sometimes, however, go on quickly to complete closure of the canal; or, on the other hand, after having reached a certain size, they may become quite stationary.

Diagnosis and Prognosis. Their hardness, comparative paleness, and circumscribed form usually distinguish them from any other morbid growth in the canal of the ear.

In very many cases they never develop to such an extent as to produce serious inconvenience. Sometimes the cutaneous lining becomes inflamed and swollen, and there may even be granulation tissue occupying the chink. If the canal be completely closed and if the growth cannot be removed, there is not only great impairment of the hearing, but there is always the possibility that, in the event

of a purulent disease affecting the middle ear, a fatal issue may arise from retention of the purulent secretion.

Treatment of Exostoses. If there be epidermic or ceruminous accumulations these must be regularly and carefully removed; this may often postpone operative treatment indefinitely, even when the lumen of the canal is reduced to a fine chink. If a small elastic tube can be introduced between the tumour and the opposite wall of the canal, the cleansing of the deeper parts is facilitated. Appropriate treatment should be employed if there be a swollen or thickened condition of the cutis, and the cautious introduction of the antiseptic cotton plugs as in the treatment of strictures (see p. 204) may be tried. If there be granulation tissue at the chink, its removal may be followed by much better hearing. In the event of a purulent discharge from the middle ear appropriate treatment should be adopted (see Chapter XII.). No operative treatment is to be adopted when the tumours are small and do not completely close the canal of the ear. Even when the canal is completely closed by these osseous growths, operative measures are not in all cases to be undertaken. Only when, owing to loss of hearing in the other ear, total deafness exists, or when dangerous symptoms due to retention of secretion in the middle ear manifest themselves, is operative treatment demanded.

Operating through the External Meatus. In those somewhat less dense growths having a narrow pedicle and associated in their origin with purulent discharge from the middle ear, *a cold steel or an electric snare*, if it is possible to introduce a wire, and encircle the growth, may, by combined penetration and traction, be sufficient to remove the exostosis. The writer removed an exostosis having a slender pedicle (Fig. 135, *b*), by encircling it with a steel wire attached to a Jarvis' nasal snare. In another case, with a thicker pedicle, he was able by means of a galvanic snare to remove an exostosis (Fig. 135, *c*) which closed the canal and brought about retention of purulent secretion. When it is possible to introduce a wire loop, this method should be tried before resorting to other more difficult operative treatment. In these varieties, also, fine but strong dentist's forceps have been successfully employed. When the exostosis is near the outer orifice, operation through the external meatus with the chisel and mallet may be adopted, if there is reason to believe that the pedicle is slender and that a gentle tap or two of the mallet will be sufficient to bring it away. Local anæsthesia (see p. 105) should be sufficient for these operations. The operation through the external meatus with the *bur*, propelled by a dental engine, was advocated and practised by Field and Dalby. The writer is of opinion, however, that if a *bur* is employed it is safer and more efficient to operate from behind. After the meatal operation, the ear should be gently syringed with an anti-

septic solution and a small quantity of the powder of iodoform and boracic acid (1 in 4) is blown into the meatus, and a narrow strip of iodoform gauze is introduced. The regular use of cotton plugs, smeared thickly with iodoform and vaseline ointment, keeps the lumen of the canal open till the healing process is complete.

Operation by Displacement of the Auricle. This method is as a rule to be preferred, as in this way the bony growth is exposed for safe manipulation. An incision is made behind the line of junction of the auricle with the mastoid, as in the mastoid operation (see p. 116). All the tissues down to the bone are severed and drawn forward so as to expose the posterior edge of the osseous meatus, where the bony growth is usually situated. The growth is carefully denuded of its lining membrane. If a bur is used it is applied to the base of the growth, which is now under complete command, and, with the dental engine, it is slowly but safely penetrated and removed. The auricle is then replaced and the wound accurately sutured. The meatus is afterwards treated in the same way as in the operation through the meatus. In a case operated on in this way by the writer (Fig. 135, *a*), the wound behind the auricle healed by first intention, and the hearing power, which had been almost entirely lost, was restored. Most operators, however, prefer the chisel and mallet, and in the hands of one accustomed to perform the radical mastoid operation, this method is safe and efficient, and is, as a rule, to be preferred. The chisel should be applied as Knapp suggests, to the bone rather behind the base of the growth, so as to chisel out a portion of the osseous wall itself; this ensures a sufficiently wide meatus afterwards.



FIG. 135.—Exostoses removed by author: *a*, removed with bur after displacement of auricle; *b*, removed with cold steel wire loop; *c*, removed with a galvanic snare.

SYPHILITIC DISEASE OF THE EXTERNAL MEATUS.

In the form of condylomata or ulceration, syphilis, either in the secondary or tertiary stage, is occasionally found in the external meatus, especially near the outer orifice. The condylomata usually occupy the outer orifice of the ear, appearing as a greyish-red mass of granulation tissue yielding a fetid discharge. Diffuse otitis externa is generally excited, causing considerable swelling of the walls of the canal, and, in some cases, pain of an intense, radiating character. Syphilitic ulcerations of the external meatus are usually circular in shape, with thickened edges, and they have a dirty white appearance. Both the condylomata and ulcerations are apt to leave patches of

pigment or cicatrices, and the cicatricial tissue may seriously contract the lumen of the canal.

Treatment. We must of course employ general antisyphilitic treatment (see General Remedies in list of Formulæ). Great attention should be given to local cleanliness by frequently syringing the ear with warm water containing a disinfectant. If long and ragged, the condylomata should be cut off with scissors, and chromic acid afterwards applied several times. Dusting the masses occasionally with calomel powder also helps to bring about their disappearance. The ulcerations should be treated by the daily application of tincture of iodine for a time. An ointment, composed of 10 grains of iodoform to an ounce of vaseline, forms a useful application in addition to cauterization, and should be inserted into the meatus on a cylinder of cotton wool to prevent contraction.

FUNGI IN THE EXTERNAL MEATUS (OTOMYCOSIS).

Schwartz and Wreden were the first to direct attention to symptoms, similar to those of otitis externa, produced by the growth and accumulation of certain fungi, generally belonging to the genus *aspergillus*.

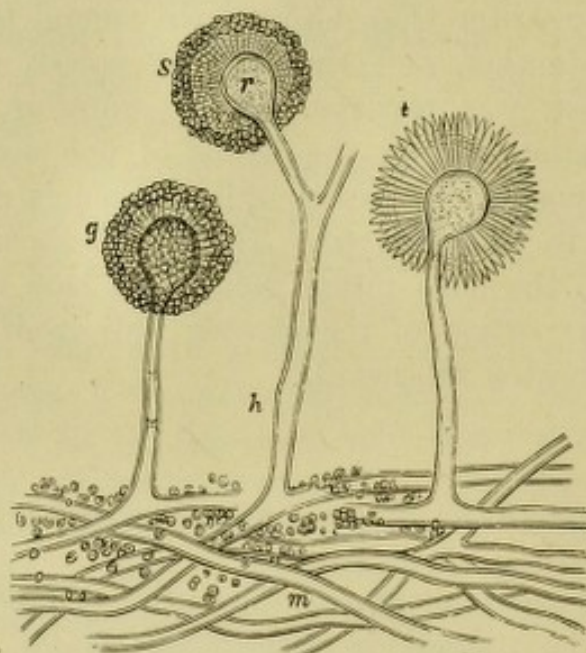


FIG. 136.—*Aspergillus nigricans*. *g*, Gonidia; *h*, hyphæ; *m*, mycelium; *r*, receptaculum; *s*, spores; *t*, sterigma (Urbantschitsch).

These fungi are usually most developed in the inner third of the canal and on the outer surface of the tympanic membrane.

Causes. These fungous masses are chiefly met with in an external meatus where there has previously been disease which has led to accumulations of epidermis, these seeming to form a nidus for the germination and growth of the parasite. A profuse purulent secretion

is unfavourable to the life of the fungi. They are most frequently found in the male sex. Judging from German writers and from its rarity in this country, it is not so common a disease in Britain as in continental countries. The writer is informed by a practitioner in Singapore that this is the commonest ear disease met with in the Malay Peninsula.

Symptoms and Consequences. The symptoms are usually pain, impairment of hearing, and some form of tinnitus aurium. The pain may be slight, but it is more often severe. Fungi have been found to exist in the external meatus, without producing symptoms. Apparently only when they penetrate beneath the epidermis, especially in an already unhealthy meatus, do they excite inflammation. The accumulations in the ear appear as if sprinkled with coal dust, from the spores of the *Aspergillus nigricans* (Figs. 136 and 137). When, on the

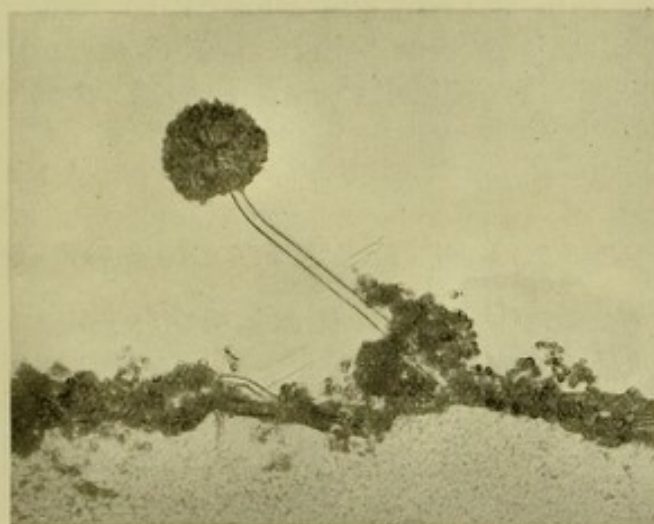


FIG. 137.—*Aspergillus nigricans* from auditory meatus of patient treated by writer (micro-photograph).

other hand, the fungi belong to the variety *Aspergillus flavus*, the collections look as if powdered with iodoform, the heads of the hyphae forming yellowish points. Microscopically these fungi are found lying between and covering the epidermic scales. They adhere very tenaciously to the tympanic membrane and to the inner parts of the walls of the canal. When they are removed, the cutis beneath is found to be reddened and thickened; and it sometimes has a tendency to bleed.

These masses are very likely to maintain a condition of chronic otitis externa, exciting occasionally acute exacerbations of the inflammation. Their presence may also lead to serious injury to the walls of the canal and the tympanic membrane. If imperfectly treated, and the fungus not thoroughly eradicated, there is a great tendency to relapse.

The disease is apt to be confounded with accumulations of cerumen. When collections in the canal of the ear are attended by great pain, we may suspect this disease. Microscopic examination is, however, the only means of arriving at a certain diagnosis. The *prognosis* is very favourable when we are aware of the precise nature of the disease.

Treatment of Fungi in the Ear. We should first use the syringe and warm water, medicated with carbolic or salicylic acid, or permanganate of potash, till we succeed in completely removing the masses contained in the ear. The syringing often requires to be repeated several times with, occasionally, the aid of forceps, before this is effected. After this has been done it is essential, in order to prevent the regrowth of the fungi, to introduce some more decided parasiticide. Either rectified spirit of wine, diluted with water at first to avoid exciting pain, or an alcoholic solution of bichloride of mercury (1 gr. to the ounce) will eradicate the fungus. Either of these, after having been warmed, is poured into the ear, and allowed to remain there for ten minutes at a time—this process being repeated several times a day for a week. Carbolized or salicylic cotton wool should be used for stopping the ear.

EPITHELIOMA OF THE EXTERNAL MEATUS.

The external meatus is usually the starting point, in the writer's experience, from which epithelioma afterwards extends to the whole organ of hearing, to the glandular structures in the neighbourhood, to the facial canal, and to the interior of the cranium. The earliest sign of the disease is that which to the eye seems to be an eczematous abrasion or a ruptured furunculus on the floor of the cartilaginous meatus; this goes on to slight ulceration, with surrounding swelling and *induration*, and involves after a time the glands immediately below the auricle, the tragus, and the mastoid tissues. Fetid discharge constantly escapes, while unhealthy looking granulation tissue may sprout from the eroded surface. *Intense and continuous pain*, usually preventing sleep, is the chief subjective feature of the disease. The remedies which usually benefit simple inflammatory conditions have but little influence on the pain, or on the purulent discharge and swelling. In an inward direction, as well as in an outward, rapid extension of the swelling, with induration and ulceration, takes place, till a large part of the interior of the temporal bone may be exposed. Facial paralysis shows itself, followed sooner or later by meningeal or cerebral symptoms, terminating in death after from one to two years from the beginning of the malady.

Treatment of Epithelioma of the Meatus. The disease has usually progressed too far, before it comes under observation, to admit

of operative treatment. A comparatively slight erosion of the meatus with thickening, when accompanied by great and persistent pain continuing for weeks, should excite our suspicion, and at such an early period thorough excision of the disease might be possible. Otherwise, antiseptic cleansing, with soothing local and general remedies, comprises the treatment.

CARIES AND NECROSIS OF THE EXTERNAL MEATUS.

Caries and necrosis of the osseous part of the external auditory canal are most frequently caused by purulent inflammation of the *middle ear*, and especially of the mastoid cells. In the latter case the upper and back parts of the inner end of the osseous canal are most frequently involved. The diffuse form of otitis externa, either primary or secondary to purulent otitis media, is less frequently the cause of caries or necrosis.

The symptoms are usually those of purulent disease of the middle ear, or of the external meatus. There is sometimes, however, very severe pain, especially when there is a sequestrum.

The use of the probe and a cytological examination (see p. 55) are the means of distinguishing caries or necrosis. In the former we feel the softened carious spot, or the probe may pass through a carious aperture into the mastoid cells. In necrosis the bare necrosed bone, attached or loose, is easily distinguished. Usually at the seat of the diseased bone we find exuberant granulations, which often bleed when touched. These granulations, if removed, immediately form again, and may indeed fill the whole canal. At a carious spot we sometimes find, instead of granulations, a cutaneous ulcer, with inflamed edges. In caries due to disease in the mastoid cells the cutaneo-periosteal linings of the walls of the canal, especially of the posterior wall, may be very much swollen or thickened, rendering an examination of the deeper parts of the canal difficult.

When affecting the inner end of the upper wall of the canal, the head of the malleus and the body of the incus may be exposed in the region of the membrana flaccida.

The course is usually a very lengthened one, especially in persons of defective constitution. Operative treatment, however, generally brings about a cure.

Treatment of Caries and Necrosis. The otitis externa, or the purulent disease of the middle ear, must be treated. In necrosis, after waiting till the sequestrum separates, we should remove it with strong forceps if syringing be not sufficient. (See Treatment of Caries and Necrosis of the Middle Ear.)

If there be a soft bulging in the upper and back part of the canal,

it should be incised, when probably a carious communication with the mastoid cells, or a necrosed part of the bone, will be found. A carious part, if unconnected with disease in the mastoid cells, may be safely scraped with a small sharp spoon; and, if this is followed by the insufflation of iodoform and boracic acid, a good result may be expected. Most frequently, however, a fistulous opening in the postero-superior wall of the bony meatus leads to caries or necrosis of the mastoid, and, if chronic, this usually calls for the radical mastoid operation.

Necrosis or caries is sometimes followed by stenosis of the canal. This must be guarded against by measures suitable for dilating the canal (see p. 204).

FOREIGN BODIES IN THE EAR.

These are generally met with in children. They are very diverse in nature, size, and shape, including such bodies as beads, peas, small buttons, small stones, stones of fruit, pieces of paper, bits of bread, small pieces of slate pencil or of wood, etc. They may get into the ear by accident, or they may be pressed into the meatus by children in play.

Symptoms of a Foreign Body in the Ear. In whatever way a foreign body may get into the ear, the kind of phenomena called forth by its presence depends upon its size, its shape, its chemical and mechanical nature, and upon the force used in introducing it. A small, smooth, round body, for example, such as a bead, may lie in the meatus for almost any length of time without exciting any morbid sensation. Most aural practitioners know of cases of small bodies remaining for many years without provoking any irritation. On the other hand, if the object be larger, and if it happen to have been pressed deeply, and with great force, into the ear, either at its admission or by subsequent efforts to extract it, serious symptoms and consequences may ensue from the pressure, and injury may be inflicted upon the walls of the canal or upon the tympanic membrane.

When the foreign body simply occupies the lumen of the canal, exerting but slight pressure on its walls, the *subjective symptoms* produced by it will probably be limited to some degree of deafness, and more or less tinnitus. If the object be larger, and if it be forcibly pressed deeply into the meatus, or if it be a smaller object, but of a vegetable nature, such as a pea, which after admission has become larger by the absorption of fluid, pain of greater or less severity will be excited, particularly if the foreign body also press upon the tympanic membrane. Many unfortunate cases have been recorded of more serious symptoms still, leading even to fatal consequences.

There can be little doubt that these have been more frequently due to the injuries inflicted by the improper use of instruments, than to the undisturbed presence of the foreign body.

Peculiar *reflex phenomena* in other organs have occasionally been observed in connection with foreign bodies in the ear. These are to be explained by the mechanical irritation exercised upon the numerous nerve twigs from the trigeminus and the vagus, which are distributed in the cutaneous lining of the external meatus and tympanic membrane. Thus cases are recorded of persistent cough, epileptiform attacks, giddiness, vomiting, constant sneezing, etc., due to the presence of foreign bodies in the ear, the removal of which was attended by the disappearance of these symptoms.

The Foreign Body should be seen. When a person comes before the surgeon, stating that a foreign body has got into his ear, the first point to determine is, whether the ear *really contains* such a body, for cases have come under the observation of most aural surgeons, in which the ear has been injured by the use of instruments, when a careful examination would have shown that no such body existed in the ear. A small round object which has gone into the ear, without being actually pressed into it, may pass out again. Hence, before the patient comes to the surgeon, the object may have dropped out of the ear during sleep, or during some movement of the head, quite unnoticed by the person. The writer has seen a case in which the outer edge of the tympanic plate was broken off by forceps employed with great force, under the impression that a pin, believed by the patient to be in the ear, was being grasped. The medical man had, unfortunately, not inspected the ear, and as a matter of fact there was no pin there. Such a possibility makes it necessary that *the statement of the patient should always be tested by inspection with the reflecting mirror and speculum*. We must never trust to the sense of touch given by a probe, introduced into the meatus, without the aid of the eye and of thorough illumination of the interior. The contact of the point of a probe with the osseous walls of the canal, or with the malleus, may easily deceive the examiner into the opinion that he is touching a hard foreign body. We should always examine the other ear if no foreign body is found in the one complained of—the patient may have forgotten the correct one.

In most cases we are able at once to view every part of the interior of the ear where a foreign body can lie, with the aid of the reflecting mirror and speculum. If, however, there has been a pre-existing perforation in the tympanic membrane, the foreign body may have passed into the tympanic cavity, and may thus have escaped beyond the reach of vision. Or the walls of the canal may be so much swollen by inflammation, that the object is rendered invisible. In either of these cases the cautious use of the probe, while the interior of the ear

is illuminated, will usually remove any doubt. A small sharp object, when imbedded in the skin of the external meatus, may be readily overlooked if the walls of the canal be not thoroughly scrutinized. The foreign body may be covered with cerumen and only be found after syringing.

The object, if a small one, may be hidden from view in the *sinus* of the external auditory canal. This in some persons is so deep that we are unable, by any methods of examination, to see the bottom of it. If the patient reports that a small foreign body is in the ear, and if, on examination, no such body can be seen, we should, if unable to get a complete view of the sinus, syringe the ear two or three times with warm water. If there really is a foreign body, we shall find either that it is washed out of the ear by the syringing, or that it has been so displaced by the injected water that it is brought into view when we again inspect the interior of the ear.

Treatment of Foreign Bodies in the Ear. Having assured ourselves that a foreign body *is* present, we have next to decide upon the best and safest method of removing it. A few general points should be kept in view by the surgeon. (1) Most of the foreign bodies which find their way into the ear (such as small beads, small round stones, tiny bits of bread or of paper, and such like) are much smaller than the lumen of the canal, and do little harm by their presence. In such cases the patient and the friends, who are often much excited, should have their minds calmed by the assurance that a little delay in the removal of the foreign body will do no harm. (2) The immediate resort to instrumental or operative interference irrespective of the size, position, or nature, of the foreign body must be earnestly deprecated. Its presence is, in the great majority of cases, much less injurious than attempts to remove it by instruments in the hands of those not accustomed to aural work. If instruments be necessary, the surgeon should be extremely cautious in their use. The interior of the ear must be properly and thoroughly illuminated by means of a reflecting mirror fixed to the forehead, so that in his manipulation every movement of the hand may be guided by the eye. *An anæsthetic should be administered* if the patient be a child or a nervous adult.

Removal of Foreign Bodies by Syringing. For small objects which neither fill the lumen of the canal, nor exert any pressure on its walls—and these as we have already seen are the most common—the treatment is simple, safe, and effective. This consists in the proper use of the syringe and warm water (see p. 79). A few well-directed streams of warm water will soon be followed by the expulsion of the body.

The syringe used should have a slender nozzle which, during syringing must be directed towards the gap between the wall of the canal and the foreign body. The addition of soap to the warm water makes

it more easy to move the body from the position it has taken up. While syringing, the auricle is to be pulled upwards and backwards with the left hand so as to remove the curve of the canal as far as that is possible. The head of the patient should also be inclined downwards towards the side to be syringed, in order that, by making the floor of the external auditory canal an inclined plane, the movement of the object outwards may be assisted. If the water is in this way injected behind the foreign body, the latter will be gradually urged by the pressure of the fluid towards the external orifice of the ear, when, if the object does not drop out, it may be easily and safely removed.

If the foreign body is a vegetable substance, such as a bean or pea, and the treatment by syringing be employed, we must be prepared to remove it at one sitting, because the pea or bean will swell from absorption of fluid, and by waiting it will become more firmly impacted, and will be much more difficult to remove.

Impaction of a Foreign Body in the Ear. When we have to deal with a larger body, which may have been pressed forcibly into the ear, and which is firmly embraced by the walls of the canal, there is greater difficulty in its removal.

The degree of difficulty will depend, first, upon the situation of the foreign body with respect to the *isthmus*, which is that part of the canal where there is usually a considerable bulging of the floor, causing a well marked narrowing of the lumen. Between this projection and the tympanic membrane there is a gradual sinking of the floor, forming the *sinus* already referred to. If the foreign body be *outside* of the isthmus, its removal is generally easy, either by means of the syringe used under the conditions which are about to be stated, or by some one of the instruments which we shall afterwards describe. *The greatest care must be taken in order to prevent the foreign body being forced from this favourable position to a part of the canal beyond the isthmus.* If it has been forced into the sinus of the canal, its removal is very much more difficult, and may require the most skilful manipulation. The difficulty is rendered still more formidable if the foreign body is a smooth, hard object such as a bead or button, which has become tightly fixed in this position by inflammatory swelling of the cutaneous lining of the canal. Secondly, the degree of difficulty will also depend to a considerable extent upon the presence or absence of a gap between some part of the foreign body and the walls of the external meatus. The lumen of the canal being oval in shape, and foreign bodies being often round, there is frequently such a gap, the exact situation of which should be carefully ascertained by inspection, in order to direct the stream of water through it when syringing the ear. If this precaution is neglected, the stream of water, instead of expelling the body, may drive it further in.

The Instrumental Removal of Foreign Bodies. If, after a fair trial with the syringe, we fail to move the body outwards, some form of instrument will be necessary, either to extract it, or to so displace it that subsequent syringing may be more successful in bringing it away.

Ordinary forceps must be discarded, as when the jaws are closed the foreign body is pressed further into the canal of the ear.

A very thin slightly curved instrument, such as shown in the woodcut (Fig. 138), employed as a lever, is most efficient, and, with the precautions already mentioned, is quite safe. An instrument (Fig. 139) for the same purpose was introduced by Lord Lister many



FIG. 138.—Instrument employed by writer for removing foreign bodies from the ear.



FIG. 139.—Lister's instrument for removing foreign bodies from the ear.



FIG. 140.—Forceps of Dr. Guye for removing foreign bodies from the ear.

years ago. The forceps suggested by Guye, and shown in the woodcut (Fig. 140), are of service. The instrument consists of two branches, which are made to fit into, and move on, one another by means of a pivot. The writer has found that one of the blades used as a lever is more efficient than the use of the two. A convenient form of instrument is made, having Lister's hook at the one end and Guye's curved arrangement at the other.

If there is a gap between the foreign body and the wall of the canal, such an instrument should be insinuated through this space and used as a lever to urge the body outwards. If there is no such gap, the foreign body being firmly impacted in the canal, the careful use of such a fine lever instrument will frequently enable us to expel the foreign body, or at least to displace it, so that the use of the syringe and warm water may be more effective. All such instruments should be made as fine and small as possible, compatible with sufficient strength. In employing them it should be remembered that the upper part of the tympanic membrane is much *nearer* the outer

orifice of the ear than the lower part (Fig. 132), and that, when the foreign body is deeply seated, the instrument should be introduced, if possible, antero-inferiorly. Quer's foreign body extractor has a movable end, which, after being introduced between foreign body and meatal wall, can be bent behind the foreign body when traction is employed. A tenaculum is useful for breaking down a pea or bean.

A wire loop, such as Wilde's snare, furnished with stiff wire, is a safe method of attempting to remove a foreign body. If we are able in this way to encircle the object we may succeed in bringing it away, or we may be able so to change its position that its removal by the syringe, or by the lever instrument, is rendered easy or possible. The wire loop is of especial value when the foreign body has passed through a perforation in the tympanic membrane into the tympanic cavity.

If we have to deal with a pea or bean, which has undergone swelling by absorption of fluid, and has consequently become tightly impacted in the deep part of the meatus, it may be necessary to break it down with a fine bent hook and remove it piecemeal or with the syringe.

Löwenberg proposes that, after the object has been thoroughly dried, a fine brush which has been dipped into a solution of glue should be applied to the foreign body; after waiting for thorough drying and adhesion, the brush is to be withdrawn, when, if successful, the foreign body will be found glued to it.

If the object be long and pointed, and lying across the canal, with the points piercing its walls, as may happen with a needle or a piece of necrosed bone, it may require to be broken with forceps, and the pieces afterwards extracted separately.

Cutting Operations for the Removal of a Foreign Body. These are recommended in cases where we are unable to achieve our object by the methods referred to, and where the symptoms produced by the foreign body are of such an urgent and serious character as to make its immediate removal from the ear imperative. In most of such cases the body is tightly impacted in the deep part of the canal or in the tympanum; and, by making an incision behind the auricle, and separating the cartilaginous from the osseous part, as in the mastoid operation, we may gain more complete access to the foreign body. In a case in which a faceted glass button was fixed in the tympanic cavity, the writer exposed the osseous canal in this way (see p. 116), and, by means of an instrument similar to a blade of Guye's forceps, but made especially strong, the foreign body was safely extracted. It might be necessary in certain cases to remove a portion of the posterior wall of the osseous meatus, or even to open the antrum.

Insects, Larvæ, etc., in the Ear. Various insects, as fleas, bugs, flies, etc., sometimes find their way into the ear. Country people, sportsmen, and field workers, are more likely than town-people to be tormented by insects crawling into the ear.

In such cases there may be only the sensation of a moving body in the ear. But, on the other hand, it is said that the presence of a flea may set up loud and most disagreeable noises, and even severe pain, by its leaping upon the tympanic membrane and the walls of the external auditory canal. A bug may excite very great pain by fastening upon and sucking some part of the canal or the tympanic membrane. The ear-wig (*forficula auricularia*) is an object of great dread to many persons, owing to the belief that, if it gets into the ear, it will make its way to the brain. While it is true that this creature sometimes runs into the canal of the ear, any such hole having an attraction for it, there is no evidence that it has, on any occasion, produced dangerous effects.

The fly (*muscida sarcophaga*), attracted by the odour of the pus in neglected chronic purulent disease of the ear, sometimes deposits its eggs in the entrance to the ear, causing the development of larvæ or maggots. These may be found in great numbers, chiefly at the inner end of the canal and in the tympanum, appearing as white worm-like creatures, moving about. They are furnished with hook-like apparatus, with which they fasten upon and penetrate the tissue, exciting in this way intense pain. Sometimes, however, no pain attends their presence in the ear.

Treatment. It is easy to kill or expel insects which have found their way into the ear, by pouring water or oil into the ear and allowing it to remain for ten minutes, when the ear is syringed. If these are not at hand, the smoke of tobacco from a cigar or pipe, blown into the canal, compels the insect to find its way into the open air. The expulsion of larvæ is to be effected by a more difficult process. Syringing with warm water will neither kill nor expel them. We must first apply some substance to the interior of the ear, which will cause their death. Rectified spirit, or the vapour of chloroform, is usually very effective. After they have been killed, they may require to be removed individually with forceps, as even after their death they so adhere to the walls of the canal, that simple syringing will not suffice to bring them away.

It is possible in applying leeches to the neighbourhood that one of them may escape into the ear. A solution of common salt must at once be poured into the canal, after which the leech may be syringed out, or removed with forceps.

CHAPTER IX.

THE TYMPANIC MEMBRANE.

ANATOMICAL AND PHYSIOLOGICAL DESCRIPTION.

Position—Attachment—Shape. The tympanic membrane, *membrana tympani*, or drum head (not the “drum”) (Fig. 141, also Coloured Plate I.), is a thin but strong inelastic membrane which is stretched across the inner end of the external meatus and forms in great part the outer wall of the cavity of the tympanum. It is not tightly stretched, and is capable of a considerable extent of movement when the air in the external auditory canal is alternately condensed and rarefied. It is fastened to a groove in the annulus tympanicus, the *sulcus tympanicus*, by means of a periosteal extension which constitutes the middle layer. This sulcus is, however, defective above, corresponding with the defect in the annulus tympanicus—the *Rivian segment*. That part of the membrane filling up the Rivian segment is thinner and looser than the rest, and is termed the *membrana flaccida*, or Shrapnell's membrane, forming the outer wall of a space—Prussak's space—in the tympanic cavity. It is not fixed to the bone, but simply connected to the skin of the canal of the ear. The loose attachment, as well as the absence of the fibrous layer, renders this part of the membrane more flaccid than the rest. The shape of the tympanic membrane varies in different persons, but is usually somewhat oval. Its longest diameter is from above downwards, and measures from 9 to 10 millimetres or about $\frac{3}{4}$ ths of an inch, while its horizontal diameter is usually one millimetre less.

Obliquity and Curvature. It is not placed upright, but is so sloped as to form an angle of about 140 degrees with the upper and back wall of the canal, and one of 45 degrees with the lower and front wall. On account of this oblique position the upper and back part of the membrane is nearer to the external orifice of the ear than the lower and front part, a fact which should be borne in mind when operating upon the membrane or removing a foreign body from the ear.

It is also curved in such a way that its outer surface presents a general concavity. This is caused mainly by the inclination of the manubrium or

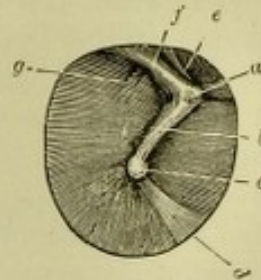


FIG. 141.—Outer aspect of right tympanic membrane—double the natural size; a, short process; b, middle of manubrium; c, umbo; d, cone of light; e, membrana flaccida; f, posterior fold; g, long process of incus shining through the membrane.

handle of the malleus, and the deepest part is at the lower end or umbo of that bone. Although there is this general concavity outwards, the membrane at several parts presents small bulgings towards the outside. These are in the situation of the cone of light, the short process of the malleus, and the anterior and posterior folds to be described presently.

Colour and Polish. The general colour of the membrane as seen from without during life is usually a pearl grey. In childhood it has a darker grey colour, while in old age it is whiter and more opaque. Immediately behind the umbo the membrane is whiter on account of its nearness to the whitish inner wall of the tympanum, in front it is darker owing to the shadow of the handle. The upper and back part has also generally a whiter appearance, which is due to the chorda tympani nerve and the posterior pouch of the membrane shining through.

The outer surface has, during life, a bright polished appearance, due to the reflection of light from the fine layer of epidermis. At the antero-inferior part the lustre is especially bright, and from its triangular form this is named the triangular light or the *cone of light*, the apex of this bright reflex being at the umbo and the base at the antero-inferior periphery of the membrane. The cone of light varies, even in healthy membranes, in length, breadth, and distinctness. In certain morbid conditions, especially after inflammation chiefly affecting the cutaneous or outer layer, the general polish as well as the cone of light may be dimmed or completely absent. For the description of the appearance of the membrane when seen through the external auditory canal, see p. 10.

Layers of the Tympanic Membrane. The tympanic membrane, with the exception of that part called the *membrana flaccida*, consists of three layers: (1) A cutaneous or outer; (2) a fibrous or middle; (3) a mucous or inner. The cutaneous layer can be easily separated from the middle layer, which, however, is intimately and inseparably united with the mucous layer.

The *external* or cutaneous layer is a very fine transparent prolongation of the lining of the external auditory canal. It is destitute of hair or the glandular elements of skin, and the cutis, which is very rich in blood-vessels and nerves, is covered by several strata of pavement epithelium. At the upper part, where this layer is thickest, the chief vessels and nerves pass down from the cutaneous lining of the roof of the canal, along the posterior edge of the manubrium to the umbo, from which the vessels radiate in small branches to the periphery, where they anastomose with smaller vessels from the other walls of the canal. These vessels, especially those passing down the membrane from the upper wall of the canal, become injected under various conditions apart from actual inflammation. After syringing the ear, after prolonged examination with the speculum, during the performance of Valsalva's method of inflation, or after suction by Siegle's speculum, they are apt to be injected. As a consequence of inflammation of the membrane the cutaneous layer may become thickened and opaque.

The *middle* layer, frequently termed the *membrana propria*, is the strongest layer of the membrane. It is composed of two sets of fibres, the outer or radiating and the inner or circular. The radiating fibres forming the lower part of the membrane are attached to the umbo, while the others are fixed to the anterior edge of the manubrium. The circular fibres are thickest in that zone of the membrane, which is intermediate between the centre and the circumference. The handle of the malleus is fixed between the radiating and the circular fibres, and the peculiar arrangement of the fibres contributes to the strength of the membrane.

The *inner* or mucous layer is a continuation of the mucous lining of the tympanum. It is extremely thin and delicate, but in chronic catarrh of the middle ear it often becomes very much thickened. Its vessels anastomose with those of the cutaneous layer at the periphery of the membrane. It is much less endowed with nerves than the cutaneous layer. The so-called pouches of the membrane found on its inner aspect will be afterwards referred to under the description of the anatomy of the tympanic cavity.

The vascular and nervous supply to the tympanic membrane will be given in the appendix.

Function of the Tympanic Membrane. The tympanic membrane serves several purposes. It protects the middle ear from the effects of injurious atmospheric and other external influences. It supports the outer end of the bridge of bones, which spans the cavity of the tympanum. It is endowed with great capacity for vibrating in response to waves of sound transmitted to it by the column of air in the external auditory canal, and it communicates these vibrations to the ossicles. Helmholtz showed experimentally, that a curved membrane has much greater capacity for resonance than a flat membrane; but, on the other hand, Fick has demonstrated that the obliquity of a membrane weakens the effects of sonorous waves falling upon it. Vibrations corresponding to tones of all varieties of pitch and intensity are received at the one instant by this membrane and transmitted along the chain of bones. The non-elastic character of the membrane is supposed to prevent the tendency to after-vibrations; and it has been asserted that the radiating fibres are comparable to a system of stretched strings fixed at one end and at the other attached to a movable cross-bar. It is interesting to note that there may be *fairly good hearing* when the membrane is perforated or even destroyed.

DISEASES OF THE TYMPANIC MEMBRANE.

As we might expect from its situation as a partition separating the external auditory canal without from the cavity of the tympanum within, the tympanic membrane generally shares in the diseases of these neighbouring parts. Primary disease of the membrane is met with, although it is generally impossible to say whether the disease is a primary one of the membrane, or whether it is secondary to a process which has had its origin in the tympanum or the external auditory canal. *Acute and chronic inflammations of the tympanic membrane (acute and chronic myringitis)* are described by authors. But, as these conditions rarely exist alone as primary conditions, and can almost never be distinguished as such, it seems to the writer that to describe them would be more confusing than profitable. In practice we find that, with few exceptions, inflammation of the membrane is really part of an inflammation of the cavity of the tympanum of which it is the outer wall, and its description as well as that of the secondary changes which are found, such as perforation, retraction, calcareous deposits, etc., will be included in the Diseases of the Middle Ear.

INJURIES OF THE TYMPANIC MEMBRANE.

A traumatic lesion of the membrane may be the result of force applied directly to the tissue of the membrane, or indirectly through the intervention of the bones of the head or of the air in the canal of the ear.

Injuries Acting Directly. Of the injuries acting directly on the membrane the most frequent are caused by objects such as a knitting needle, hair pin, tooth-pick, straw, or small twig, being forced into the canal of the ear and through the membrane. While, for example, a woman is engaged in knitting, she applies the point of the needle to the external meatus to relieve a feeling of itchiness, and the needle, from some accidental cause, such as a push from some one passing, is driven into the ear and through the tympanic membrane. Such an accident is attended by a loud detonation and by a very acute pain in the ear, with subjective sounds, while the person may become faint or giddy. There is usually some escape of blood from the ear, and on examining the membrane we find the seat of the penetrating wound covered with blood. When we are able to get a complete view of the parts, it is generally found that the wound is in front of the manubrium, and that around the aperture the membrane has a more or less dark red colour from extravasated blood. Cases are recorded of fracture of the manubrium resulting from such an injury. The membrane may also be wounded or even perforated by efforts to extract foreign bodies from the ear, by the improper use of the probe, by a point of the syringe with a long nozzle when clumsily used, by severe syringing, and by the long-continued pressure on the membrane of a foreign body or even of hard cerumen. Dangerous injury to the membrane may likewise be caused by boiling water, molten lead, or caustic substances finding admission into the ear. Perforating wounds of the tympanic membrane often heal quickly by first intention, but they may be followed by inflammation and suppuration of the middle ear.

Indirect Violence. Rupture of the membrane, due to indirect violence, may be caused—(a) by sudden and great condensation of the air in the external auditory canal or in the middle ear; (b) by concussion or fracture of the bones of the head. Both of these causes may act simultaneously, as in the case of a severe blow on the side of the head. In all cases the membrane is more likely to give way if it be already in a morbid condition, especially if atrophied, or if adhesions have formed with other parts, or if there be obstruction of the Eustachian tube, preventing the force expending itself in that direction.

Rupture of the membrane from sudden condensation of the air in the external auditory canal may arise from the report of artillery in

the vicinity of the ear. A diver, striking the surface of the water with the side of the head, may have his tympanic membrane ruptured by the sudden condensation of the air in the canal of the ear. The great air pressure in caissons or diving bells may produce rupture of the tympanic membrane and other injury to the ear. *Boxing the ears* is a not infrequent cause of rupture of the membrane. Dr. Chimani, of Vienna, found that of 54 cases of rupture of the tympanic membrane coming under his notice, 38 were due to this cause, and of these 36 were, as we might have expected, on the left side. A lady came under the observation of the writer whose tympanic membrane was ruptured by the impact of a tennis ball upon the tragus.

Sudden condensation of the air in the naso-pharyngeal cavity, propagated to the air in the tympanum, may also rupture the membrane, particularly if the latter be weakened by disease. In this way the membrane has been ruptured in severe paroxysms of coughing, especially in whooping cough, also in inflation by Politzer's method or through the Eustachian catheter.

At the moment of rupture of the tympanic membrane the patient usually experiences a loud crack in the ear, followed immediately by severe pain, by subjective sounds in the ear, by deafness, and sometimes by giddiness.

Appearance of the Tympanic Membrane after Injury. There may be considerable effusion of blood, not only into the external auditory canal, but also into the middle ear, and, through the Eustachian tube, into the nose and throat. The blood may for some days prevent a full or accurate examination of the condition of the parts. When a perforation of the membrane has a traumatic origin, it is found that by Valsalva's method air is forced through the perforation with a very distinct blowing sound, heard by bystanders, the inflation being much more easily and completely effected than in perforations from disease. The tear in the membrane is most frequently found behind the manubrium, or at the antero-inferior quadrant. The edges of the tear are not, as a rule, approximated, for the opening generally gapes and is oval or elliptical in form. Sometimes there is a flap inclining outwards or inwards. We may find ecchymosis in the neighbourhood of the rupture, and injected vessels along the manubrium. Inflammation and suppuration in the middle ear do not so often follow rupture of the membrane from force acting indirectly as in the case of direct wounds of the membrane. Within a week or two the opening heals, unless it has been injudiciously treated by irritating applications. If inflammation and suppuration do ensue, the parts generally recover in a few weeks, although occasionally the disease takes a chronic course. If the injury be limited to rupture of the membrane, the function of the organ is, as a rule, completely regained. Sometimes the subjective sounds

in the ear continue for a long time, and more rarely they remain a permanent annoyance.

Injury of the Deeper Parts. In addition to the rupture of the membrane, however, the nervous structure of the labyrinth may be injured by the concussion of the air or of the bones of the head. In such cases the deafness is greater, and the subjective sounds are more distressing, while both are likely to remain permanently; there is also likely to be vertigo. If the membrane be not ruptured, the injury to the labyrinth may be even still greater, as the force, not being spent in tearing the tissue of the membrane, is exerted upon the chain of bones, which may be driven violently in upon the fluid of the labyrinth, and so injure the terminations of the auditory nerve.

The tuning-fork, applied to the bones of the head, is very useful in giving us information as to the presence or absence of injury to the labyrinth. If the vibrating fork, when in contact with the nasal bones or middle line of the head, is heard *better* on the injured side, the great likelihood is that no serious mischief has happened to the nerve structures in the labyrinth.

Medico-legal Bearings. Rupture of the membrane, due to blows on the ear, may give rise to an action at law for damages. In the event of a legal inquiry the medical man should have the following points in view: (1) After the first few days, it is impossible to determine with certainty whether a perforation of the membrane has had a traumatic origin, or has been the result of a pathological process. (2) Several months must elapse after the injury, before we are able to say if permanent mischief to the structure and functions of the organ remains behind. (3) It is very difficult to say whether the deafness or the subjective sounds, complained of after an injury, may not be due to previous chronic disease in the middle ear, a condition which, in one ear or in both, affects a very large number of people. (4) If inflammation and suppuration follow the injury, it is within the range of possibility that very serious consequences, even death, may ensue. (5) If there be evidence of labyrinthine mischief having resulted from the injury, deafness and serious noises in the ear may continue during the whole of the patient's life.

Relation to Basal Fracture of the Skull. As is well known, fracture of the base of the skull is commonly attended by rupture of the tympanic membrane. In this case the tear is usually a continuation of a fissure made in the roof of the external auditory canal or in the roof of the tympanum. Usually copious bleeding takes place, partly from the vessels of the membrane, partly from the osseous issue and sometimes from rupture of the lateral sinus. The escape of blood from the external auditory canal or nose, after an injury to the head, does not necessarily mean that there is a fracture of the base of

the skull. A considerable quantity of blood may escape from the ear and nose if the tympanic membrane be simply ruptured, or if there be tearing of the soft parts of the tympanic cavity and of the skin of the external auditory canal, without fracture of the osseous roof of the ear. We have already spoken of fracture of the tympanic plate of the external auditory canal being occasionally the source of bleeding from the ear (see p. 189).

The escape in considerable quantity of serous-looking fluid, which continues flowing for some time, is a much more serious indication of fracture of the base of the skull than the escape of blood. This symptom, after an injury to the head, generally means that there is fracture along the upper surface of the petrous part of the temporal bone, through the roof of the tympanum and the osseous part of the external auditory canal, with rupture of the tympanic membrane, tearing of the meninges, and escape of the cerebro-spinal fluid. The escape from the ear, a day or two after the injury, of a smaller quantity of serous-looking fluid perhaps mixed with blood is not however a certain indication of a fracture. This fluid may be due to catarrh of the middle ear set up by the injury, with fluid exudation escaping outwards through the fissure in the membrane. A basilar fracture of the skull does not necessarily involve a fatal termination; and, if the patient live, a purulent disease of the middle ear is likely to follow.

Treatment of Injuries of the Tympanic Membrane. When the membrane has been torn or ruptured, meddling treatment should be avoided. Sterilized cotton wool or gauze should be worn in the ear to protect the exposed tympanum from injurious atmospheric or bacterial influences. Syringing with water or pouring into the ear various kinds of fluids is more likely to infect the middle ear, exciting purulent inflammation, than to expedite healing. The meatal walls may be carefully cleansed with a cotton wool mop moistened in an antiseptic solution. The wound in the membrane is usually soon sealed by a blood clot. If inflammation and suppuration ensue, these must be treated in the manner to be described afterwards in chapter xii.

All persons should be warned against the application of sharp-pointed instruments to the external meatus for the relief of itchiness. Besides the danger of injuring the membrane, the practice is injurious to the canal of the ear. Syringing the ear should be done with care, and syringes with very thin long nozzles should not be used. When the membrane is softened by acute inflammation, the patient is to refrain from strong expiratory efforts. The importance of great caution in the removal of foreign bodies from the ear has already been fully referred to. Before taking a "header" the diver should plug the ears with cotton wool, and he should take care not to strike

the surface of the water with the side of the head. The same precaution of stopping the ears with cotton wool should be adopted by artillerymen or persons who are exposed to loud and sudden sounds. Workers in caissons should not enter or leave the compressed air too suddenly. *Parents and teachers should be warned against inflicting chastisement by boxing the ears.*

CHAPTER X.

ANATOMICAL AND PHYSIOLOGICAL INTRODUCTION TO THE DISEASES OF THE MIDDLE EAR.

UNDER the term Middle Ear (Fig. 142) are comprised: (1) A passage—the *Eustachian tube*; (2) a narrow cavity—the *Tympanum*; (3) a cavity of considerable size above and behind—the *Antrum mastoideum*, or more correctly, considering its development as a distinct part of the middle ear tract, the *Tympanic antrum*; (4) a large number of small spaces chiefly below and

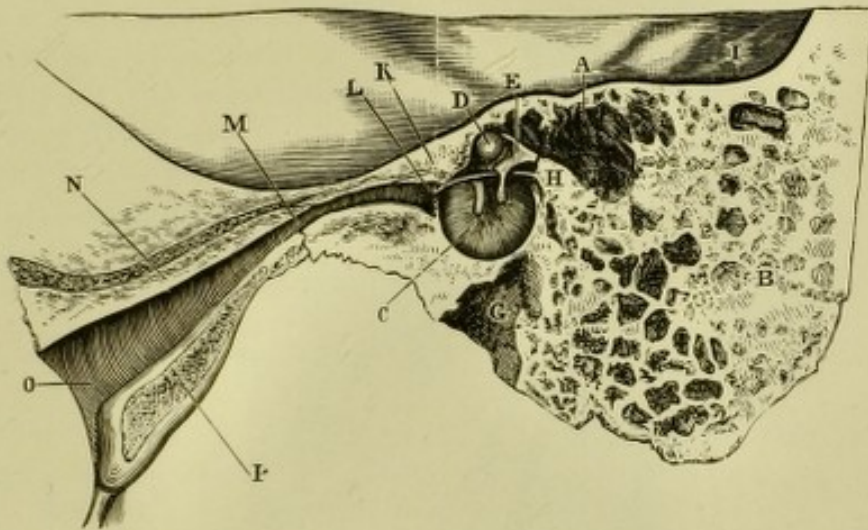


FIG. 142.—Section through the whole extent of middle ear. A, Antrum mastoideum; B, mastoid cells; C, inner surface of tympanic membrane, at lower end of manubrium; D, head of malleus; E, body of incus; F, fossa for jugular bulb; H, pyramidal partition of bone separating the cavity of the tympanum from the antrum mastoideum; below the letter H, a portion of the canal for the facial nerve is shown; I, dura mater; K, chorda tympani nerve; L, tympanic mouth of Eustachian tube; M, isthmus of the Eustachian tube; N and P, cartilaginous walls of Eustachian tube; O, pharyngeal mouth of Eustachian tube.

external to these—the *Mastoid cells*. These are in communication with one another, and, by the Eustachian tube, with the naso-pharynx, while they are shut off from the external auditory meatus by the tympanic membrane. They are mostly filled with air, and their walls, in great part formed of bone, are lined by mucous membrane, which is simply an attenuated continuation of the mucous membrane of the pharynx. In four situations the walls are composed of soft and more or less yielding tissue, namely, (1) the membrano-cartilaginous part of the Eustachian tube; (2) the tympanic membrane; (3) the membrane closing the fenestra rotunda; (4) the annular ligament of the fenestra ovalis.

As the middle ear is in reality an offshoot from the naso-pharyngeal cavity, we shall begin its description with the Eustachian tube.

THE EUSTACHIAN TUBE.

The pharyngeal mouth of the Eustachian tube (Fig. 143) is found on the outer wall of the naso-pharyngeal cavity (Fig. 15), just behind the posterior end of the inferior turbinated body. It is an opening of considerable size, measuring a third of an inch in the vertical direction, and a fifth of an inch in the horizontal direction. The upper and back part of the circumference of this opening presents a thick rounded bulging formed by the projection of the end of the median cartilage—the Eustachian prominence. This bulging is a useful guide to the introduction of the Eustachian catheter.

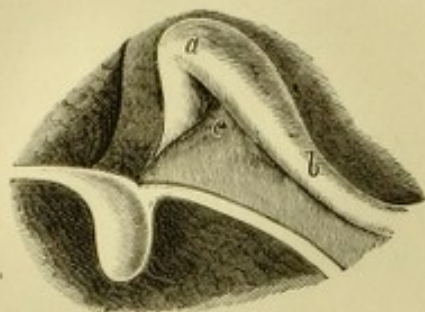


FIG. 143.—View of the left Eustachian orifice. *a*, Eustachian prominence; *b*, salpingo-pharyngeal fold; *c*, posterior tubal sulcus (Cresswell Baber).

From this opening the Eustachian tube passes outwards, upwards, and backwards, forming an angle of 135 degrees with the external meatus, till, at a distance of an inch and a half from the pharynx, it passes into the cavity of the tympanum. The walls of the third of the tube nearest the tympanum are formed of bone continuous with the upper

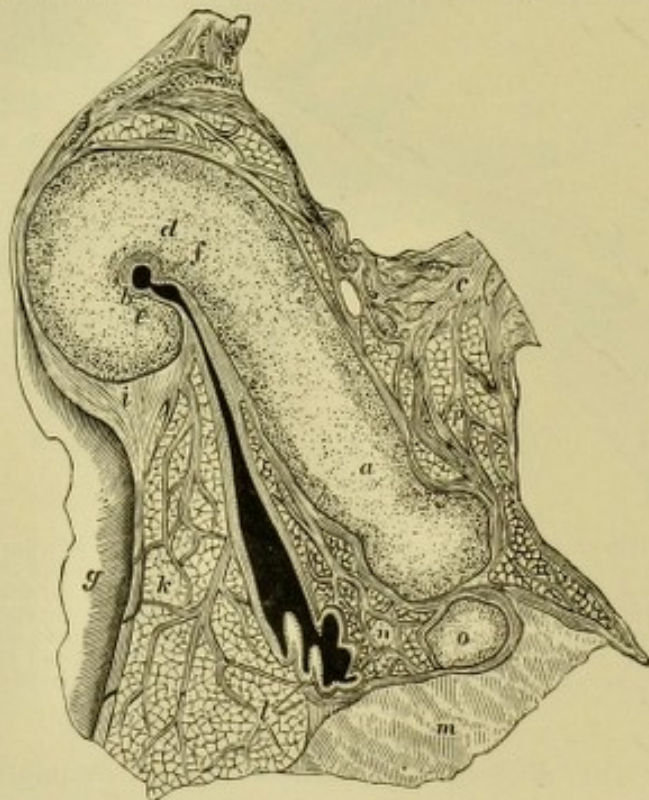


FIG. 144.—Cross section of lower third of membrano-cartilaginous part of Eustachian tube—right ear (Rüdinger). *a*, Median cartilage; *b* and *f*, folds of mucous membrane; *c*, fibro-cartilage at base of skull; *d*, the part of the canal enclosed by the hooked cartilage; *e*, end of the hook-shaped cartilage; *g*, the tensor palati muscle; *i*, attachment of the muscle to the cartilage; *k*, fatty tissue between the tensor palati and the membranous part of the tube; *l*, folds of mucous membrane in lower part of lumen of tube; *m*, levator palati muscle; *o*, isolated piece of cartilage lying below the lower end of the median cartilage.

part of the tympanic cavity. The tensor tympani muscle lies in an osseous canal above, and parallel to, this part of the Eustachian tube.

Membrano-Cartilaginous Part of the Eustachian Tube. The other two-thirds of the tube are formed partly of cartilaginous and partly of membranous tissue. The point of junction between this and the osseous portion is the narrowest part, and is hence termed the *isthmus*, which measures three millimetres in height, and half a millimetre in width. The membrano-cartilaginous part, which measures an inch in length, is not a permanently open tube, such as the external auditory meatus. At its pharyngeal opening, and at a point near to its junction with the osseous part, it is permanently open; but, in the intervening part, the membranous wall lies against the cartilaginous, the mucous surfaces being in contact with one another, forming an S-shaped slit. This part, indeed, forms a kind of valve, which, by opening and shutting, regulates the supply of air to the rest of the middle ear. A transverse section of the membrano-cartilaginous part of the tube shows a peculiar arrangement (Fig. 144). The inner and upper part of the circumference is composed of cartilage, which is of considerable thickness, and is usually described as consisting of two parts, although there is no natural division between them—(1) a triangularly shaped plate of cartilage, called the median cartilage, which, near the osseous part of the tube, is attached to the fibro-cartilaginous tissue at the base of the skull, and forms the inner wall of the tube; (2) the smaller portion or hook-shaped cartilage, which bends round from the upper part of the median cartilage in a direction downwards and then inwards, like a bent hook. The circumference of the tube is completed in the outer and lower parts by membranous tissue. This extends from the lower aspect of the hook-shaped cartilage to the inferior end of the median cartilage. The fibres of the tensor palati muscle are attached to the whole length of the membranous part of the tube and to the lower part of the hook-shaped cartilage, the fibres of the muscle having a direction almost at right angles to the walls of the tube. The levator palati muscle lies under the floor of the tube, with which its fibres are parallel.

THE TYMPANIC CAVITY.

From the outer or upper end of the Eustachian tube opens the most important part of the middle ear—the tympanic cavity, tympanum, or “drum of the ear.” This is a narrow space (Fig. 145, B) interposed between the tympanic membrane and the outer wall of the labyrinth.

Spanning this narrow space there is a bridge formed of three bones—the malleus, incus, and stapes (Fig. 146), constituting an osseous connection between the tympanic membrane and the labyrinth.

The narrowest part of the cavity measures two millimetres or one-twelfth of an inch, and occurs between the tympanic membrane, at the lower end of the manubrium, and the inner wall. The widest part, measuring fifteen millimetres, extends from the opening of the Eustachian tube to the opening into the antrum exactly opposite. From the roof to the floor, on a line with the manubrium, the cavity measures twelve millimetres.

We shall describe the walls of the tympanic cavity in the following order:

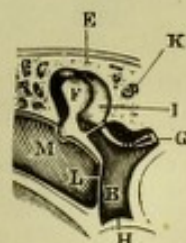


FIG. 145.—Vertical section of tympanic cavity. E, Roof of tympanic cavity; F, head of the malleus; G, foot-piece of stapes; H, floor of tympanic cavity; I, body of incus; K, Fallopian canal; L, tympanic membrane; M, short process of malleus.

(1) Outer wall or tympanic membrane; (2) inner or labyrinthine wall; (3) roof; (4) floor.

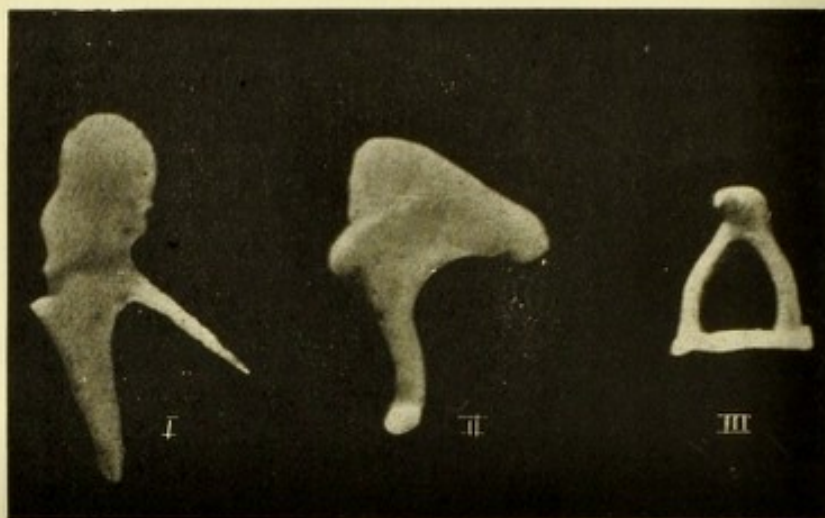


FIG. 146.—I. Malleus; II. Incus; III. Stapes. (From Rüdinger.)

Inner Aspect of the Tympanic Membrane (Fig. 147). The handle of the malleus is seen fixed into the membrane, as already described, while the head projects upwards and inwards, till its upper surface is close to the roof of the tympanum. The posterior surface of the head of the malleus is articulated to the

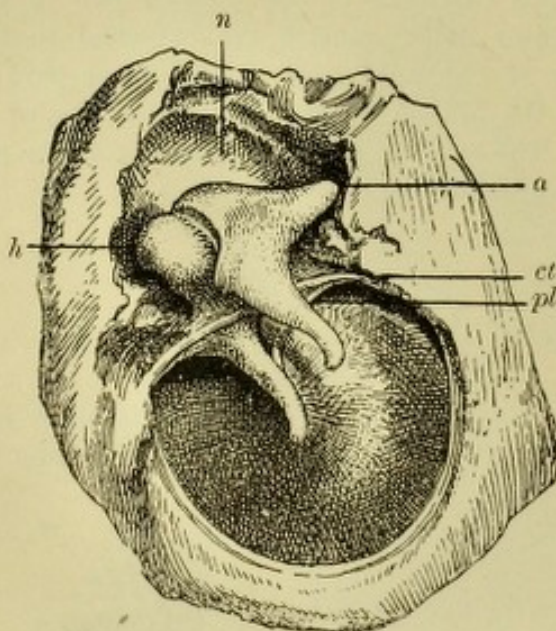


FIG. 147.—Inner surface of the right tympanic membrane, with the malleus and incus, enlarged $3\frac{1}{2}$ times (Politzer). *n*, Malleo-incudal niche at the outer wall of the attic of the tympanum; *h*, head of the malleus; *a*, incus; *pl*, von Tröltsch's pouch; *ct*, chorda tympani.

body of the incus, whose long process extends downwards, behind and parallel with the manubrium at a distance of two millimetres from the postero-superior quadrant of the membrane, but it does not extend so far down as the lower end of the manubrium. The short process of the incus passes backwards and slightly downwards to rest with its tip on the floor of the opening into the antrum mastoideum.

The Attic (epitympanum).

It is to be noted that the upper half of the malleus and the body and short process of the incus are higher than the tympanic membrane, in what is called the upper tympanic cavity or

attic. This cavity measures about six millimetres in height, its outer wall being the inner end of the roof of the external meatus. The head of the malleus and the body of the incus are here articulated together in such a way as to form an osseous partition, incompletely dividing the space into an outer and an inner compartment, the inner being the wider of the two. The outer is termed the outer attic (Fig. 148), which is divided into a lower—Prussak's space—having the membrana flaccida as its outer wall and limited above by the external ligament of the malleus; and an upper space limited above by the superior ligament of

the malleus, and subdivided into a number of spaces by folds of the mucous membrane. Suppurations having their seat in the outer attic are as a rule particularly intractable and attended by perforation of the *membrana flaccida*.

The Pouches of the Tympanic Membrane. On removing the incus a fold of fibrous tissue is seen, extending between the upper part of the manubrium and the posterior wall of the tympanum near to the sulcus tympanicus. This forms the inner wall, and the corresponding part of the tympanic membrane forms the outer wall of a space, open below, and named by von Tröltsch the posterior pouch of the membrane. There is a much smaller space in front of the manubrium—the anterior pouch. The chorda tympani nerve, coming from the facial nerve in the Fallopian canal, is seen forming the lower edge of the inner leaf of the posterior pouch: it then comes in close contact with the inner surface of the neck of the malleus, and, after taking part in the formation of the anterior pouch, it finally emerges from the tympanum by the Glaserian fissure (petro-tympanic suture) on its way to the tongue.

The Inner Wall of the Tympanum (Fig. 149).

Here are found two openings in the bone closed by membranes, which separate the tympanum from the watery fluid (perilymph) of the labyrinth. These openings are the *fenestra ovalis* or opening into the vestibule, and the *fenestra rotunda* or opening into the cochlea. The fenestra ovalis is in the upper and back part of the inner wall of the tympanum, at the bottom

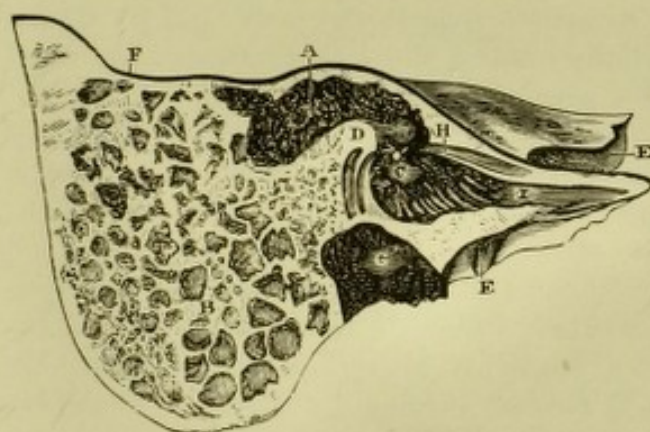


FIG. 149.—View of inner half of osseous part of middle ear. A, Antrum mastoideum; B, mastoid cells; C, promontory on inner wall of tympanum—above is seen the stapes in its recess; D, partition between cavity of tympanum and antrum—below is part of the canal for the facial nerve, and in front of this canal the stapedius muscle; E, the carotid canal; F, the dura mater; G, the fossa for the jugular bulb; H, the belly of the tensor tympani muscle; I, inner wall of the osseous part of the Eustachian tube.

of a recess or niche, the *pelvis ovalis*. This recess is seen to accommodate the stapes, the footpiece of which is attached to the membrane closing the fenestra ovalis; while its head, in the natural condition, articulates with the lower end of the long process of the incus. The slender crura of the stapes are separated by only a very small interval from the walls of the pelvis ovalis. The base of the stapes does not completely fill up the fenestra ovalis, there being a small space between the circumference of the footpiece of the stapes and the edge of the opening. This space is filled up

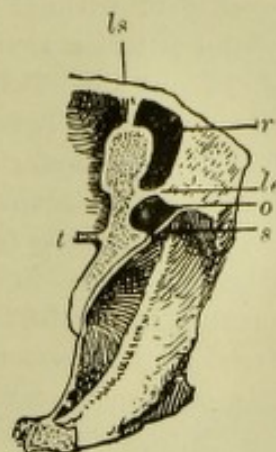


FIG. 148.—Section through the tympanic membrane, malleus, upper and outer tympanic wall of a decalcified preparation. l, Ligamentum mallei externum; s, membrana Shrapnelli; o, Prussak's space; r, system of cavities between the malleus and incus, and the external tympanic wall; t, tendon of the tensor tympani muscle. (After a preparation in Politzer's collection.)

by an annular band of fibrous tissue, lined on its inner surface by the periosteum of the vestibule, and on its outer surface by the mucous membrane of the tympanum. The fenestra rotunda, closed by the *membrana tympani secundaria*, is also situated at the bottom of a recess in the bone. This recess is lower down

than that leading to the fenestra ovalis, at the postero-inferior part of the inner wall of the tympanum. It looks *backwards* and not outwards like the pelvis ovalis, and, owing to this peculiarity, the membrana tympani secundaria can never be seen from without even in complete destruction of the tympanic membrane. Only the anterior rounded edge of the opening leading to this recess is visible from the outside. Between, and in front of, the openings leading to these two fenestræ is the *promontory*, a smooth rounded prominence just opposite to the middle and anterior part of the tympanic membrane. It forms the outer wall of the first turn of the cochlea. Behind the promontory is a rather deep depression—the *sinus tympani*, varying in size but generally having a constricted entrance. Disease in this region is apt to be persistent, and has a special importance owing to the proximity of the facial nerve and the fenestral spaces. In front of the promontory the inner wall of the tympanum is thin and porous, and is continuous with the inner wall of the osseous part of the Eustachian tube. Behind and above the fenestra ovalis there is an elongated prominence constituting the upper wall of the pelvis ovalis. This is a part of the Fallopian canal—the osseous tube which contains the facial nerve. Behind this at the uppermost and hindermost part of the inner wall of the tympanum a smooth white surface is seen marking the position of the external or horizontal semicircular canal. At the upper part of the inner wall of the tympanum, at the junction of the inner wall with the roof, there is seen a part of the slender osseous canal (not usually complete) containing the *tensor tympani* muscle. This osseous canal extends above, and parallel with, the Eustachian tube, while posteriorly, just above and in front of the pelvis ovalis, it terminates in a process (*processus cochleariformis*) round which the tendon of the tensor tympani muscle turns outwards so as to cross the tympanic cavity, and be inserted into the manubrium just below the neck of the malleus. Behind and below the entrance to the fenestra ovalis there is a conical osseous eminence—the pyramid—containing a canal for the *stapedius* muscle, for, like the tensor tympani, it is enclosed in a bony canal. This is the smallest striated muscle in the body, and its tendon is inserted into the posterior part of the head of the stapes. Behind the canal containing the stapedius muscle lies a part of the Fallopian canal.

The roof of the tympanum—*tegmen tympani*—consists of a layer of bone of very variable thickness and density, which forms part of the floor of the middle cranial fossa, and is lined on its upper surface by dura mater. The floor of the tympanum is also formed of a layer of bone of very variable thickness, and has a tessellated appearance, being thrown into many small depressions and ridges. It may, however, bulge upwards somewhat, forming a thin bony cortex to the jugular bulb lying below. It is at a somewhat lower level than the floor of the external meatus; the cavity thus formed, varying in depth, is sometimes termed the “cellar” of the tympanum, or the hypo-tympanum.

ANTRUM MASTOIDEUM AND MASTOID CELLS.

Antrum Mastoideum. A distinct opening in the upper part of the posterior wall of the tympanum, just opposite to the mouth of the Eustachian tube, leads by a short, narrow passage, the antro-tympanic passage or *aditus ad antrum*, into the *antrum mastoideum* (Fig. 150), a cavity of very variable size and depth. The upper tympanic space (*atticus tympanicus*), to which we have already referred, passes directly backwards into this, and the tympanum and

antrum mastoideum are roofed in by one and the same lamina of bone, separating both spaces from the dura mater lining the floor of the middle fossa of the skull. But, while they are continuous at the upper part, the lower two-thirds of these cavities are separated from each other by a thick pyramidal partition of bone, in consequence of which the floor of the antrum is at a much lower level than its opening of communication with the tympanum. This formation is unfavourable to the escape of secretion collected in the antrum. The upper or narrow part of this partition is a rounded ledge, which forms the floor of the aditus, and on this ledge the short process of the incus rests. The antrum mastoideum is separated from the postero-superior wall of the inner end of the external meatus by only a thin layer of bone, which, in purulent diseases of the antrum, may be perforated by caries.

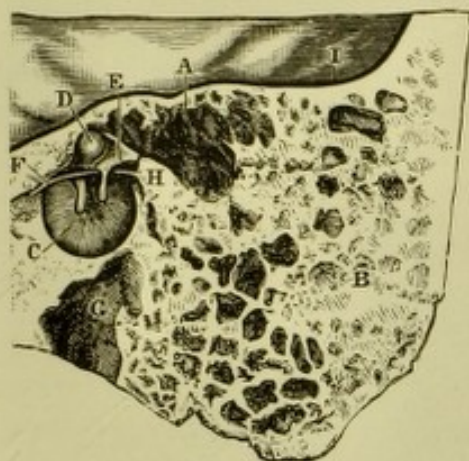


FIG. 150.—Vertical section through tympanum, antrum, and mastoid cells, which are partly pneumatic and partly diploetic. A, Antrum mastoideum; B, mastoid cells; C, inner surface of tympanic membrane; D and E, head of malleus and body of incus, forming the osseous partition dividing the upper tympanic space into two compartments—in the drawing the outer compartment is concealed by these two bones; F, chorda tympani nerve; G, fossa for jugular vein; H, pyramidal partition of bone separating the cavity of the tympanum from the antrum mastoideum. Below the letter H, a portion of the canal for the facial nerve is shown; I, dura mater.

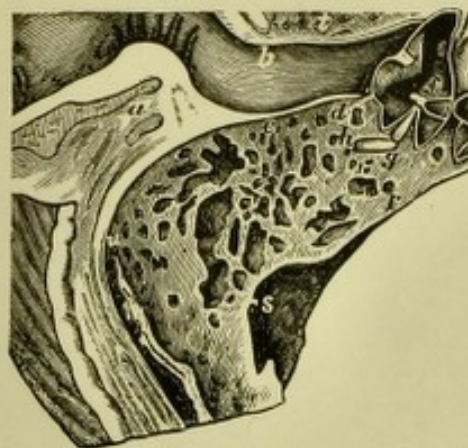


FIG. 151.—Horizontal section through the external auditory canal, tympanum, and mastoid cells, showing the relations of the latter to the two former (after Rüdinger). a, Posterior cartilaginous wall of external auditory canal; b, external auditory canal; c, anterior wall of mastoid cells, or posterior osseous wall of external auditory canal; d, tympanic membrane; f, cavity of tympanum close to stapes; g, stapedius muscle; h, a portion of facial nerve; r, section of a semi-circular canal; s, inner wall of mastoid cells, over the groove for the lateral sinus; u, outer wall of mastoid cells.

Mastoid Cells. The remaining cellular spaces in the mastoid process, sometimes termed *the vertical cells*, are of various sizes (Fig. 150), and are situated for the most part lower down, and more superficially, than the antrum. The largest of them and the greatest number are found in the mastoid part of the temporal bone, which presents great variety in size and length, but they occur also in various other parts of the temporal bone. They exist, for example, in the bone forming the roof and floor of the tympanum and antrum, in the roof of the osseous part of the external auditory canal, extending sometimes into the zygoma, and even as far as the apex of the petrous part of the temporal bone, also on the inner wall of the anterior part of the tympanum and around the tympanic orifice of the Eustachian tube. They sometimes extend backwards as far as the occipital bone. These cellular spaces also present great varieties of size in different persons as well as in the nature of their contents. In less than half of the temporal bones examined the spaces are entirely *pneumatic* or air-filled, and large in size, especially in a bulky mastoid process; those cells which

are near the antrum generally communicate with that cavity. In the majority of temporal bones the cells are partly pneumatic and partly *diploetic*, the latter containing a fatty substance. The diploetic substance usually occupies the lower part of the mastoid process. The larger number may be diploetic, and in some cases the whole mastoid process, with the exception of the antrum, may be occupied by small diploetic spaces containing no air. The *sclerotic* mastoid is also met with; here there is dense ivory-looking bone with few or no cellular spaces; but this condition is more frequent as a consequence of chronic purulent disease of the middle ear. Cheatle, however, suggests that the so-called sclerosed mastoid is really a persistence in an exaggerated form of the infantile type of mastoid, for he has observed this type in adult bones where there were no evidences of middle ear suppuration. In advanced years it is also often found. It is important to remember that the antrum is usually *smaller* and *more deeply situated* in the sclerotic mastoid. The antrum and mastoid cells are enclosed by a shell of compact bone, the cortical part (Fig. 151). That which bounds the cells internally is related above and mesially to the groove for the lateral sinus, while below,

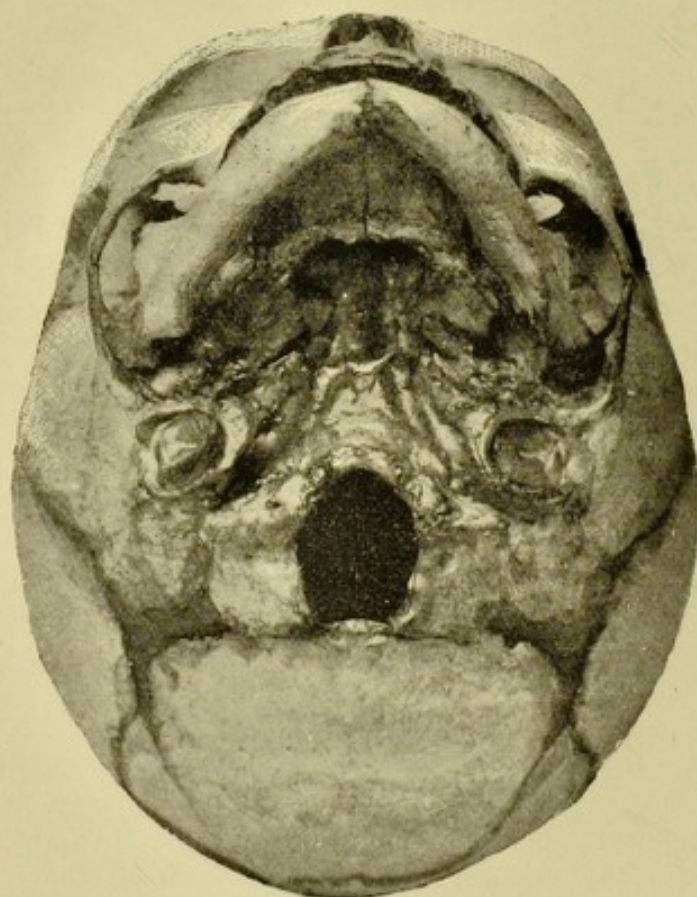


FIG. 152.—Base of skull of new-born infant, showing tympanic membranes almost on a level with the base of the skull.

where it is sometimes very thin, it forms the outer wall of the digastric groove. At the roof—*tegmen antri*—the cortical part is in contact with the dura mater, and in front it forms the posterior osseous wall of the external auditory meatus. Externally it forms the convex surface, very variable in size and thickness, behind the auricle. As the result of purulent disease in the mastoid cells fistulous apertures often form spontaneously on this external wall, which is also the situation where an artificial opening is usually made for the relief of purulent collections in the mastoid cells.

PECULIARITIES OF THE MIDDLE EAR IN CHILDHOOD.

The middle ear presents in the young child some peculiarities worthy of attention. The *tympanic membrane* is (1) thicker and, in proportion to the size of the body, much larger than in the adult, indeed, shortly after birth, it has attained almost its complete size; (2) it is rounder in shape and darker in colour than in the adult; (3) its position is more *horizontal*. At the end of foetal life it really forms part of the base of the skull (Fig. 152), and is almost on a line with the roof of the external meatus. With the development of the tympanic plate, which largely forms the bony external auditory meatus in the adult, and the lateral walls of the skull, the membrane gradually takes the position which it has in the adult. The *Eustachian tube* is shorter, wider, more horizontal, and less cartilaginous. On this account the tube is more easily inflated in childhood, while secretion passes more readily from the tympanum to the pharynx than in the adult. The projection at the upper and back part of the mouth of the tube is also much less marked, and the pharyngeal opening is not so open, being more like a slit. In early childhood the *mastoid cells*, with the exception of the antrum mastoideum, are very slightly developed (Fig. 153), the mastoid process being not only very small, but consisting simply of cancellated bone. During the first few years of life it gradually develops downwards and outwards, till it acquires the conical bulging form. The *antrum mastoideum* is, however, in childhood always well developed, and it occupies a more superficial position than in the adult. It is also higher up (being really in the squamous portion of the bone). There is also often in childhood a very distinct fissure in the roof of the tympanic cavity, the petro-squamosal fissure. Through this fissure a process of dura mater, with vessels and nerves, passes down, and becomes continuous with the mucous membrane lining the tympanum. The masto-squamosal suture (Fig. 153 *d, d*) is also open in early infancy and favours the escape of pus from the antrum. It is sometimes well marked in the adult temporal bone. The tympanic cavity is occupied by a gelatinous tissue before birth, after which this tissue quickly degenerates and becomes absorbed, giving place to air.

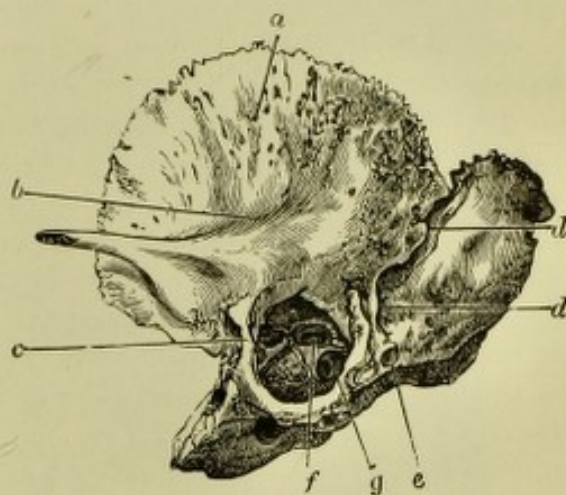


FIG. 153.—Outer view of the temporal bone of a new-born infant (Left). *a*, Upper portion of the squama; *b*, its inferior portion, below is the linea temporalis passing backwards; *c*, annulus tympanicus; *d, d*, suture between the squamous portion and the mastoid process, extending to the foramen stylo-mastoideum; *e*, foramen stylo-mastoideum; *f*, fenestra ovalis; *g*, fenestra rotunda. (Politzer.)

LINING MEMBRANE OF THE MIDDLE EAR.

The walls and contents of the middle ear are everywhere lined by mucous membrane. We saw that the cutaneous lining of the ear became gradually thinner from without inwards, until over the outer surface of the tympanic membrane it became so thin as to be transparent. So the mucous lining of

the ear, comparatively thick at the pharyngeal mouth of the Eustachian tube, becomes gradually thinner as it passes up, until over the walls and contents of the tympanum and the interior of the antrum and pneumatic mastoid cells it is quite transparent. At the pharyngeal mouth of the tube the mucous membrane contains a large number of racemose glands, which are also found, but in less number, higher up. In the membranous part of the tube the mucous membrane is thrown into numerous folds. In the whole of the Eustachian tube and partly in the tympanum the membrane is provided with ciliated epithelium, the movements of the cilia being directed towards the pharynx. In the tympanum the extremely delicate mucous membrane covers the small bones, the tendons of the muscles, the fenestral structures and recesses—in short, the whole of the walls and contents of this cavity. Over the osseous walls and the small bones it is inseparably united to the periosteum (*muco-periosteum*), so that we must look upon every inflammation of this lining as having to some extent the gravity of a periostitis.

The Diseases of the Middle Ear are simply various grades of catarrh or inflammation of the mucous membrane, and the pathological changes found in the different parts of the middle ear, causing disturbance of the function of the organ, are generally due to the effects of these catarrhal processes. In the Eustachian tube, the swelling and exudation frequently obstruct the canal, while agglutinations and adhesions may take place, and hinder the proper separation of the walls during swallowing. So in the cavity of the tympanum the swelling or thickening of the mucous membrane may cause adhesions between the outer and inner walls. Again, exudation of mucus, serum, or pus may partially or completely fill the cavity of the tympanum and even the mastoid cells, often leading to other and permanent changes. It is found, however, that thickening, swelling, and hypersecretion of the mucous membrane covering the chain of bones, especially the stapes, and of that lining the walls of the two fenestral recesses and of the fenestral membranes themselves, are particularly injurious to the function of hearing. In this way the delicate movements of the bridge of bones, and more especially of the stapes, and the mobility of the structures closing the fenestræ, are seriously disturbed. The mucous membrane lining the mastoid cells, especially the antrum mastoideum, generally shares to a greater or less extent in the catarrhal or inflammatory states of that lining the tympanic cavity.

THE RELATIONS OF THE WALLS OF THE MIDDLE EAR TO NEIGHBOURING PARTS.

These are of very great importance in view of the effects which may result from purulent inflammation of the mucous membrane of the middle ear. The bony walls of the middle ear are at particular parts in direct contact with, or closely contiguous to, (1) the dura mater and brain; (2) large blood-vessels; (3) the facial nerve (Fig. 154).

Relation to the Dura Mater and Brain. The dura mater is separated from the mucous membrane of certain parts of the middle ear by thin bone. At one part this bony partition separates the tympanum, antrum, and mastoid cells from the dura mater lining the floor of the middle fossa of the skull, where rests the temporo-sphenoidal lobe of the brain. At another part the bony partition separates the antrum and mastoid cells from the lateral and anterior part of the posterior fossa of the cranium, where we find the concavity for the sigmoid sinus. These

osseous partitions are never thick, and are frequently so thin as to be transparent. They are always perforated with apertures for connective tissue, vessels, and nerves, especially at the roof of the tympanum where there exists the petro-squamosal suture. Again, in a considerable number of skulls, gaps caused by defective development are found in either or both of these partitions, so that at these gaps the dura mater and the mucous membrane of the middle ear are in direct contact. Through these two partitions microbic infection may readily

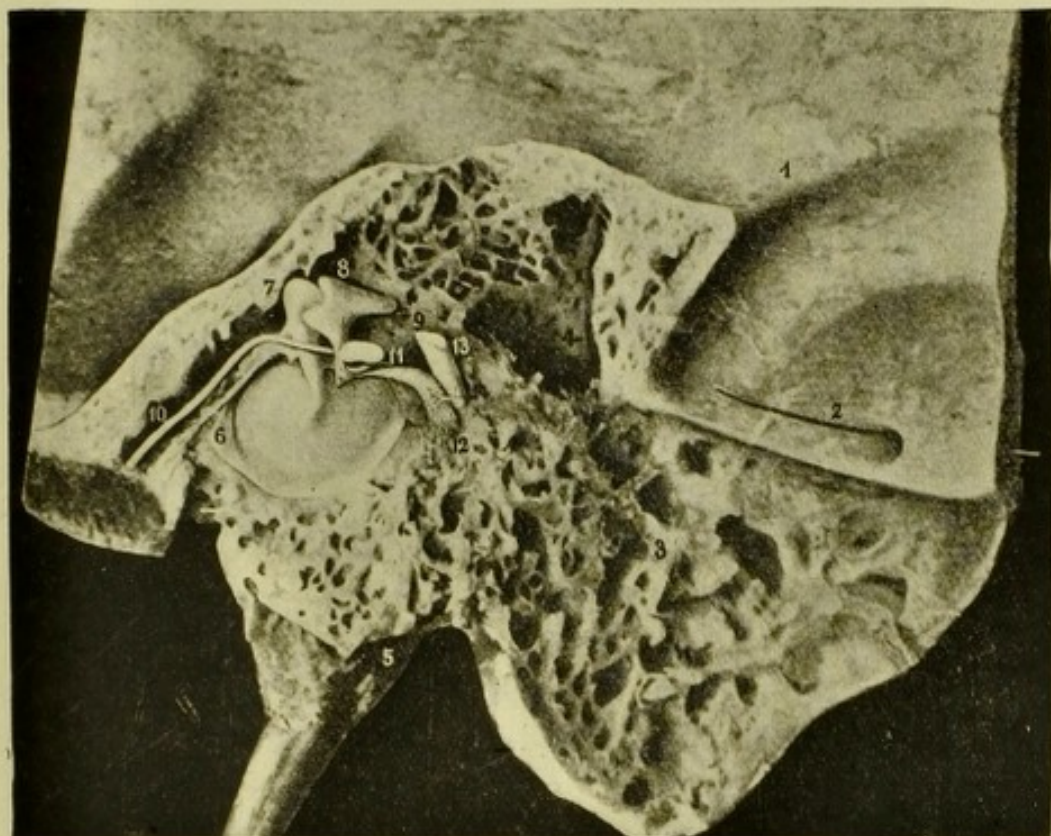


FIG. 154.—Section through the right temporal bone, showing some of the relations of the cavities of the middle ear. 1, Below is the groove for the lateral sinus, and in front is the roof of the antrum; 2, mastoid foramen (with bristle introduced). A vein from the sigmoid sinus passes outwards through this foramen. 3, The vertical mastoid cells; 4, the antrum mastoideum; 5, styloid process; 6, the tympanic membrane close to its insertion in the sulcus tympanicus—the mucous layer extending somewhat beyond the sulcus; 7, the malleus; 8, the incus; 9, short process of the incus; 10, chorda tympani nerve; 11, the stapes with its foot-piece slightly turned up, to show the head and crura; 12, stapedius muscle; 13, facial nerve, giving off, 14, the branch to the stapedius. (From Rüdinger.)

extend either by carious openings (Fig. 155) or by the blood-vessels, or by direct continuity of tissue, to the dura mater and brain.

But there is another pathway by which septic infection may pass to the dura mater, namely, through the interior of the labyrinth. The cochlea may be invaded through the fenestra rotunda, or through a carious aperture in the promontory; the vestibule through the structures closing the fenestra ovalis. Caries of the extreme upper and back part of the inner wall of the tympanum may convey disease to the interior of the horizontal semicircular canal. The disease, having reached the interior of the labyrinth, is separated from the dura mater of the internal auditory canal only by the perforated lamella of bone, through which pass the fibres of the auditory nerve. Disease in the labyrinth may also infect the cerebellar cavity through the bone between the internal auditory meatus and the groove for the lateral sinus, also through the aqueducts of the vestibule and cochlea. The middle cranial fossa is more rarely infected from the labyrinth.

Instances are also recorded, in which the disease passed from the tympanum to the internal auditory canal by the Fallopian canal and sheath of the facial nerve.

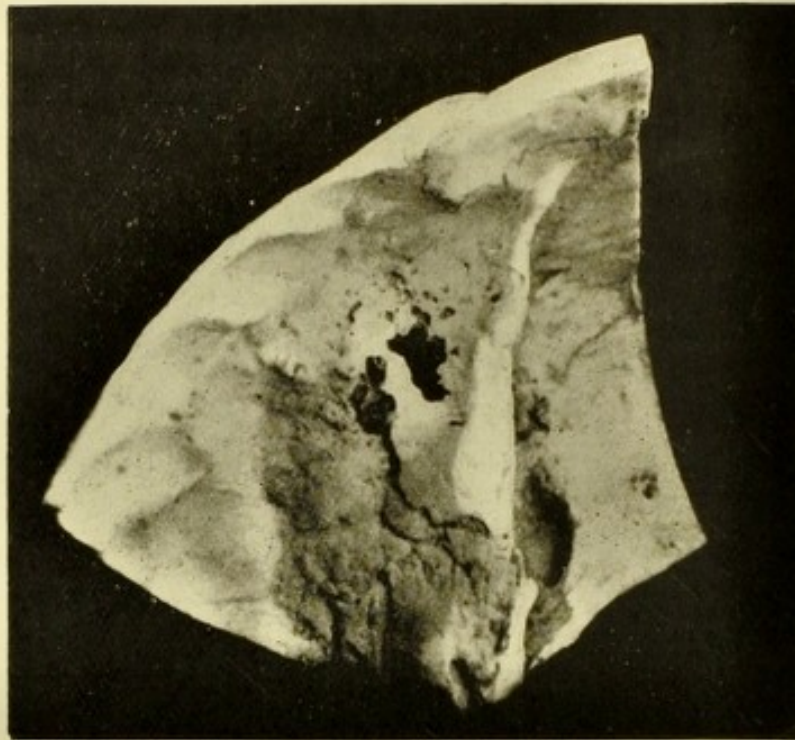


FIG. 155.—Upper and anterior surface of petrous portion of temporal bone, showing carious apertures in the roof of the middle ear, from patient who died from cerebral abscess.

Relation to Blood-vessels. One of the main arterial trunks and three venous channels are in close proximity to, and only separated by thin osseous walls from, the mucous membrane of the middle ear. The *internal carotid artery*, contained in the carotid canal, lies on the mesial side of the inner wall of the tympanum and osseous part of the Eustachian tube. The great intra-cranial venous trunk, the *sigmoid sinus*, is separated from the antrum and mastoid cells only by the inner wall or cortical covering of the latter. Scarcely less important is the position of the *internal jugular vein* at its bulb exactly under the floor of the tympanic cavity, while of less but yet of considerable importance, is the proximity of the *superior petrosal sinus*, which is situated upon the upper edge of the petrous part of the temporal bone near the roof of the middle ear. The petro-squamosal sinuses, which in early foetal life are important channels through which venous blood leaves the inside of the skull, may in early infancy be

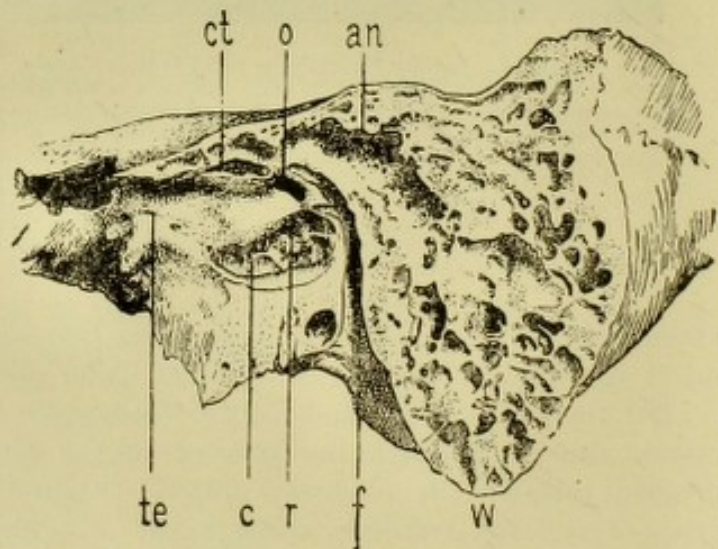


FIG. 156.—Sagittal section through the roof and floor of the tympanic cavity, showing the course of the facial nerve; *te*, osseous Eust. tube; *ct*, canal for tensor tympani muscle; *c*, floor of tympanum; *o*, fenestra ovalis; *r*, fenestra rotunda; *an*, antrum; *f*, canal for facial nerve; *w*, mastoid process. (Poltzer.)

infected from the middle ear and cause septic thrombosis extending to the lateral sinus, or, especially when the petro-squamosal suture remains patent, infection may be transmitted direct to the meninges or temporo-sphenoidal lobe. The osseous partitions separating these vessels from the middle ear have the same peculiarities as the osseous partitions in contact with the dura mater. They may be thin to transparency, they may have gaps, and they are perforated by openings for connective tissue, vessels, and nerves. In purulent diseases of the middle ear any one of these blood channels may be involved. From the internal carotid fatal hæmorrhage has ensued, due to caries of the osseous partition. Perhaps more frequently, however, septic infection of the carotid canal, with pus formation round the artery, takes place; according to Gradenigo, the sixth nerve may be implicated by this route. In the venous channels, especially the *sigmoid sinus*, septic thrombosis with its consequences is probably the most common of the serious complications of purulent disease of the middle ear. The positions of the internal carotid artery and of the internal jugular vein, with reference to the middle ear, also explain the sense of throbbing and the venous murmurs experienced in the ear by some persons.

Relation to the Facial Nerve. We have seen the close connection of the facial nerve with the inner wall of the tympanum and the mastoid cells (Fig. 156). The osseous partition separating the nerve from the mucous membrane of the middle ear is often extremely thin and sometimes defective, especially in its position above the fenestra ovalis. We meet with facial paralysis most frequently in purulent diseases, but occasionally also in non-purulent catarrh of the middle ear.

FUNCTIONS OF THE MIDDLE EAR.

The various parts of the middle ear either directly or indirectly conduct sonorous vibrations from the external auditory canal to the fluid of the labyrinth.

Function of the Tympanum. The tympanum is engaged directly in the conduction of sound, while the Eustachian tube and the mastoid cells are indirectly concerned in the due performance of this function. While the air in the tympanic cavity and the membrana tympani secundaria are to some extent the media by which the vibrations of the tympanic membrane are transmitted to the fluid of the labyrinth, there is no doubt that the chain of small bones—the malleus, the incus, and the stapes—with the membrane closing the fenestra ovalis, forms the chief conducting medium between the tympanic membrane and the fluid of the inner ear. The chain of bones forms a delicate lever apparatus, which is placed, by the vibrations of the tympanic membrane, in a state not only of molecular movement, but also of movement *en masse* inwards and outwards. These movements are much more extensive in the malleus than in the stapes. According to the experiments of Dr. Buck, of New York, the extent of movement is twice as great in the malleus as in the incus, and twice as great in the incus as in the stapes. The labyrinth is protected in this way against the effects of great concussions in the neighbourhood of the ear, or of undue inward pressure of the tympanic membrane. On the other hand, when the air in the middle ear is abnormally compressed, and the tympanic membrane thereby forced outwards, the excessive withdrawal of the stapes from the fenestra ovalis is hindered by the structure of the joint

between the malleus and the incus. This is furnished with a "catch" which limits the movement outwards of the long process of the incus, and renders it much less than that of the malleus. The movements of the base of the stapes are very limited. According to Helmholtz, when the membrane is moved outwards and inwards by alternate condensation and rarefaction of the air in the external auditory canal, the movements or excursions of the stapes do not extend over more than an eighteenth to a fourteenth of a millimetre. In the movements excited by sonorous vibrations, the excursions of the stapes are extremely short; in very weak yet clearly perceptible tones they escape recognition even by a powerful microscope. The vibrations probably become intensified in passing from the comparatively large tympanic membrane to the much smaller membrane closing the fenestra ovalis.

Function of the Eustachian Tube. By the free passage of air through the Eustachian tube, the atmospheric pressure is always the same on both sides of the tympanic membrane. This ensures a proper degree of tension of the membrane and ossicular chain, which is essential to the healthy condition of the ear. Whenever there is a hindrance to the due passage of air through the Eustachian tube, the tension is disturbed, because, the air in the tympanic cavity becoming more rarefied than the air on the outer surface of the tympanic membrane, the latter is pressed unduly inwards, and its tension as well as that of the whole chain of bones is increased; owing, also, to the reduction of the intra-tympanic air pressure the mucous membrane tends to secrete more actively. It has been pointed out that, in ordinary conditions, the greater part of the membrano-cartilaginous tube is closed. It opens, however, every time one performs the act of swallowing; and it is found that air may pass from the naso-pharyngeal cavity to the tympanum at other times also. During ordinary breathing the tympanic membrane in some persons moves synchronously with inspiration and expiration, but probably in these cases the tube is unusually wide and open. In forced expiratory efforts, as coughing, singing, blowing the nose, etc., the air may pass through the Eustachian tube to the cavity of the tympanum. If the nasal passages are closed from any cause these expiratory efforts have a greater effect in forcing air through the Eustachian tubes. The width and permeability of the Eustachian tubes undoubtedly vary much in different persons and even in the same person in different circumstances, such as the state of the weather, etc. Fluid secretion in the tympanic cavity may, in certain circumstances, escape through the Eustachian tube to the nasal passages, but the situation of the tympanic opening of the tube at the *upper* part of the tympanum is unfavourable to its function as an exit tube.

Function of the Mastoid Cells. Besides imparting lightness to the thick temporal bone, the air-filled mastoid cells may act as resonance chambers to the tympanic vibrating structures and thus intensify the sound, while they probably also form a reservoir for supplying the tympanum with air, in partial or temporary obstruction of the Eustachian tube.

Functions of the Four Muscles of the Middle Ear. The *tensor palati* or *circumflexus palati* is the chief means of opening the Eustachian tube. From the direction and attachment of the fibres, already referred to, it is clear that when this muscle contracts, as it does during the act of swallowing, the outer or membranous wall, with the hook-shaped cartilage, is withdrawn from the inner wall. As this muscle seems to have no action on the soft palate, its action being confined to the Eustachian tube, von Tröltsch suggested that it be named the *abductor tubæ*. The tensor palati receives its nervous supply through

the otic ganglion from the motor fibres of the fifth nerve (internal pterygoid branch).

The *levator palati* muscle has a much less important action on the tube, being chiefly a palate muscle. During contraction it forces the floor of the tube upwards and backwards, and in this way increases the transverse diameter of the tube. It is supplied by a branch from the pneumogastric nerve and also by one from Meckel's ganglion.

The *tensor tympani* muscle in contracting pulls the handle of the malleus inwards, and thus increases the tension of the tympanic membrane. The inward movement of the malleus is communicated to the long process of the incus, and the stapes is thus pressed in upon the labyrinth. The tendon of this muscle is apt to become abnormally and permanently shortened, when the tympanic membrane has continued for a length of time in an indrawn position, and the contracted tendon may resist any efforts made to restore the tympanic membrane and ossicular chain to their proper position and degree of tension. It receives its nervous supply from the same source as the tensor palati.

The *stapedius* muscle is understood to have an action antagonistic to that of the tensor tympani. It prevents the stapes from being unduly forced into the fenestra ovalis. It derives its nerve supply from the facial nerve in the Fallopian canal.

The function of these two muscles therefore is to regulate, in some degree, the tension of the tympanic membrane and ossicular chain, so as to facilitate the conduction of sound waves and *preserve the due amount of pressure* of the stapes upon the fluid of the labyrinth.

Some writers describe another muscle—the *salpingo-pharyngeus*—as acting upon the tube. Good authorities, however, look upon this as merely a fascia. If muscular, it may be considered as contributing to the fixed position of the median cartilage.

The vascular and nervous supply of the middle ear is described in the Appendix.

THE DISEASES OF THE MIDDLE EAR.

Diseases of the middle ear may be conveniently divided into two great classes.

I. **The purulent or perforative inflammations**, which are attended by perforation of the tympanic membrane and discharge from the middle ear. This class is usually sub-divided into (1) the acute form (*otitis media purulenta acuta*) and (2) the chronic form (*otitis media purulenta chronica*). These, however, are simply stages of one and the same disease, namely, purulent inflammation of the middle ear. This disease and its consequences are so important that the following five chapters are devoted to their consideration.

II. **The non-purulent or non-perforative diseases** of the middle ear, which are attended neither by perforation of the tympanic membrane nor discharge from the ear. This class is conveniently sub-divided into two. (1) Where there is pronounced inflammation or catarrh, with exudation, in the middle ear, especially in the tympanic or tubo-tympanic cavity. This sub-division includes (*a*) *acute non-*

purulent or non-perforative inflammation and (b) *simple exudative catarrh* without perforation. (2) The non-exudative or dry conditions. These are also sub-divided into (a) *non-exudative or interstitial inflammation of the middle ear (chronic adhesive or dry catarrh)*, and (b) *otosclerosis*, a disease primarily affecting the foot-piece of the stapes and the annular ligament, but involving also the bony capsule of the labyrinth.

While these divisions are convenient and approximately correct, it is to be remembered that the one may merge into the other, or the one may be a result of the other. For example, a simple exudative catarrh may readily become an acute otitis media, either perforative or non-perforative; so also the conditions embraced in the term chronic adhesive catarrh may be the products of purulent or non-purulent inflammation, or of simple exudative catarrh.

CHAPTER XI.

PURULENT OR PERFORATIVE INFLAMMATION OF THE MIDDLE EAR.

THIS is probably the most important of all the diseases of the ear, not only on account of its frequency, but also of its serious effects upon the ear as well as upon the surrounding structures, effects which often involve life itself. As to its frequency, statistics drawn up by various authorities agree in showing that from 30 to 35 per cent. of all ear diseases belong to this class.

The early stage is usually termed *acute purulent or perforative inflammation of the middle ear (otitis media purulenta acuta)*, *acute purulent ear catarrh* (von Tröltsch), *acute suppuration of the middle ear* (Roosa). If the affection has gone on for a few months, it is usually termed *chronic purulent inflammation of the middle ear (otitis media purulenta chronica)*, *chronic purulent ear catarrh* (von Tröltsch), *chronic suppuration of the middle ear* (Roosa), *pyogenic otitis media*. Also it is frequently spoken of as *otorrhœa* from the most pronounced symptom, discharge from the ear.

In his description of purulent disease of the middle ear, however, the writer has not followed the usual plan of separating the acute form from the chronic, but has regarded the former as simply the early stage. Both are therefore included in the common term of *purulent inflammation of the middle ear*, and this is described in three stages:—(1) The stage before perforation; (2) the stage of purulent discharge; (3) the stage after the discharge has ceased—the non-secreting stage.

PATHOLOGY.

Acute Stage. In the early stage of the disease the mucous membrane of the middle ear, *especially of the tympanic cavity*, is in a state of congestive swelling with round celled infiltration and increased exudation. The exudation consists of serum, mucus, pus, or blood in varying proportions with pathogenic organisms (see p. 72). In severe forms, associated with more viru-

lent pathogenic organisms, the inflammation and swelling become more intense, the deeper or muco-periosteal layer is involved, while the exudation becomes more purulent in character. There is in most cases a tendency to softening, ulceration, and necrosis, especially in the tubercular and scarlatinal forms, while with few exceptions it is *attended by perforation of the tympanic membrane*. The disease is frequently confined to one ear, although both may be affected, especially in the exanthematous diseases. As time goes on the epithelial lining usually becomes lost and the surface presents a red, soft, granular, or smooth appearance. From this surface granulation tissue or so-called polypi may project as a result of hyperplastic growth. Cario-necrotic disease of the bone may take place even in the acute stage.

In the Chronic Stage there is frequently new-formation of connective tissue elements, leading to thickenings, adhesions, or cicatrices. Calcification and atrophy not unfrequently take place both in the mucous lining of the middle ear and in the tympanic membrane. In a very advanced stage the mucous membrane may become white from atrophy. The infective process often leads to *serious changes in the osseous walls and ossicula*, such as erosion or caries, necrosis and exfoliation, or thickening and hyperostosis. Certain cases, especially in young children, associated with extensive caries and necrosis of bone and enlarged cervical glands, are really tubercular. Desquamative, caseous and cholesteatomatous collections are frequently found in the attic and antrum. Granulation tissue and mucous polypi frequently spring from the diseased mucous membrane or from carious or necrotic bone. In both the acute and chronic forms the adjoining parts of the ear, the external meatus on the one side and the labyrinth on the other, generally participate more or less in the inflammatory process. In the labyrinth, while this participation may simply consist of transient hyperæmia, with perhaps serous exudation, there may, on the other hand, be destructive purulent formation (purulent labyrinthitis), leading to total and permanent loss of hearing and other serious consequences.

Purulent inflammation of the middle ear is in a few exceptional cases unaccompanied by perforation of the membrane, owing probably to previous thickening of its layers or to the perforation being closed before the patient came under observation. In such circumstances the purulent secretion may escape through the Eustachian tube; or it may be isolated in the mastoid cells, or even in the extra-dural space. Purulent collections in the middle ear, unattended by perforation of the membrane, seem to be relatively common in new-born or very young infants (von Tröltsch).

CAUSES OF PURULENT INFLAMMATION OF THE MIDDLE EAR.

The disease is met with at all ages, but frequently begins in childhood, originating in very many cases before the age of fifteen years.

Exciting Causes. The following are the most important. (1) The exanthematous diseases—scarlet fever, measles, and smallpox, but especially scarlet fever, which, when complicated with nasal diphtheria, probably gives rise to the most destructive and persistent type of the disease. (2) The extension of nasal and pharyngeal diseases, with accompanying organisms, through the Eustachian tube to the

tympanic cavity. The migration of infective organisms from the naso-pharynx, especially in children whose naso-pharyngeal spaces are so often occupied by adenoids and infective secretions, is a fertile source of this disease. (3) The action of cold through the external meatus, as in diving or immersing the head in water; exposure of the ear to cold wind, especially with rain, sleet, or snow; or the trickling of water into it from ice applied to the head. These cold impressions are usually associated with the entrance of pathogenic organisms. (4) Reflex action, as from cold feet, teething in infants, or dental disease. (5) Injuries, such as a blow on the ear, the presence of foreign bodies or *instrumental efforts* to remove them, caustic applications, traumatic rupture of the tympanic membrane (especially its improper treatment), the propulsion of fluid by the nasal douche or syringe through the Eustachian tube into the tympanum. (6) General diseases (in addition to the exanthemata which have been already referred to). Epidemic influenza is a frequent cause, and the form arising from it has a special tendency to mastoid inflammation. Mumps, diphtheria, phthisis pulmonalis, typhoid fever, malarial diseases, diabetes, pneumonia, and bronchitis are all recognized though less frequent causes. A form apt to be accompanied by effusion of blood into the tympanic cavity (*otitis media hæmorrhagica*) is sometimes associated with chronic Bright's disease and with leukæmia.

Predisposing Causes. Predisposing conditions often exist, such as a hereditary tendency, the tubercular constitution, chronic disease in the naso-pharynx, *especially adenoid vegetations*. Pre-existing disease in the ear itself is a common predisposing cause. For example, if there be already chronic purulent disease, an acute attack may be excited by some fresh irritation; or, if there be a "dry perforation" remaining after the secreting process has passed away, there is a tendency to a renewal of the old "otorrhœa." So, in simple catarrh of the middle ear, fresh irritation and the invasion of more virulent pathogenic bacteria may readily induce an acute purulent condition. The disease may also be due to secondary infection from the external meatus or tympanic membrane.

Micro-organisms. These play a most important part in the causation and maintenance of purulent ear disease. The organisms chiefly met with are described at p. 72.

Causes of the Persistence of Purulent Inflammation. (1) The smallness or unfavourable position of the perforation, preventing the efficient drainage of secretion from the middle ear. (2) The formation of exuberant granulations or polypi; these not only perpetuate the discharge, but render it more profuse. (3) Retention and decomposition of the purulent secretion with *formation of cholesteatomatous material* in the attic or antrum. (4) The formation

of adhesions or septa, which may partition the middle ear into several spaces retaining or enclosing part of the secretion. (5) Caries, necrosis, or hyperostosis of the osseous walls or ossicula. (6) The existence of the tubercular or syphilitic diathesis, or of bad hygienic conditions. (7) A most important factor in its persistence is the neglect of treatment and specially of proper and thorough cleansing. It is a common experience of those specially engaged in the practice of aural surgery to find persons who have suffered from this disease for many years without any effort having been made to cure it. This is mainly due to the usual absence of pain or disturbing subjective symptoms, to the fact that the morbid processes are concealed from view, to ignorance of the possible consequences of the disease, and to the advice often given by the practitioner to "leave it alone."

SUBJECTIVE SYMPTOMS OF PURULENT INFLAMMATION OF THE MIDDLE EAR.

Pain in the Ear. In the *acute* stage the first symptom usually complained of is a sense of heat, fulness, and pressure in the ear. Very soon the sensation becomes that of distinct pain, often intense and penetrating, which is felt not only in the ear, but shooting thence along the side of the head as far as the forehead in front or the occiput behind. There may also be a benumbed sensation over the corresponding side of the head. The pain may be less intense during the day, generally becoming very much worse at night and preventing sleep. It is usually aggravated during the acts of swallowing, hawking, coughing, blowing the nose, etc. The mastoid process and the glands below the ear are frequently tender on pressure. The pain is usually much relieved when perforation takes place, although cases are not uncommon in which it persists or returns in spite of the rupture of the membrane. It is to be noted, however, that, when this disease occurs during a bad attack of scarlet fever, the gravity of the general symptoms may entirely mask the ear affection, and lead to its being overlooked. It is also to be remembered that cases are met with, not unfrequently, where there is *neither pain nor general disturbance*, when the only indications of the disease are, perhaps, a slight fulness and dulness in the ear followed by a sense of moisture in, or discharge from, the meatus. This is most likely to occur in persons with old perforations, or in tubercular patients.

In the *chronic* stage probably nothing so contributes to the neglect by patients of this disease as the frequent *absence of painful symptoms*. In most cases either there is no pain during the whole course of the disease, or, if pain be experienced, it is at long intervals, and is due to some complication. Thus, obstruction to the exit of the secretion by temporary closure or insufficiency of the perforation, by a polypus or by contraction of the external meatus,

may excite severe pain in the ear. An acute exacerbation may excite great pain; so may also the occurrence of furunculi in the external meatus. The extension of the inflammation to the mastoid cells or to the mastoid periosteum is usually attended by severe pain in the mastoid region. In the chronic condition heavy dull *pain in the head*, chiefly in the region supplied by the trigeminus, is sometimes complained of, particularly by anæmic and weakly persons. In severe and persistent headache, especially on the side corresponding to the affected ear, we should consider the possibility of extension of the inflammatory process to the dura mater, brain, or venous sinuses.

Subjective Sounds. In the *acute* stage, subjective sounds in the ear, especially those of a rushing or hissing character, are frequently present, while, after a few days, bubbling or crackling sounds are heard, especially during swallowing or blowing the nose. The patient at this stage usually complains of throbbing in the ear, sometimes referred to as "a hammering or pumping," which may be removed for the time being by pressure on the carotid artery of the same side.

In *chronic* cases subjective sounds in the ear are complained of only in a comparatively small proportion. Chronic *purulent* disease presents in this respect a striking contrast to chronic *non-purulent* inflammation. Probably the existence of a perforation, by preventing rarefaction of the air in the tympanic cavity and consequent inward pressure of the stapes, accounts for their comparative infrequency in the purulent diseases.

Impairment of Hearing. This is usually very considerable, especially after exudation takes place. It varies from very slight and unobserved dulness to almost complete loss of hearing. The deafness is, in the same person, liable to fluctuation owing to changes in the quantity and the situation of the secretion, and in the degree of swelling of the mucous membrane. It is commonly believed that the defect of hearing is mainly the result of the perforation in the tympanic membrane. *This is a mistake.* There are many persons with perforation of the membrane, even on both sides, whose slightly impaired hearing is scarcely noticed by their friends. The deafness is only partially, and in a comparatively slight degree, caused by the defect in the membrane. It is chiefly due to the following conditions:—(1) Swelling or thickening of the mucous membrane covering the ossicles and the fenestral membranes or recesses leading thereto; (2) the presence of fluid or inspissated secretion upon these parts; (3) adhesions or bands connecting the ossicula with the walls of the tympanum, especially the stapes with the walls of its recess; (4) rigidity of the joints of the ossicula,

loss of one or more of the ossicula, or loss of continuity in the ossicular chain; (5) a concomitant affection of the labyrinth, when the deafness may be extreme. In short, if there be a freely movable stapes, with a normal fenestral membrane and a normal nerve, the conducting function of the ear may not be seriously impaired, although the tympanic membrane be destroyed.

The Hearing in the Third or Non-Secreting Stage of the Disease is variously affected. A dry perforation is quite compatible with fairly good hearing. There is not such severe or frequent fluctuation of the hearing as in the secreting stage, while there is not so great a tendency to progressive aggravation of the deafness, or to implication of the labyrinth, as in chronic non-perforative inflammation. A cicatrix does not *necessarily* cause impaired hearing. If it is large or adherent, there is usually more or less defective hearing, due in the first case to diminished tension of the membrane, and in the second to the adhesion binding the ossicula and impeding their vibrating power. Inflation, in either case, usually improves the hearing, at least for a time. Other kinds of adhesions, connecting bands or cords, or extensive formations of connective tissue, have usually a more important influence in impairing the hearing than a cicatrix. When these exist in the upper part of the tympanum, binding the ossicula to the walls of the cavity or to one another, the hearing may be very materially decreased. The most serious forms of deafness, which may even be total, are produced by thickenings or connective tissue formations in the fenestral coverings, by complete binding down or ankylosis of the stapes in its fenestra, and by serious involvement of the labyrinthine structures. It has also to be observed that, when total deafness exists in one ear as the result of chronic purulent disease, the other ear is apt in time to become gradually deaf often owing to chronic adhesive catarrh.

Bone-Conduction. In all stages, with few exceptions, hearing by osseous conduction is much in excess of air-conduction as tested by Weber's, Rinne's and Schwabach's tests. The patient's own voice sometimes sounds to himself, especially in the early stage, with increased resonance on the affected side, *autophonia*, just as when the healthy ear is closed with the finger.

Giddiness. The acute stage is occasionally ushered in with a distinct attack of giddiness, which may also be excited by the pressure of the inflammatory products upon the walls of the middle ear or by concomitant inflammation of the labyrinth. In the chronic stage the pressure of inflammatory products, especially caseous and cholesteatomatous masses, may excite severe attacks of the vertigo. The whole series of Ménière's symptoms may result, especially if the infective process has involved the labyrinth or semicircular canals when nystagmus is often also observed, or there may be frequent attacks of slighter giddiness (p. 56).

Feverish Disturbance. There is often in the acute stage considerable feverish disturbance with a temperature of from 101 to 103° Fahr., and, occasionally, delirium. In the chronic stage such temperatures would give rise to the suspicion of some complication.

In young children the disease may be manifested in the early stage by great restlessness, by apparent difficulty in sucking and swallowing, and by screaming when the ear is touched or pressed upon. Great disturbance of the nervous system, such as convulsions or coma, is sometimes excited in the young child by an acute inflammation in the middle ear. This might be expected from the anatomical connection which exists in childhood between the mucous membrane of the middle ear and the dura mater (p. 237).

Vision, Taste and Smell. Vascular changes in the optic disc are not unfrequently met with (see p. 63). Patients occasionally complain of impaired or depraved sense of taste. The investigations of Urbantschitsch and others show that impairment of the sense of taste very commonly exists, although rarely complained of by patients. Occasionally patients speak of a very disagreeable sense of taste and smell, which they attribute to the passing of the fetid purulent matter into the pharynx.

OBJECTIVE SYMPTOMS OF PURULENT INFLAMMATION OF THE MIDDLE EAR.

Appearances in the First Stage. At the earliest part of this stage the vessels of the cutaneous layer of the tympanic membrane are found markedly injected, especially over the *pars flaccida*, the manubrium, and the periphery of the membrane (Coloured Plate II., Fig. 3). The other parts may at the same time have a leaden, dull, and lustreless appearance. In severe forms of the disease the individual vessels of the membrane can no longer be distinguished, and the whole surface of the membrane assumes a bright red or a bluish red colour.

With the *stage of exudation* the aspect of the membrane changes, owing to its being bulged outwards by the secretion in the cavity of the tympanum, or by exudation below the epidermic layer of the membrane. The manubrium is no longer visible, owing to the congested cutis and the swollen macerated epidermis which covers it. In some cases the superficial layers of the membrane may be thrown off in flakes. Instead of a general bulging outwards there may be a partial bulging (Coloured Plate II., Fig. 4). When the inflammation chiefly affects the attic of the tympanum, the bulging is limited to the *pars flaccida*. The colour of such bulgings varies in different cases; most frequently they are yellowish or reddish grey, but sometimes they are greenish, and at other times dark blue in colour. Saccular bulgings, which are yellowish grey or green in colour (Coloured Plate I., Fig. 13), projecting from the upper and back part of the membrane, may overlap and cover the manubrium, while the rest of the membrane may be but little altered from

the normal condition. These saccules may contain serum, blood, or pus; and they may or may not communicate with the cavity of the tympanum. In certain cases, more particularly where the membrane has been already thickened by previous disease, there may be no bulging of the membrane, although exudation is present in the tympanic cavity.

The skin covering the osseous walls of the external meatus is usually somewhat injected and swollen, while the glands below, behind, or in front of the ear, especially the former, may be swollen and tender.

Appearances in the Second or Perforation Stage. In this stage *the tympanic membrane is found perforated*, and the external meatus contains *secretion* which has escaped through the perforation from the middle ear.

The Secretion. In quantity this varies in different cases from a slight moisture, not showing itself at the outer orifice of the ear, to an almost constant discharge. At first the discharge may be very thin and copious, resembling yellowish clear serum, becoming afterwards more mucoid or purulent in character. Blood may stain the secretion at this stage. In *otitis media hæmorrhagica*, a discharge of blood when the membrane ruptures is the leading feature. As the disease progresses the character of the secretion presents great varieties in different cases and in the same case at different times. It may be altogether purulent, white or yellowish in colour, mixing uniformly with water. Or the mucous element may predominate, the secretion being composed of strings or flakes, which do not dissolve in water, but remain floating in it. This mucous secretion is sometimes so tenacious that there is considerable difficulty in completely removing it from the deep parts of the ear (blennorrhœa). Again, the secretion may be rendered thin and less opaque, owing to the pus being mixed with a considerable quantity of serum. The secretion may be tinged with blood, especially when there are granulations or polypi. In caries or necrosis the discharge is sometimes like flesh rinsings (Politzer), and has a very irritating quality. If the discharge be small in quantity, and if there be abundant formation of cerumen, it may be mistaken by the patient for thin wax. In the chronic stages dried masses are sometimes found occupying the inner end of the canal and adhering to the upper and back wall. These are composed of epidermic or epithelial laminated masses—cholesteatomata—which may have a shining pearly appearance from the presence of cholesterine between the plates. They generally cover a perforation. No discharge may appear externally, while, on examination, a small crust may be seen, on the removal of which pus may be found underneath. This is most common at the *membrana flaccida*.

The discharge has frequently an *offensive smell*, except in the early stages, especially if regular cleansing has been neglected; in spite, however, of regular cleansing the offensive odour may persist. The odour is particularly offensive when there is diseased bone, or when the secretion remains mixed with the ceruminous and oily matter of the canal. In some cases the odour is disgusting, and infects the air in the neighbourhood of the patient. In very chronic cases, especially those associated with cholesteatomata, the odour frequently resembles that of old cheese.

Condition of the External Meatus. In order to ascertain this we must, unless the discharge be very slight, syringe the ear, and afterwards dry the parts carefully with absorbent cotton. In the acute stage, plates of sodden epidermis are often found adhering to the walls of the inner end of the meatus or to the tympanic membrane. These must be removed. If there is very little discharge, simply wiping it away with absorbent cotton wool is to be preferred to syringing. Granulations or small polypi may occupy part of the meatus, or a polypus may even protrude from the outer orifice. Caries or necrosis of the walls may be found, or the calibre of the canal may be considerably contracted, owing to swelling or thickening of the cutaneous lining or to hyperostosis. The cutaneous lining of the canal is, in many cases, reddish and swollen, from the irritating action of the secretion. When this secretion is very acrid there may be excoriation, especially on the floor of the meatus, extending, it may be, to the outer parts as far as the lobule. Eczema of the auricle may result from such irritation.

Appearances of the Tympanic Membrane. Perforation. The tympanic membrane is always found in a pathological condition. In the first place there is an aperture in the membrane, forming an abnormal communication between the external meatus and the tympanic cavity. This aperture may be no larger than a very small cleft, or a pin-point (Coloured Plate III., Fig. 1), or there may be almost complete destruction of the membrane (Coloured Plate III., Fig. 9). In the acute stage, on the removal of the secretion by syringing and mopping, the membrane is usually found to be red and swollen, while its normal projections and concavities are obliterated, and abnormal bulgings may be seen. The perforation takes place most frequently in the centre of the posterior half of the membrane, when it sometimes appears as a sharply defined black spot. As it is usually at first small and with more of the character of a minute cleft, it is often difficult, or impossible, to distinguish it in the swollen inflamed tissue. In certain cases characterized by great persistence, we find the perforation, minute in size, situated at the apex of a nipple-shaped projection (Coloured Plate II., Fig. 7),

springing usually from the upper part of the membrane and projecting downwards. Even in a recent case, however, the perforation may be large, involving the greater part of the membrane, and this is likely to be the case *if it has originated in scarlet fever*. There is probably never *complete* loss of the membrane. Even in the worst cases a portion of the upper segment, including the short process and upper part of the handle of the malleus, or even the whole of it, as well as a narrow rim all round, usually remain (Coloured Plate III., Fig. 12), although these remnants may be difficult to see owing to the swollen state of the tissues. Between the pin-point perforation and almost complete destruction we find great varieties in the extent of loss of the membrane. There is usually only one perforation, but occasionally two are found, and very rarely three.

Situation and Shape of the Perforation. Probably the most common situation is the lower half of the membrane. Perforations are, however, not at all uncommon in the upper part, especially when the source of the secretion is in the attic. The perforation is then commonly in the *membrana flaccida* (Coloured Plate III., Fig. 8). The aperture may in these cases be very small, and situated close to the upper edge of the Rivinian segment; or the whole of the *membrana flaccida* may be removed with a portion of the bony edge of the Rivinian segment. When the antrum mastoideum is the source of the secretion, the perforation is generally in the postero-superior quadrant of the membrane over the incudo-stapedial joint. Perforations are most frequently roundish or oval in shape (Coloured Plate III.). When the lower end of the manubrium projects into the gap, the latter has a *kidney shape* (Coloured Plate III., Fig. 11), with the *hilum* upwards. Above the short process of the malleus a small perforation is apt to escape notice; so also when it is at the antero-inferior periphery.

The Remnant of the Tympanic Membrane. This presents various appearances. It may, especially in the early stage, be congested and swollen. In the chronic cases it is usually greyish and hypertrophied. There is not unfrequently a well-defined calcareous patch (Coloured Plate III., Fig. 1); this is, however, most commonly seen after the purulent process has ceased. There may be several calcareous patches (Coloured Plate III., Fig. 5), and even the whole of the remnant of the membrane is sometimes found converted into a calcareous mass. The edge of the perforation is often red and granular, and in contact with, or even adhering to, the inner wall of the tympanum or to one of the ossicula (Coloured Plate III., Fig. 13).

Tympanic Cavity as seen through the Perforation. The tympanic mucosa, as seen through the perforation, is generally

red and swollen or even hypertrophied, and the surface may be either smooth or granular. Granulation tissue or a polypus often sprouts from the inner wall or from the edge of the perforation, and may thus cover and conceal the perforation (Coloured Plate III., Fig. 6). Sometimes, especially in very old cases, the tympanic wall is yellowish grey or whitish in colour (dermoid), or part may be red and swollen and part grey and thinned.

The part of the tympanic cavity exposed to view depends upon the size and position of the perforation (Fig. 157). The mucous covering of the *promontory* immediately behind and below the umbo is very frequently laid bare. In the postero-inferior quadrant we often see the anterior rounded edge of the opening into the fenestra rotunda, and behind that the opening itself is seen as a dark semi-lunar depression directed backwards (Coloured Plate III., Fig. 9). When the lower part of the membrane is destroyed, the irregular tessellated appearance of the floor comes under observation; while, if the loss of membrane is in the antero-superior part, the portion of the inner wall corresponding with the position of the carotid artery and, more rarely, a part of the entrance to the Eustachian tube are exposed.

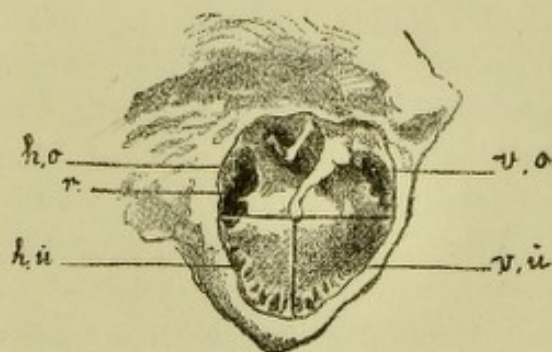


FIG. 157.—View of inner wall of tympanum divided into four parts, tympanic membrane (not manubrium) being removed. *v.o.*, Antero-superior quadrant; *v.u.*, antero-inferior quadrant; *h.o.*, postero-superior quadrant; *h.u.*, postero-inferior quadrant; *r.*, niche of the fenestra rotunda.

One or more of the Ossicula may be clearly seen through the perforation. When the *membrana flaccida* is destroyed, the neck of the *malleus* and sometimes a part of its head are brought into view. The *manubrium* is often entire even when the membrane is destroyed, and the lower end may be in contact with the inner wall of the tympanum, or even immovably fixed to it by adhesions. In many cases, however, it is shortened, owing to a carious destruction of the lower part (Coloured Plate III., Fig. 9), and sometimes nothing remains but the short process and a small part immediately below, both much thickened, or it may be entirely invisible. But the manubrium may be invisible or appear shortened, not because of its destruction, but because of displacement upwards. This is due to its having lost the support of the tympanic membrane, so that the tensor tympani muscle, being no longer antagonized, pulls the malleus so far upwards and inwards, that it comes to lie in the attic and so disappears from view. In destruction of the upper and back part of the membrane the *long process of the incus* and its articulation with the head of the *stapes* are not

unfrequently seen (Coloured Plate III., Fig. 14), although, even when the stapes is exposed, this process of the incus may be wanting. Rarely is the long process of the incus exposed to view, with no part of the stapes visible. The *knob-shaped head* of the stapes may alone be seen, or, in addition, one or other of the crura, particularly the posterior, may be visible (Coloured Plate III., Fig. 13), when the tendon of the stapedius muscle is sometimes observed extending from the head of the stapes towards the back wall of the tympanum.

Glandular Structures. Enlargement and tenderness of the cervical glands below the ear are often found associated with purulent disease of the middle ear, the pre-auricular and the post-auricular less frequently. Suppuration or tubercular infiltration, particularly in the cervical glands, is not unfrequently met with, especially in infants and young children.

The Third or Non-secreting Stage. If the perforation has closed, we often find injected vessels radiating from the centre to the circumference, with hyperæmia of the manubrium and membrana flaccida. Later on there is a dulness, flatness, and slight opacity or want of lustre of the membrane. In many cases, especially after an attack of short duration, there is no evidence of any deviation from the normal condition; in others a slight indentation is seen corresponding with the seat of the past perforation, or there may be a depression, representing an adhesion to the inner wall of the tympanum. In others a general opacity of the tympanic membrane is left behind.

Cicatrix—Opacity—Calcareous Deposit. In cases which have pursued a chronic course, a well-marked *cicatrix* in the tympanic membrane is frequently seen (Coloured Plate I., Fig. 10). A cicatrix is dark in colour; its edge is sharply defined, while it is much thinner than, and, on that account, is depressed below the level of, the rest of the membrane. When the tympanum is inflated, or when the air in the external meatus is rarefied, the cicatrix is seen to bulge out somewhat like a small bladder, which, however, collapses soon afterwards. If the cicatrix be large, we may see through it parts of the inner wall of the tympanum and of the ossicula; the promontory, the opening into the fenestra rotunda, or the articulation of the incus and stapes, may then be clearly seen, as if through a perforation (Coloured Plate III., Figs. 14 and 15). Inflation produces a bladder-like bulging of the cicatrix with the disappearance for a short time of these intra-tympanic parts. The cicatrix may in some cases form adhesions with the inner tympanic ossicles, and this may be ascertained by the use of the pneumatic speculum. Along with a cicatrix there is often

opacity, or a *calcareous deposit* (Coloured Plate III., Fig. 13), in the neighbouring parts of the membrane. The calcareous deposit is usually white or whitish yellow in colour, semilunar in shape, and, like a cicatrix, clearly demarcated from the neighbouring membrane. We may find several calcareous patches, and frequently one is seen in front of the handle of the malleus, and another behind.

Dry Perforation. One of the commonest conditions, especially after a long-continued discharge, is a *dry perforation*, generally large in size, sometimes involving almost the whole of the membrane. In these cases the edge of the perforation is usually thickened and callous, and has an epidermic covering. As seen through the perforation, the exposed tympanic wall, which frequently includes the promontory, is generally dry, greyish or yellowish, and shining (Coloured Plate III., Fig. 9). The remnant of the membrane is here also frequently the seat of calcareous deposit or opaque thickening; there may be a calcareous deposit on the inner tympanic wall. In a large number of persons such changes are found—the effects of an old discharge, dating it may be from childhood, the existence of which is often unknown to the individual.

COURSE AND CONSEQUENCES OF PURULENT INFLAMMATION OF THE MIDDLE EAR.

The Duration and Mode of Termination of the First Stage.

The duration of the disease before rupture of the tympanic membrane varies in different cases from a few hours to a fortnight. In most cases, however, the rupture takes place in from three to four days. This stage is likely to be shorter if a perforation or a cicatrix already exists. On the other hand, the rupture may be delayed owing to the membrane being thickened, or the seat of calcareous deposition. As in children the tympanic membrane is normally thicker than in adults, it may offer resistance for a longer time to the pressure of secretion pent up in the tympanic cavity. The rupture may take place by ulceration of the membrane, or the latter may be so thinned and weakened by the pressure of the fluid and the softening effect of the inflammation, that a slight additional pressure, such as may take place during sneezing, or while blowing the nose, is sufficient to burst it. A hissing sound in the ear and a discharge of fluid, often tinged with blood, usually signalize the rupture, while marked relief to the pain and the other subjective symptoms is, in most cases, immediately experienced. This relief, in children, is often very remarkable both in the completeness and suddenness with which the subjective symptoms disappear. Sometimes, however, little or

no effect in relieving the pain follows the rupture, or the relief may be temporary, owing to the intensity of the inflammatory process, obstruction to the escape of secretion, or the occurrence of mastoid complication.

The Duration and Consequences of the Second Stage. The period from the rupture of the membrane to the healing of the perforation may be no longer than a few days. In certain cases the perforation closes almost immediately after the escape of some serous fluid, leaving only a mark of blood at the site of the aperture. In many cases cicatrization takes place within two weeks; but the virulence of the original infection, the state of the naso-pharynx, the general health, the habits of life, and especially the character of the treatment, influence very materially the duration of this stage. Some cases terminate in a few months, a large number only after many years, while a certain proportion of cases *continue for a lifetime*. The discharge may be constant, but there are, in a considerable number, intermissions of days, weeks, or even months.

Aural Polypi and Granulation Tissue. These are very frequently found in the ear during the second stage: Mucous polypi, if small,

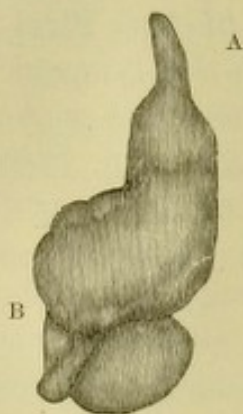


FIG. 158.—Large mucous polypus, which dilated the external auditory canal, and protruded from the orifice of the ear—A, pedicle; B, head.

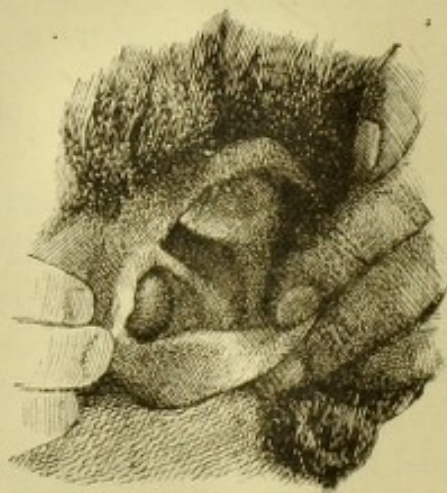


FIG. 159.—Polypus protruding from external meatus.

can scarcely be distinguished, either histologically or clinically, from granulation tissue.

Both polypi and granulation tissue appear as red, soft, globular, or, if large, club-shaped masses, which are apt to bleed, from even gentle touching (Coloured Plate III., Fig. 7). Their surfaces are frequently beset with small, red, granular projections, resembling the surface of a raspberry. When they are so large as to fill the tympanum and the external meatus, the surfaces, by pressing upon the surrounding

walls, usually become smooth. Their attachment is frequently pedunculated, but they are also found broad and sessile. In nearly all cases polypi and granulation tissue have their roots in some part of the mucous lining of the middle ear, and the growth is seen through a perforation in the tympanic membrane, or, if large enough, it extends into the meatus, even so far as to project at its orifice (Fig. 159). They spring most frequently from the postero-superior or inner wall of the tympanum, but they may also come from the inner surface of the membrane near the edge of a perforation and occasionally from some part of the ossicular chain. They have often their origin in the attic, aditus or antrum, from which they may protrude into the tympanic cavity and the external meatus. Cases occur in which a polypus seems to consist of the tissue of the membrane itself—polypoid degeneration of the membrane. The size of these growths presents great varieties, from that of a hempseed or pin-head, so small as to be scarcely distinguishable in the secretions of the tympanum, to a mass which fills the tympanum and external meatus, projecting, fungus-like, from the external opening of the ear (Fig. 159).

Structure of Polypi. Three forms of polypus are met with in the ear: (1) Mucous polypi, (2) Fibrous polypi, and (3) Gelatinous polypi or myxomata. The mucous variety is by far the most frequent, the

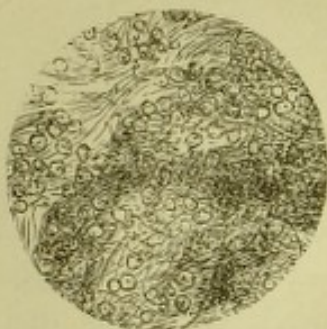


FIG. 160.—Section of aural polypus (mucous). Central portion (300 diam.). Mucous areolar tissue, containing granular cells and nuclei of cells.



FIG. 161.—Section of aural polypus (mucous). General view of portion near surface (40 diam.) showing—*a*, Mucous areolar basement tissue, with granular cells and nuclei; *b*, gland-like follicle, lined by epithelium, chiefly cylindrical; *c*, small blood-vessels.

gelatinous is extremely rare. *Mucous polypi* (Figs. 160 and 161) consist, microscopically, of numerous round cells, connective-tissue fibres, glands, cystic spaces, and blood-vessels. The surface has often a papillary structure or contains many gland-like depressions, and stratified epithelium covers it, while on the deeper part of the growth, near the root, the epithelium may be columnar and ciliated. When the polypus protrudes from the outer orifice of the ear, the part which projects externally is sometimes covered by a fine cutis. Several

such polypi may exist in one ear, while it is not uncommon to find them in both ears. Fibrous polypi are much less frequently met with. They are paler and smoother than the mucous variety, and contain no cysts and comparatively few vessels. The tissue consists of a pretty dense fibrous stroma with spindle cells, and they are covered with stratified epithelium. The true fibrous polypus seems generally to arise from the periosteum of the external canal or of the tympanum. The *myxomatous variety* is extremely rare, and consists of a gelatinous mucous tissue.

These low forms of tissue are often connected with caries or necrosis or cholesteatomatous masses, and then of course they tend to recur after removal. In tubercular disease of the temporal bone in infants the external meatus is often filled with granulation tissue which the probe shows to be connected with caries or necrosis. Cavities in the mastoid are often found to be filled with granulation tissue.

When a polypus is large enough to cause obstruction and pressure, there may be great pain excited in the ear, as well as severe tinnitus and giddiness.

If large, the red mass is seen in the external meatus or even protruding from the outer orifice (Fig. 159). If it is small, the purulent secretion requires to be removed and the parts dried, when we generally see the small red mass in the tympanic cavity. It is

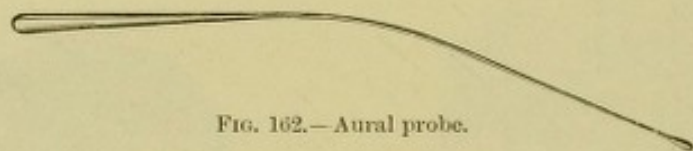


FIG. 162.—Aural probe.

generally necessary to use the probe (Fig. 162) in order to make quite sure of its existence; this must be done with great caution, the interior of the ear being illuminated, so that the eye may guide the hand. With the probe we are able to move the growth, and thus distinguish it from simple hypertrophied tissue or the swollen mucous membrane of the inner wall of the tympanum, while by moving the point of the probe cautiously round the growth we may determine its attachment, although this may not be ascertained until after the treatment has been carried on for a time. There is generally considerable destruction of the tympanic membrane; there may, however, be a large polypus or granulation mass and a very small perforation; this is especially met with in perforation of the membrana flaccida.

The discharge from the ear, where polypi or granulation tissue exists, is frequently slightly *tinged with blood*.

Such growths sometimes form very rapidly, and have been known to attain the size of a bean in a week or two. Their growth is, however, usually slower, and after they have reached a certain size

they frequently become stationary. A polypus with a thin pedicle occasionally *separates spontaneously*, and comes away during syringing. The occasional appearance of blood in a purulent discharge from the ear should excite suspicion of the presence of these growths.

Grave Consequences and Complications arising during the second stage. These are so important in their nature, and demand such full consideration, that they will be discussed separately and in detail in Chapters XIII. and XIV.

These consequences and complications will be described in the following order:—

I. Consequences limited to the ear and Fallopian canal.

A. Affections of the mastoid process.

(a) Acute mastoid periostitis.

(b) Acute purulent collections in the mastoid cells (acute mastoiditis).

(c) Caries, necrosis, and other changes in the osseous framework.

(d) Desquamative and cholesteatomatous collections.

B. Labyrinthine suppuration.

C. Facial paralysis.

II. Intra-cranial and vascular infective complications.

A. Cerebral and cerebellar abscesses.

B. Meningitis (purulent lepto-meningitis, serous meningitis, pachy-meningitis).

C. Septic thrombosis of the sigmoid sinus and other intra-cranial venous sinuses (pyæmia, septicæmia, emboli, metastatic abscesses).

D. Tuberculosis, hæmorrhage.

How the Purulent Process terminates. We may conveniently distinguish three groups of cases to illustrate the various modes in which the purulent process may terminate and the condition in which the organ of hearing is left. (1) Those in which the inflammation gradually subsides, with diminution and, ultimately, complete cessation of the secreting process, terminating in closure or cicatrization of the perforation and recovery of the function of the organ. This course is common in cases of short duration, and by no means rare in chronic cases. (2) Those which terminate, like the first group, in cessation of the purulent process and complete cicatrization of the perforation; but where permanent damage to the hearing is left behind from thickening and rigidity of the mucous membrane, from adhesions or bands in the cavity of the tympanum, or from thickening, calcification, or atrophy of the tympanic membrane, or from involvement of the labyrinth.

(3) Where there is recovery from the chronic purulent process, but *persistence of the perforation*, the so-called "dry perforation," with more or less injury to the hearing, mainly from the same causes as in the second group.

Healing by Cicatrization of a long existing perforation in the tympanic membrane is not at all unfrequent. While it is rare for almost total destruction of the membrane to end in the formation of a cicatrix which completely fills up the gap, such a result has been observed. Small or moderate-sized perforations, however, not unfrequently heal, even after they have existed for many years. There is usually left behind a permanent cicatrix, consisting of a thin layer of connective tissue having an epithelial covering both on its outer and inner side. It is sometimes found that after closure of the perforation the hearing is less acute than before. This possibility should not, however, deter us from using every means to bring about closure. If the hearing be worse after cicatrization, it may ultimately improve either spontaneously or as the result of treatment.

Dry Perforation. In a considerable proportion of cases, however, the perforation remains open, the so-called "dry perforation," after the purulent process has ceased. We are not able to explain satisfactorily why in one person a perforation may completely cicatrize, while in another a perforation of equal size, and apparently under similar circumstances, may never cicatrize. It is to be noted, however, that cicatrization may take place years after the cure of the discharge. When a permanent "dry perforation" remains, the patient is more exposed to attacks of acute purulent inflammation than when cicatrization has closed the opening. This liability is due to loss of the protective power of the membrane and exposure of the tympanic mucous lining to injurious influences from without, such as cold wind, water trickling into the ear, with the entrance of pyogenic organisms.

Permanent Structural Changes in the Tympanum left behind by the Purulent Process. Adhesive processes, or formations of bands of connective tissue, very frequently take place during some part of the course of a case of chronic purulent inflammation of the middle ear. From prolonged contact of soft, inflamed, granulating mucous surfaces, permanent adhesions may form, especially between the tympanic membrane and the inner wall of the tympanum, or between the tympanic membrane and the incus and stapes. Adhesions, bands, or cords may partition off the middle ear into two or more compartments, having no communication with each other. In this way we may have the upper tympanic space shut off from the lower or from the Eustachian tube, or the anterior part of the tympanum from the posterior. Membranous septa may in some instances completely shut off the antrum mastoideum, in others the Eustachian tube, from the cavity of the tympanum. In like manner the recess into the fenestra rotunda may be completely closed. Cords or bands may also bind the ossicular chain or individual bones of it, and so diminish or destroy their vibrating or conducting

power. The stapes is in this way frequently bound to the walls of the pelvis ovalis, or the handle of the malleus to the promontory. Cases are also met with, in which the fenestral recesses are filled with connective tissue, the stapes being thereby rendered absolutely immovable, and access to the membrane of the fenestra rotunda shut off. Loss of continuity in the ossicular chain, by the exfoliation of the incus or its separation from the stapes, is also a not uncommon result. In consequence of these changes, after the secreting process has come to an end, the hearing may remain much impaired, although *a permanent dry perforation is quite compatible with fairly good hearing* if there are no other changes. As has been already indicated, there is not such severe or frequent fluctuation of the hearing as in the secreting stage, while there is not such a tendency to progressive aggravation of the deafness, or to implication of the labyrinth as in the chronic non-perforative forms.

Permanent changes may also take place in the external meatus, such as stenosis from cutaneous thickening, adhesions, false membranes, or hyperostosis. In certain cases also the labyrinth may be left permanently damaged by the purulent process.

DIAGNOSIS OF PURULENT INFLAMMATION OF THE MIDDLE EAR.

Diagnosis in the Stage before Perforation. When, as is too frequently the case, no examination is made of the interior of the ear, purulent inflammation may be readily overlooked, especially *in the acute stage*, when the pain in the ear and the side of the head is looked upon as toothache or as neuralgia connected with diseased teeth. This mistake often leads to serious blunders in treatment. A large number of the so-called *caraches* are really cases of this disease.

In infants or very young children this disease in the acute stage is sometimes mistaken for meningitis, or congestion of the brain. If the physician trusts to subjective symptoms alone it is easy to see how such a mistake may be made. The pain which, even in an adult, may be described as being more in the side of the head than in the ear, the giddiness, the stupor or delirium, the convulsions, which occasionally occur, may readily, in the absence of objective examination of the ear, be regarded as pointing to intra-cranial inflammation. The impairment of hearing may readily pass unnoticed, and thus no suspicion of aural disease may be entertained. When the inflammation occurs during an exanthematous disease, especially during scarlet fever, it is particularly liable to escape detection, being masked by the graver general disease. It is to be remembered, on the other hand, that the inflammation may actually extend in the child to the membranes of the brain through the squamo-petrosal fissure. A careful objective examination will at once remove any doubt. Obscure illnesses in young children, with feverishness, irritability, and symptoms of cerebral disturbance, are sometimes explained by the ultimate appearance of a discharge from the ear.

When the *second* stage with discharge has been reached, the diagnosis depends very much upon the existence of a perforation in the tympanic membrane.

Diagnosis of a Perforation in the Tympanic Membrane. A perforation in the tympanic membrane is generally easy of recognition. In the first place, it may be said that, if a person has a muco-purulent discharge from the ear, there is *great probability* of a perforation. This is confirmed if, while syringing the ear, the patient says he *feels the injected liquid in his nose and throat*, or if we see the fluid escaping from the nostrils. We have already described the appearances and the usual situations of these perforations (see p. 253). After careful cleansing and drying, the tympanic membrane should be examined in all its parts, not omitting that above the short process of the malleus or the antero-inferior quadrant. If granulation tissue or a polypus is present, while there is almost certainly a perforation, we cannot be sure of its size or situation till these are removed.

A pulsating movement observed in the secretion or other fluid lying over the membrane generally denotes a perforation. The movement is due to pulsation in the small arterioles of the inflamed mucous membrane of the tympanic cavity causing a rhythmical rising and falling, or sometimes a lateral movement, of the secretion in contact with it. It is generally most marked when the perforation is small, and it is also most distinct in spots where there is a special reflection of light. Pulsating movements are occasionally seen, however, when the membrane is certainly intact.

In cases of almost complete destruction we usually see, after syringing and careful drying, a portion of the tympanic membrane at the upper part (*membrana flaccida*), with the handle of the malleus, in whole or in part, and a rim or fissure round the periphery. The red and swollen mucosa of the inner tympanic wall may be confounded with an inflamed tympanic membrane.

Inflation in the Diagnosis of a Perforation. Inflation by Politzer's or Valsalva's method is an important aid to diagnosis. If the perforation be small and the Eustachian tube clear, a *hissing* or *whistling* sound is usually heard, during inflation, through the auscultation tube, and it may even be so loud as to be heard by a bystander.

When there is almost complete loss of the membrane, but the Eustachian tube obstructed by swelling or secretion, we can usually make out a loud hissing or whistling sound during inflation. If, however, there is no obstruction, the sound is an exaggeration of the normal auscultation sound, being full and blowing, and giving the impression of being produced in the auscultator's ear.

By inspection during inflation, if there be secretion in the tympanic

cavity, we are usually able to see it mixed with bubbles of air projected from the orifice in the membrane. When there is only a small perforation, especially if of the nipple-shaped variety, and if the pus contained in the tympanic cavity is very thick, we may find on inspecting during the attempt to inflate by Valsalva's method that only a drop of thick pus appears at the perforation, with no passage of air; and when the effort to inflate has ceased the drop of pus recedes again into the tympanic cavity. If we find, after inflation, air bubbles in the inner end of the meatus, which were not there before inflation, we may assume the existence of a perforation; likewise if, after removing all secretion from the interior of the ear, we find more after inflating.

If the edge of the perforation is in contact with, or adhering to, the incus and stapes, or the inner wall of the tympanum, examination of the membrane during inflation of the middle ear (or during suction by the pneumatic speculum) will usually aid materially in the diagnosis of the case. When there is transparency, due to atrophy or a cicatrix, and the parts inside the tympanum are seen as if there was loss of the membrane, the actual condition is shown by the bulging outwards of the thinned membrane during inflation (Coloured Plate III., Fig. 15). If the perforation is a fissure, the separation and moving outwards of its edges during inflation will ensure its recognition.

It is to be remembered, however, that we sometimes cannot inflate the middle ear, in consequence of Eustachian obstruction from swelling of the tubal mucous membrane, adhesions, etc. Or there may be adhesions in the tympanic cavity, which prevent the current of air reaching the perforation. On the other hand, if the Eustachian tube be freely open, we may find persons with a perforation able, by Valsalva's method, to expel a current of air of strength sufficient to affect a light held opposite the ear. In these cases we sometimes meet with individuals who can force tobacco smoke from the throat out of the ear.

PROGNOSIS OF PURULENT INFLAMMATION OF THE MIDDLE EAR.

In viewing the prospects of a patient who suffers from this disease, we must take into account the possible consequences and complications, both to the structures within the ear and those outside of it, which may attend this affection. Such a consideration will impress us with the truth of Wilde's oft-quoted saying that, "*when a discharge from the ear exists, we can never tell how, when, or where it will end, or to what it may lead.*"

Amount of Structural Damage. In estimating the prognosis we must consider the amount of damage inflicted upon the structures of the ear. If there be almost complete destruction of the tympanic membrane, a permanent perforation may be anticipated. This exposes the tympanic cavity to injurious influences from without, and thus tends to encourage the recurrence of the purulent process. When there is a small perforation, on the other hand, especially if of the nipple-shaped variety, there may be considerable difficulty in curing the disease; but, when it is cured, there is much less tendency to recurrence. If granulations, polypi, or great thickening of the mucous membrane exist, the purulent process will continue until the removal of these conditions; the frequent recurrence, after removal, of granulation tissue and polypi, should raise the suspicion of caries or necrosis, or other deep-seated mischief. Adhesions or false membranes in the tympanum, or stricture of the Eustachian tube or external meatus, are unfavourable circumstances, owing to the hindrances which they present to the drainage of the purulent secretion, and to the application of healing agents. Caries is of specially serious import if it affect the *bony partitions between the middle ear and the interior of the cranium or the canals for the large blood-vessels*, by exposing the patient to the danger of extension of the disease to the meninges, sigmoid sinus, or brain, leading to a fatal issue. Necrosis is not usually so formidable a complication, for, by the removal of the sequestrum, the cure of the discharge is generally achieved.

The Source and Character of the Discharge are important considerations in the prognosis. If the *source* of the secretion be in the attic, antrum mastoideum, or mastoid cells, especially with only a small perforation in the membrana flaccida, the difficulty of curing the discharge and the danger of serious complications are much greater. On account of the anatomical formation of the parts, the complete removal of the secretion is extremely difficult, and stagnation, accumulation, and decomposition of the purulent products form a constant menace to the life of the patient from septic absorption or extension to the interior of the cranium. The tympanic cavity and antrum may be regarded in these cases as excellent incubators for the growth of pathogenic organisms. The *character* of the secretion may throw light upon the prognosis. If very profuse and not much influenced by regular antiseptic cleansing there is likely to be a reservoir in the mastoid process. If the discharge be thick, with a small perforation, the case is likely to be lingering. An offensive odour, which is strong and persistent in spite of frequent and thorough cleansing, raises the suspicion of diseased bone or cholesteatomata. When the discharge is composed chiefly of copious, stringy mucus (blennorrhœal), with a pretty large perforation, the case is often

obstinate. Bacteriological and cytological examination of the discharge may yield valuable prognostic indications (see p. 55).

The State of the Hearing Function may supply useful information. If the hearing be not very defective, and if it be improved considerably by cleansing and inflation, the obstacles to the conduction of sound are probably remediable. If there be great deafness not relieved by inflation, but with good bone conduction, there are probably adhesions and fixation of the ossicles; there is small prospect of improvement in hearing, although the secreting process may be put an end to. Marked tinnitus and vertigo, with weak bone conduction, probably point to involvement of the labyrinth.

The Cause of the Disease, its duration, and the results of treatment must be taken into account. When it originates in diphtheria, scarlet fever, influenza, or tubercular disease, or when associated with a strong hereditary tendency to ear disease, it is often specially obstinate. In most cases the longer the disease has existed the more difficult is its successful treatment. *The failure of long-continued judicious treatment* is a very unfavourable omen.

The Constitution of the Patient, as well as his avocation, habits, and position in life, influences our prognosis. The strumous, tubercular, and syphilitic constitutions must be regarded as highly unfavourable to rapid or complete recovery. In the strumous patient diseased bone and glandular enlargements or suppurations are more frequent complications; in the tubercular, rapid softening and destruction of the tympanic membrane and, especially in infants, extensive destruction of bone; while in syphilis, labyrinthine complication is not unfrequent. The course of the disease is also naturally less favourable in persons who are frequently exposed to inclement weather with insufficient protection, or in ill-fed and ill-tended children.

Relation to Longevity. A very important question may be asked. *What proportion of patients, who suffer from chronic purulent disease of the middle ear, have their lives cut short thereby?* This is a question regarding which our information is still meagre. With the increased interest in diseases of the ear taken both by the public and by the profession, and especially as the result of fuller and more correct knowledge of the serious consequences which are apt to attend them, we may ere long be in a position to give at least an approximate answer to this question. Von Tröltsch and others assert, as the result of their observation of large numbers of aural patients, that sufferers from otorrhœa have not the average duration of life, and that they frequently fall victims at a comparatively early age, either to the direct consequences of the disease, or to phthisis or other wasting disease. It is noteworthy, at all events, that, while this disease comes extremely frequently under our notice in children and persons before

middle life, we meet with it comparatively rarely after middle age, either in the actually secreting form or in the stage of "the dry perforation" with impaired function of the organ, a condition in which, considering the great frequency of the secreting stage of the disease in early life, we would expect to find very many aural patients who have passed middle life.

Relation to Life Insurance. This leads us to the consideration of the question whether a person who suffers from chronic discharge from the ear should be accepted by an insurance company. Von Tröltsch was of opinion that its significance in relation to life assurance is as serious as many cases of valvular heart disease, tubercular disease of the lung, or hernia. Without attributing to it any such importance as that of organic heart disease or phthisis, the writer thinks its existence in an applicant for insurance should be taken into account in calculating the probable duration of life, and that forms of proposals issued to intending insurers should contain the question, "Is there or has there been any long-continued discharge of matter from the ear?" The unfavourable points requiring consideration in deciding upon the degree of gravity of any particular case have just been referred to. The effects of treatment are probably of greatest importance in deciding the suitability for life assurance. If treatment has been attended by complete cicatrization of the perforation, the life may be accepted without reservation. If, however, a dry perforation has been left behind, although the purulent process has been cured, the risk of recurrence of the disease should be met by some addition to the annual premium. On the other hand, if rational and long-continued treatment has failed in putting an end to the purulent process, acceptance should be postponed or a considerable addition made to the premium.

Are sufferers from chronic discharge from the ear fit for military service? When we consider the tendency in this disease to acute inflammatory attacks which would incapacitate a soldier for duty, the fluctuating condition of the hearing, and the possibly serious consequences to life itself, the writer thinks it would be proper in the interests both of the individual and of military efficiency to exclude persons suffering from this disease from such a life of exposure as that of a soldier in the field.

CHAPTER XII.

TREATMENT OF PURULENT INFLAMMATION OF THE MIDDLE EAR.

TREATMENT OF THE FIRST OR ACUTE STAGE—BEFORE PERFORATION OR DISCHARGE.

IN deciding upon the kind of treatment to be adopted we must have regard to the severity of the attack, and especially to the intensity of the subjective symptoms.

Local Abstraction of Blood. In a severe attack, signalized by great pain and occurring in a healthy adult, local abstraction of blood is of great value in the early stage (see p. 83). In an adult four leeches should be applied—two over the tragus and two at the lower part of the mastoid process. If the symptoms be less acute, one leech in each of these situations will suffice. In a young child one leech applied over the tragus gives sufficient depletion. Pain and throbbing in the ear are usually decidedly mitigated by this treatment. The good effects are enhanced by the use of hot sponge fomentations after the bleeding has ceased.

Antiseptic and Anæsthetic Applications. In any case, whether we employ leeches or not, antiseptics and anæsthetics are of great service in preparing the meatus for rupture of the membrane and in relieving pain. It is to be remembered that the meatus usually contains cerumen, epidermis, and impurities from the air, and that, when rupture of the membrane takes place, fresh infection of the tympanum from the meatus is apt to take place. We should therefore purify the meatus, rendering it, as far as possible, a clean, aseptic cavity. The instillation of a strong solution of carbolic acid in glycerine (1 in 15) is very useful, not only as an antiseptic and softening agent, but as a valuable means of relieving pain, and bringing about transudation of serum from the congested vessels. A few drops of this phenol-glycerine are well warmed and allowed to trickle down the meatus, repeated every three or four hours if pain continues, or it may

be introduced at the end of a long cylinder of cotton wool. Gentle syringing some time afterwards with hot sterilized water, containing boracic acid in solution, will remove any of the softened material remaining. The walls of the meatus should then be carefully and gently dried with sterilized cotton wool and a wick of sterilized gauze or a strip of iodoform or cyanide gauze introduced. The meatal walls might be more thoroughly sterilized by friction with cotton wool soaked in a 5 per cent. solution of carbolic acid.

Warm Applications are also of great service in relieving pain. A sponge or piece of folded lint, pressed out of hot water, placed closely over the ear, and covered with impermeable material, has often a very soothing effect. Simple *warm sterilized water* (100° F.) poured into the ear from a teaspoon, renewed every few minutes, usually gives relief; or a continuous stream from a jug through a tube of india-rubber introduced into the ear, on the syphon principle, may be more efficacious. *Warm poultices* of linseed meal applied over the ear and side of the head often afford relief and comfort. It is found, however, by experience that their continued use tends to produce softening of the tympanic membrane and the meatal lining, encouraging also sepsis and the growth of flabby granulations. Holding the ear over hot water so as to allow of the entrance of the vapour is a simple and useful remedy. Resting the ear upon an india-rubber bottle containing hot water is said by patients to be very soothing and comforting.

Medicated Applications are often useful. In an adult, 10 drops of a solution of morphia (2 grs. to an oz.), warmed and instilled into the ear every three or four hours, may have a more sedative effect than the warm water. At other times a few drops of warmed tincture of opium, placed on a pellet of cotton wool and laid in the outer orifice of the ear, forms a convenient and efficient sedative application. A cylinder of cotton wool smeared with an ointment of menthol, iodoform and vaseline or lanoline (Formula 87), and introduced into the meatus seems to relieve pain, while it has also an antiseptic effect.

Soothing embrocations, such as menthol, chloroform, and olive oil (Formula 95), applied to the neighbourhood of the ear, will assist in allaying the pain, which often extends along the temple and side of the head. Politzer recommends the application of equal parts of chloroform and olive oil—20 or 30 drops are sprinkled over a piece of cotton wool the size of the palm of the hand, and this is laid over the ear.

Vesicants are frequently used behind the ear by practitioners. Their utility is doubtful, and they have the disadvantage of masking the onset of mastoid mischief.

Internal Sedatives and Antipyretics. These are required when there is great pain and feverishness. For an adult a full dose of

nepenthe, or of a solution of morphia, or a subcutaneous injection of the same, may be indicated; for a child a dose of Dover's powder may be preferred. Antipyrin or phenacetin is often very valuable, relieving the pain and bringing down the temperature. When there is marked febrile disturbance a warm bath and medicinal diaphoretics, such as Dover's powder or the solution of acetate of ammonium, with the addition of a saline laxative, are indicated. Bromide of potassium or sodium may be prescribed when there is much nervous irritation.

Precautionary Measures. Light diet and abstinence from alcohol and tobacco are wise precautions, while rest and quiet in the house conduce very much to a favourable issue, especially during winter or cold weather. *Recurrence of the disease, as well as serious complications, are often due to exposure and fatigue.* For a time after the attack has passed off the interior of the ear should be protected from cold air, dust, loud sounds, etc., by means of a light plug of aseptic cotton wool in the meatus.

In an infant perfect quietness, absence of strong light, rest in a comfortable position, and the avoidance of pressure on the affected side, are precautions which should not be neglected. If cerebral symptoms arise, appropriate remedies should be employed, such as bromide of potassium, aperients, the application of cold to the head, etc. We must be careful to prevent the trickling of cold water into the ear from cold applications to the head.

Incision of the Tympanic Membrane. When the pain remains unrelieved by the foregoing treatment, while a yellowish bulging of the membrane, or a saccular elevation, serous or hæmorrhagic, is observed upon it, the membrane should be incised. (See "Incision of the Tympanic Membrane," p. 109). In suitable cases, the incision of the membrane decidedly alleviates the pain, limits the evil effects of pressure upon the ossicular chain and the walls of the middle ear, and perhaps obviates such a loss of the substance of the membrane as would take place if we waited for spontaneous rupture. It is of special value in those cases where the membrane is thickened and more unyielding in consequence of previous disease, and where, therefore, the process of spontaneous rupture is rendered more difficult. In such cases, timely incision of the membrane may prevent, we may reasonably suppose, the extension of the disease to the mastoid antrum, and cells, and even to the labyrinth and meninges. We must not, however, at once incise the membrane when it is simply acutely inflamed, in the *absence of localized yellowish bulging*, unless the pain is persistent and will not yield to the other remedies, because we may be dealing with a case of non-purulent otitis media, when perfect recovery may take place without rupture, while incision may be

followed by an obstinate purulent discharge, which might have been avoided if the membrane had been left alone. Of course, pain over the mastoid, continuous feverishness or convulsions in children, would call for immediate incision. Only a practitioner well experienced in the treatment of ear disease should undertake the operation of incising the tympanic membrane.

TREATMENT OF THE SECOND STAGE—THE STAGE DURING
WHICH THERE IS A DISCHARGE FROM THE EAR.

Treatment immediately after Rupture of the Membrane. At this stage it is very important, after the incision of the membrane, to provide against infection from without, and therefore dry antiseptic treatment is desirable at first. After inflation by Politzer's or Valsalva's method, the secretion is mopped up by means of sterilized cotton wool, and the meatus occupied, as far as the drum-head, with a narrow strip of iodoform or sterilized gauze, then a pad of gauze is laid over the ear, secured with a bandage; the dressings should be changed once a day by the surgeon himself. This treatment is also the proper one, when spontaneous rupture has occurred, if the secretion is small in quantity and free from odour. When, however, the discharge of serum or purulent fluid is considerable, syringing is necessary. The following plan is suitable in most cases:—The ear is syringed *gently* with 2 ounces of boiled water or a warm 2 or 3 per cent. solution of boracic acid (see "Syringing the Ear," p. 79), then inflated by

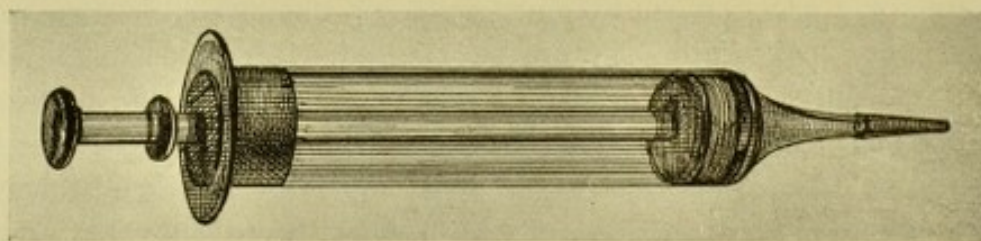


FIG. 163.—Glass ear syringe for use of patients

Politzer's or Valsalva's method; this will probably force secretion through the perforation into the external meatus (see "Inflation of the Middle Ear," p. 76). The canal of the ear should again be syringed, and then dried, first at the outer orifice of the meatus, and then as far as the tympanic membrane, with absorbent cotton wool. Inflation not only assists in removing the secretion from the middle ear, but it also tends to improve the hearing and counteract the formation of adhesions. Either a glass syringe (Fig. 163), with a proper flange for the fingers, or a ball syringe with, in the case of infants, a soft rubber ear-piece (Fig. 164), should be employed.

In regard to the syringing, it is very important to instruct patients properly, or those undertaking the treatment at home, in the use of the syringe. Careful instruction must also be given as to the proper method of drying the ear. Either a cotton holder or a thin metallic crochet needle, or a thin wooden match, may be used for fixing the cotton, a firm cylinder of which should project from the instrument for about half an inch so as to avoid all danger of doing injury. Patients should also be enjoined to keep all the appliances, the syringe, insufflator, liquid, powder, cotton wool or gauze, in a dust-tight place. The hands of the person carrying out the treatment should be thoroughly washed with hot water and soap each time before employing the treatment. The glass or ball syringe should also, at the beginning of the treatment, be sterilized by boiling, and before and after each application it should be well washed with very hot water.

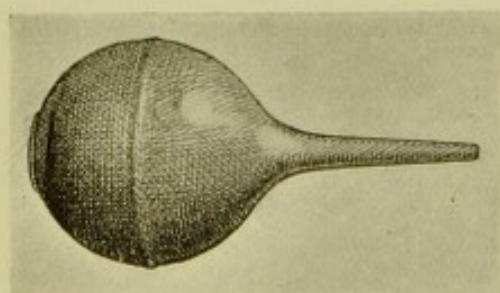


FIG. 164.—Ball ear syringe made of soft rubber.

If the patient is unable to force air through the perforation by Valsalva's method, he may have to be taught Politzer's. The frequency of the syringing will depend on the amount of discharge. If very copious, it may be done every three or four hours, and a cylinder of sterilized cotton wool or a strip of iodoform gauze should occupy the canal of the ear in the intervals to absorb the moisture; but, if the discharge be less copious, twice, or even once daily may suffice. After the syringing and drying it is often a good thing to insufflate a very small quantity of finely powdered boracic acid, just sufficient to cause a fine dust on the walls of the meatus, but not so much as to block the perforation. It may be noted that *severe pain in the ear with throbbing may continue after the perforation*. In such cases, the treatment already described may be required. Syringing with the hot antiseptic solution will also tend to relieve the pain. In favourable cases, the treatment just described will suffice to bring the discharge to an end, and heal the perforation in two or three weeks. Frequently, however, the discharge has existed for so long a time before efficient treatment has been brought to bear upon it that the conditions which have developed are much more difficult to deal with.

Treatment of the Chronic Stage of the Discharge. When the discharge has gone on for several months we may regard the condition as *chronic*. The treatment of this stage demands very careful and full consideration. The chief difficulty is due to the peculiarly complicated anatomical structure of the spaces forming the middle ear interfering with drainage and rendering the thorough removal of the secretion a difficult task.

Cleansing and Disinfection of the Ear. In order to obtain success it is essential to cleanse and disinfect the interior of the ear as

far as possible. This may be done through the external meatus and through the Eustachian tube. By the external meatus we may employ ordinary syringing (see p. 79), intra-tympanic syringing (see p. 81), or simple drying.

Ordinary syringing is always necessary when the discharge is profuse (Fig. 165). It should be done once, twice or three times a

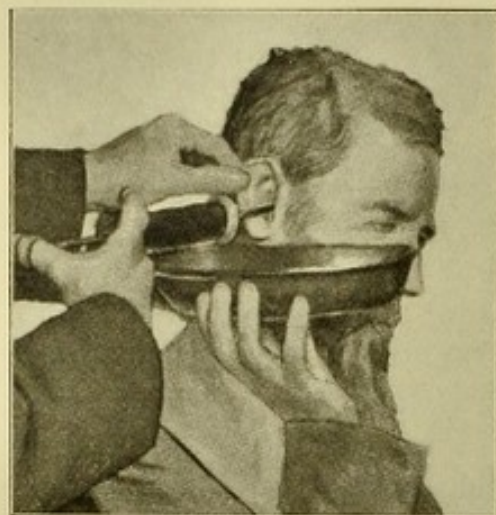


FIG. 165.—Mode of syringing the ear.

day, according to the amount of the discharge. *Dry cleansing* by means of absorbent cotton wool on a cotton holder (Fig. 3), or small pieces of antiseptic gauze with forceps, is to be preferred to syringing, if the latter constantly produces disagreeable symptoms, such as pain or giddiness, or, *if the secretion be small in quantity*, and not offensive to smell. In any case, after fluid injections, the moisture in the ear must be *thoroughly mopped up* with the cotton wool or strips of gauze. There

is no good ground for the assertion that syringing done properly as directed leads to further infection of the middle ear spaces.

Solutions for Syringing the Ear. A selection may be made from the following:—(1) Boiled water or sterilized normal saline solution; (2) a solution of boracic acid in water (2 to 3 per cent.); (3) a solution of resorcin in water (2 to 3 per cent.); (4) a solution of carbolic acid in water (2 per cent.); (5) a solution of permanganate of potassium in water (Formula 52); (6) a 1 per cent. solution of lysol in water; (7) a teaspoonful of a 10 per cent. alcoholic solution of salicylic acid to a wine-glassful of water; (8) 15 to 20 drops of formaline to a litre of boiled water (Politzer).

For cleansing through the Eustachian tube the first and second solutions are most appropriate (for Syringing through the Eustachian tube, see p. 82).

These solutions must all be used *warm*, say at a temperature of 98° Fahr.; and the syringe should first be heated by filling and emptying it with water of the same temperature, otherwise the temperature may be too low. The fluid used in syringing may pass through the Eustachian tube and be felt by the patient in the nose or throat. The syringing must not be done too strongly, especially when there is a large perforation. The efficiency of these cleansing measures is aided by inflation of the middle ear, especially by Politzer's method, which is very useful in forcing secretion from the middle ear into the external meatus, more particularly when the perforation is

small. In a certain proportion of cases, especially in the earlier stages, simple cleansing and disinfection, carried out in a thorough and effective manner as described, are sufficient to remove the disease and close the perforation. In most cases, however, it is necessary, in addition, to act upon the diseased mucosa of the middle ear with various kinds of *medicinal agents*. The first in value is undoubtedly the group of antiseptics.

Treatment by Fine Powder. In boracic acid, introduced by Bezold of Munich, employed as a fine powder, we have a valuable remedial agent. Its value is dependent partly upon its antiseptic qualities, and partly upon its being a fine, usually non-irritating, powder.

The powder should be extremely fine, and should be blown into the ear by means of a ball insufflator (Fig. 166). A portion of a quill or a

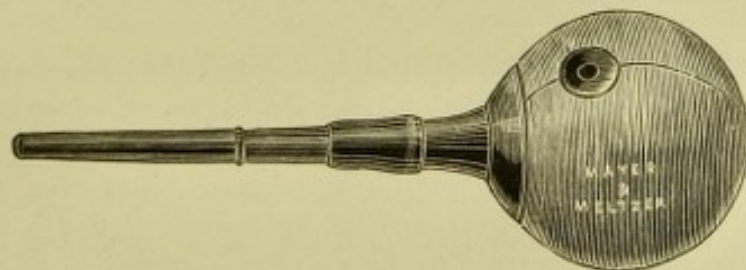


FIG. 166.—Ball insufflator for ear.

glass tube forms a cheap and convenient instrument for poor patients. A small quantity of the powder is placed in the tube, and blown into the external meatus; a piece of india-rubber tubing attached to one end of the quill will enable the patient to blow the powder into his own ear. If the meatus be wide the powder may simply be put in with a small scoop. In order to increase the antiseptic effect of the powder, Politzer adds, in cases having a peculiarly strong fetid discharge, 1 grain of carbolic acid to 15 grains of boracic acid, while in the blennorrhœal forms he adds 3 to 4 drops of oil of turpentine to 15 grains of the boracic acid. The writer has found the addition of calendula (Formula 74) to be an advantage. Other fine powders are sometimes used with advantage, such as aristol (combined with three times as much boracic acid), zeroform and formidine. These powders, being insoluble, require to be employed by the surgeon himself, and are only suitable in pretty extensive destruction of the membrane. In using boracic acid or any other fine powder the ear is first syringed with one or other of the solutions already mentioned, and the moisture carefully mopped up with sterilized cotton wool or small portions of gauze. The middle ear is next inflated by Politzer's or Valsalva's method; and, if more secretion is thereby forced out of the perforation, the mopping process should be repeated. The fine powder is then insufflated so as to fill the inner half of the meatus, while the outer

part is to be occupied by a plug of absorbent cotton wool, or a narrow strip of iodoform or cyanide gauze is introduced with a probe or forceps. It is to be carefully noted, however, that if the perforation be very small, as is frequently the case in the acute or early stage, only a *very small quantity* of the powder should be insufflated, just sufficient to form a fine dust upon the membrane and osseous walls of the meatus. If entirely dry treatment is decided upon, for reasons already mentioned, the syringing is avoided, the moisture being simply mopped up as described, and the powder insufflated.

When the treatment is entrusted to the patient at home, *thorough instructions should be given previously by the surgeon*, who should make sure that the patient is able to blow the powder into the inner end of the canal. If too wide a tube be employed, in the case of a child, or of a person with a narrow external meatus, the powder is very likely to reach no further than the outer part of the meatus.

In cases of profuse discharge the application may have to be made twice a day, in others once a day. When this mode of treatment answers well, the powder will soon be found to remain dry for two or three days, and by and by for weeks. When it is finally syringed out, the interior of the ear must be dried and no powder introduced. In a few cases, three or four applications of this treatment are sufficient to put an end permanently to the secreting process; in many cases, however, the continuance of the treatment for a considerable time is needed before permanent cessation of the secreting process is achieved. It is important to remember that sometimes boracic acid *excites a copious watery discharge* after being insufflated. In such cases we should discontinue its use, and try some other form of treatment.

Treatment by Rectified Spirit. This is a very valuable method of treatment. It is most useful in cases associated with granulation tissue or polypi, and probably acts partly by virtue of its power of absorbing water and removing serous infiltration. After its application the mucous membrane is seen to be paler.

The ear is first cleansed, dried, and inflated as already described. If the perforation be large, 15 drops of the warmed solution are poured into the ear, while the head is inclined to the opposite side and the auricle drawn well back, the drops being allowed to remain in the ear for ten minutes. The solution is then allowed to flow out, the inside of the ear is dried, and a plug of antiseptic cotton wool or gauze introduced into the meatus. This is repeated twice daily, or oftener if the discharge be very copious.

If the aperture in the membrane be small, the fluid lying in the external meatus will penetrate into the middle ear more effectually if the tragus is pressed firmly inwards; if the head is at the same time tilted back, the fluid tends to enter the back part of the middle ear. For the same purpose inflation of the middle ear, either by Politzer's or

by Valsalva's method, is very useful; air is thereby forced through the perforation and through the fluid in the canal, giving rise to visible bubbles followed by a subsidence of the fluid in the canal, which sinks through the perforation into the middle ear. Swallowing with the nostrils closed also tends to suck the fluid into the middle ear. When by one or other of these methods the fluid passes into the middle ear, the patient may, if the Eustachian tube be permeable, feel it in his nose or throat. It is well at first to dilute the spirit with an equal quantity of water or, in some cases, with twice its bulk of water, till we ascertain how it is tolerated; the weaker form has a more powerful antiseptic effect. While the first contact of the spirit often produces a momentary "nip," it is usually tolerated very well. The effect of the spirit may be enhanced in some cases by the addition of 3 per cent. of boracic acid or resorcin, and, if the discharge be persistently offensive, the addition of 2 per cent. of carbolic acid is beneficial; iodol in spirit (1 in 20) is also a good remedy. This mode of treatment may be continued for months, and can be carried out very conveniently by the patient at home.

Peroxide of Hydrogen (10 vols. strength) is a very valuable remedy in these cases. In contact with the decomposing secretions of the ear, oxygen is disengaged and escapes in minute bubbles as foam welling out of the ear. Twenty drops may be instilled into the ear either after syringing and drying (when its effects may be enhanced by adding a fourth part of rectified spirit and 2 per cent. of boracic acid), allowing them to remain in the ear for five minutes, or till bubbles subside; or the drops may be instilled first, and after five minutes the ear syringed with a solution of boracic acid, and dried—either method is usually repeated twice daily. Peroxide of hydrogen is not only useful in uncomplicated cases, but is especially useful in cases associated with desquamative collections or granulation tissue; it has also an excellent effect in softening dried purulent or desquamative masses. This remedy is not so suitable where the perforation is very small.

Iodoform in powder or solution is especially useful in the tubercular form of purulent disease of the ear. It is applied in the same way as boracic acid (see p. 275), and it should be diluted with boracic acid—1 of the former to 3 of the latter. The disagreeable odour is much removed by adding a few drops of oil of geranium. Iodoform, being a less soluble substance than boracic acid, is apt to collect in the ear, if it is not carefully removed by syringing, hence the surgeon should see the patient pretty frequently while the treatment is going on, so as to make sure that the iodoform is not being deposited as a solid substance. Its use is only allowable when there is considerable destruction of the tympanic membrane. Folded narrow strips of iodoform gauze, introduced with a probe so as to occupy the meatus

and exercise some degree of pressure on thickened tissue or the root of a polypus, may be very useful. Some persons cannot tolerate iodoform in any quantity owing to its *producing a violent eczematous inflammation* of the external meatus and the neighbourhood of the ear. The writer sometimes employs it mixed with rectified spirit; only a portion of the iodoform is dissolved by the spirit, the rest remaining in suspension, and thus the thorough shaking of the mixture is necessary before its use.

Nitrate of Silver in a strong solution may be very useful, particularly when there is extensive destruction of the tympanic membrane, with much swelling of the mucosa of the inner tympanic wall. The solution should be 40 grs. to the oz. of water, and it is best applied by means of cotton wool on a cotton-holder, with the aid of a mirror and speculum. Pain is rarely excited—only a slight warmth is produced in the ear. The more thoroughly the mucous membrane intended to be treated is freed from all moisture, the better will be the therapeutic effect of the nitrate of silver. The mucous membrane is whitened by the solution; and a fresh application should not be made until this white layer has been thrown off, which will probably occur in three or four days. The writer has found in some cases other remedies more efficacious after a few applications of the caustic solution.

Treatment by Astringents. Until the introduction of antiseptic remedies, astringents were more frequently employed than now in the treatment of purulent middle ear disease. There are cases, however, although comparatively few, in which astringents do good after the other remedies have failed. They should not be employed during an acute exacerbation of the inflammation, when they tend to irritate, increasing the pain and inflammation. One of the best and most useful astringents is sulphate of zinc; the addition of carbolic acid probably adds to its usefulness (Formula 57). Sulphate of zinc is specially useful when the secretion consists of stringy mucus, and the perforation is behind the umbo. A solution of alum has the disadvantage of frequently exciting boils in the meatus. Solutions of acetate of lead and perchloride of iron are sometimes employed; but their tendency to form depositions on inflamed or abraded surfaces makes them objectionable. Politzer recommends Burow's solution (containing alum and acetate of lead) as an efficient application.

External Applications, such as vesicants or stimulants, are frequently used behind the ear by practitioners. These applications are sometimes injurious, and, in the absence of proper treatment to the interior of the ear, quite useless. The practice of using them without any attention to the seat of the suppuration, without even any attempt to clean away the decomposing pus which fills the ear, is utterly bad. Only in syphilitic or tuberculous persons

are applications of iodine preparations behind the ear likely to do any good, and always merely as *auxiliary* to the careful treatment of the *interior of the ear*.

The Relative Value of these Remedies. Of these various local applications for purulent disease of the middle ear, we cannot, in a given case, predict with certainty which will prove most successful. The size of the perforation, the presence or absence of granulations, and the actual source of the secretion, have all to be taken into account in the selection of the remedy. One remedy after another has sometimes to be tried, until we come upon the best one, and what is found to be an ineffective remedy at one stage of the disease may be very successful at another stage of the same case. As a rule, if no improvement shows itself in a fortnight, a change should be made. Boracic acid, alcohol, peroxide of hydrogen, and fluid astringents may be continued for a length of time, after the patient thoroughly understands how to apply them. When we entrust the carrying out of the treatment to the patient or his friends, it is desirable to see the case at least every two weeks in order to judge whether a change or modification of treatment may be required. The proper manner of using these remedies is of great importance. The surgeon should not only give precise directions to the patient or friends, but he should also once or twice cause the treatment to be carried out in its details in his own presence. Unsatisfactory results are very frequently due to the inefficient way in which the treatment is employed. In view of the possible consequences of the disease, the patient should be urged to continue the treatment, even for several months if necessary, so as, if possible, to put an end to the purulent process. In a *large majority* of cases this will be achieved by perseverance and by a proper selection and variation of remedies. It is desirable that, some time after apparent recovery, the surgeon should examine the ear to make sure that the recovery is real, as patients are very ready to think that the disease is cured if no discharge appears externally; we know, however, that even then the purulent process may still exist. Crusts or desquamative collections often form after the discharge has ceased, and these should be treated by peroxide of hydrogen and removed. The removal of these may materially improve the hearing.

TREATMENT OF CASES PRESENTING SPECIAL DIFFICULTIES OR COMPLICATIONS.

Small Perforation and Thick Secretion. The extreme smallness of the aperture in the membrane often hinders proper tympanic drainage and prevents the complete expulsion of secretion, or the admission of the cleansing fluid. In such a case free enlargement of the perforation with a blunt-pointed paracentesis knife is likely to exercise a very good effect upon the course of the disease. A cross incision may be desirable, followed by aspiration with Siegle's pneumatic speculum. This should be followed by one or other of the already mentioned methods of treatment. If the membrane should present a bulging, as if from accumulated secretion, at a place separate from the existing perforation, a second aperture made into the

bulging part is likely to have a beneficial influence (see "Incision of Tympanic Membrane," p. 109).

Nipple-shaped Perforation. When the perforation is on the summit of a nipple-shaped projection, the case often proves peculiarly obstinate to ordinary treatment. For this condition the injection of warm sterilized normal saline solution or of a solution of boracic acid into the middle ear through the Eustachian catheter, repeated daily for a week, is recommended. Enlargement of the perforation is also indicated. By the addition of these to the ordinary methods of treatment, the secreting process will eventually be brought to an end.

Polypi or Granulation Tissue often lead to a prolongation of the disease. Polypi are most efficiently removed by the use of *Wilde's snare* (Fig. 70), as described in the chapter on operative Treatment of the Ear at p. 107. In the removal of small soft polypi or granulation tissue such forceps as those represented in Fig. 72 are very useful. *Toynbee's lever ring forceps* (Fig. 73) are also convenient for the removal of small polypi, especially when the canal of the ear is very narrow. Politzer employs a small ring knife (Fig. 74, c) for removing small polypi or granulation tissue from the walls of the

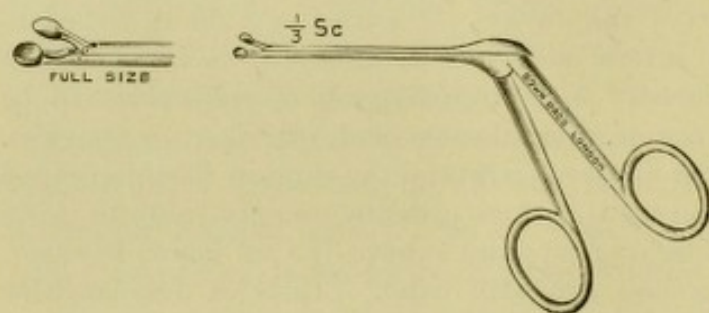


FIG. 167.—Hartmann's scoop forceps.

external meatus. For the firm granulation tissue often found in obstinate cases on the inner tympanic wall, or for that protruding out of a perforation in the membrana flaccida, the use of a sharp spoon for curetting or Hartmann's forceps

(Fig. 167) is required. In young children or very nervous persons it is well to give a general anaesthetic, and thoroughly remove the whole of the morbid tissue, afterwards packing the meatus lightly with narrow strips of iodoform gauze. In adults a 10 per cent. solution of cocaine with adrenalin may be used as an anaesthetic, or preferably Formula 65.

It may be necessary to cauterize the root of the polypus or the granulation tissue. *The chemical caustics* most frequently used are chromic acid, trichloroacetic acid, solid nitrate of silver, and perchloride of iron. They are specially useful in the dense fibrous granulation tissue found on the inner tympanic wall. Chromic acid is probably the most efficient. The point of the probe is first held in a spirit flame till it is almost red-hot, and then gently pressed upon a crystal of chromic acid when a portion of the latter is fused, and, on cooling, the caustic forms a bead adhering to the point of the probe. Or it may be applied as a very concentrated solution on the point of a

silver or platinum probe. We must be most careful to dry the parts thoroughly and avoid touching the neighbouring tissue; if much pain be excited a syringe of a warm solution of boracic acid will relieve it. The acid may require to be applied several times at intervals of a few days. Solid nitrate of silver is applied fused in the same way. Its effect is more superficial. Politzer speaks highly of the efficiency of perchloride of iron for destroying the roots of polypi or granulation tissue. He applies the crystal or a strong solution on the point of a probe or cylinder of cotton wool. A small dark crust is formed, the removal of which should be followed by a fresh application of the substance; this is repeated until complete destruction of the morbid tissue is effected.

In certain cases where the growth is more dense and fibrous in character no caustic is so effective and advantageous as the galvanic cautery applied in the manner described at p. 89. This, as well as strong chemical caustics, especially chromic acid, should only be employed by those well experienced in the treatment of ear disease.

In many cases, however, after the removal of the morbid tissue so far as is possible by means of instruments, the continued use of the spirit treatment, as described at p. 276, will suffice, without the application of caustic substances, to bring about a satisfactory result. To secure a complete and permanent cure it is essential that remedies be diligently employed for the *removal of the purulent disease* on which the growths depend, especially the treatment by rectified spirit as already described. Until the ear is perfectly dry we are not safe from recurrence.

Treatment of Attic Disease (epitympanic). When the source of the discharge is mainly in the attic, with perforation of the membrana flaccida, the course of the disease is usually remarkably obstinate. In this condition desquamative masses are often found occupying the inner end of the meatus, adhering tenaciously to its walls and covering or projecting from the perforation. The removal of these is essential. The instillation of peroxide of hydrogen (see p. 277) several times, followed by antiseptic syringing, perhaps with the help of forceps and a probe, or a small curette or sharp spoon, will effect their removal, so far as the visible parts are concerned; frequent saturation during two days with a solution of bicarbonate of sodium, carbolic acid, and glycerine (Formula 64) is also a good way of preparing for their removal. If the perforation is of such a size as to admit of it, the attic syringe (see p. 81) may now be used for the regular daily washing out of the attic with an ounce or more of an antiseptic solution. It may be necessary, however, to enlarge the perforation by scraping the softened edge of the bone with a strong sharp spoon, removing as far as possible any granulation tissue or cholesteatomata contained in it. The syringe may day after day bring away little

masses resembling wet paper or small gritty lumps along with purulent secretion. The following solutions may be used with the attic syringe: a 2 per cent. solution (in equal parts of rectified spirit and water) of carbolic acid, boracic acid, or resorcin; or a solution of peroxide of hydrogen (10 vols. strength). Such injections may be repeated once daily for two weeks. The insufflation, through a fine tube introduced into the attic, after syringing and drying, of powdered boracic acid or of iodoform and boracic acid (1 in 4) has also been used by the writer with advantage. In some cases the attic may be lightly packed with a fine strip of iodoform gauze or a ball of sterilized cotton wool; a thread is attached to secure its removal, after twenty-four or even forty-eight hours, during which it may advantageously remain in the attic. The writer has met with considerable success in the use of the attic syringe, and, although there is no doubt in many cases a tendency to recurrence of the discharge at intervals, requiring a fresh course of syringing, the patient may prefer an occasional course of this treatment to operation, especially if the hearing is fairly good on the affected side while defective on the other. The possibility of injuring the hearing by operation seriously impresses a patient, who may have no more hearing than is barely sufficient to enable him to retain his means of living. If the discharge from the attic persists in spite of the foregoing treatment, the question of removing the malleus and incus (see p. 111) must be considered. The outer wall of the attic, or its lower edge, should also at the same time be removed, if the width of the meatus admits of this being done per meatum. The removal of the outer wall of the attic may be effected with a strong sharp spoon or a suitable chisel and hammer in the hands of an experienced operator; the attic should be carefully packed with gauze during chiselling. The writer usually follows the operation of removal of the malleus and incus by a course of attic syringing.

If these methods of treatment do not bring the purulent process to an end, or if it recurs from time to time, especially if the patient complain of headaches or vertigo, *the radical mastoid operation* is indicated (see p. 126). It has to be admitted that the removal of the malleus and incus has frequently to be followed eventually by the radical operation or some modification of it.

Stenosis of the External Meatus may offer considerable difficulty in the treatment of purulent disease. Staphylococcic infection of the meatus giving rise to furunculi causing more or less stenosis of the meatus, is a common complication of the purulent cases. The special treatment for this will be found described at p. 197. The special modifications of treatment required in other forms of *stenosis of the external meatus* have been already described at p. 204.

Stenosis of Eustachian Tube. When this is present, and the benefits of inflation cannot be obtained, suction by means of Siegle's pneumatic speculum, fitted air-tight into the external meatus, is useful in drawing out the secretion from the middle ear, especially when the perforation is small, as well as in separating adhesions or preventing their formation. The pus, which exudes from the perforation during suction, is to be wiped away, and suction again applied until secretion no longer appears, when a suitable application is to be made. In such cases it is specially necessary that the perforation should be as large as possible to ensure good drainage.

Caries or Necrosis. For the treatment of this complication, see p. 299.

Desquamative or Cholesteatomatous Masses. See p. 301.

Acute Mastoid Periostitis. See p. 288.

Acute Purulent Inflammation in the Mastoid Cells. See p. 291.

Intra-cranial Complications. See Chapter XV.

TREATMENT OF THE THIRD STAGE—AFTER THE DISCHARGE HAS COME TO AN END.

The cure of the purulent process is generally attended by improvement, sometimes very considerable, in the hearing power. When the hearing still remains defective, after the secreting process has ceased, there are certain modes of treatment, designed to improve the hearing, which should be tried. (1) When the perforation has closed, and there are no indications of labyrinthine mischief, the treatment is on the same lines as that of non-exudative catarrh of the middle ear, to which the student is referred in Chapter XVIII. (2) When there is a persistent or permanent perforation we may employ (*a*) certain operative measures or (*b*) the so-called artificial tympanic membrane or "drum."

Operative Treatment for improving the Hearing. When the defect of hearing is very great, and when no improvement is effected by other methods, incision of the adherent or thickened tissue may be followed by benefit. A certain degree of mobility, as tested by suction, must exist before such measures are employed, and no attempt of this kind should be made, unless the state of the osseous conduction of sound shows that the nervous apparatus for hearing is good. Attempts are sometimes made to secure cicatricial closure of old dry perforations by cauterizing the edges with trichloroacetic acid or other caustic substance. Such attempts may excite a return of the purulent disease, and lead to further injury to the organ, while efforts of this kind rarely succeed in closing the perforation. Complete closure of the perforation, it is to be remembered, may be attended by *increase*

of the deafness. Hence cicatrices are sometimes opened up again by cutting or by the galvanic cautery, with the intention of improving the hearing power; but this is usually unsatisfactory, as fresh cicatricial tissue forms, with, it may be, aggravation of the deafness. Repeated incisions into a cicatrix or an atrophied part occasionally prove useful. In the various forms of adhesions between the tympanic membrane and the inner wall of the tympanum, or between the membrane and the incus and stapes, attempts with sharp instruments to separate the adhering parts are unsafe and ineffective; but, as Politzer has suggested, incisions made through the membrane close to the adhesions, followed by inflation, are not unfrequently advantageous to the hearing. When, for example, the membrane is adherent to the promontory, simple incision around the adherent part may prove beneficial; and, when it is adherent to the articulation of the incus with the stapes, a horizontal incision below the adhesion, by lessening the tension, may improve the hearing. When bands connect and bind the handle of the malleus to the inner wall of the tympanum or to the long process of the incus, their division with the knife may help to set free the ossicular chain. When, however, the manubrium is bound to the inner wall of the tympanum by direct adhesion, we must not endeavour to separate them by insinuating a knife between, but content ourselves with repeated incisions in the membrane, in the neighbourhood of the manubrium. Incision into the tense posterior fold of the membrane may help to set free the indrawn manubrium. So, also, a perpendicular incision behind the manubrium into the thickened and stiff membrane may relieve the tightness and improve the hearing. When the recess leading into the fenestra ovalis is exposed to view, and the stapes appears to be unduly drawn backwards and inwards by a shortening of the tendon of the stapedius, the division of this tendon has been recommended; and, when it is cicatricially shortened, such a division may be useful. The propriety of these operative measures can only be judged of, and the manipulations should only be undertaken by, an experienced aural surgeon.

Subcutaneous injections of fibrolysin, a preparation of thiosinamin, have been tried with the object of softening or causing absorption of fibrous bands in the tympanic cavity. While some improvement in the hearing after such treatment has been recorded, the writer has so far personally met with little success.

The Artificial Drum. The method of improving the hearing after a chronic purulent process has come to an end, or even before it has totally ceased, by the use of the *artificial tympanic membrane*, has been fully described in the chapter on Methods of Treatment (see p. 93).

Precautions where there is a Permanent Perforation. In cases where a permanent perforation is left behind, a plug of cotton wool should be kept in the orifice of the ear during cold, windy, or wet weather, while water should be carefully excluded from the interior of the ear. Diving, or simple immersion in water, is injurious, and may even prove dangerous, by the vertigo which is likely to be excited owing to the pressure upon the walls of the middle ear of cold water entering through the meatus (or even by the Eustachian tube). It is probable that cases of drowning while bathing are sometimes due to this cause. Where there is a permanent perforation, therefore, efficient means should be taken to protect the interior of the ear against the entrance of water (see p. 97). It would also be a wise precaution if bathers, who are aware of having a perforation of the tympanic membrane, should not enter deep water unless assistance is near.

The Nasal and Pharyngeal Mucous Membrane should, in all stages of the disease, be examined, and, if any morbid condition be found to exist, such as *adenoid vegetations* or *chronic rhinitis*, it must be properly treated (see Chapter VII.).

General Constitutional Treatment is often required, especially when the disease occurs in persons of an anæmic, syphilitic, or tubercular constitution (see General Remedies in list of Formulæ). The student is also referred to "Hygienic Treatment" (p. 97).

CHAPTER XIII.

CONSEQUENCES OF PURULENT INFLAMMATION OF THE MIDDLE EAR.

THIS chapter will be taken up with the consideration of certain more or less serious consequences of purulent inflammation which are *limited to the cavities of the ear, including the Fallopian canal*. These will be described in the following order :

I. Affections of the Mastoid Process.

- (1) Acute mastoid periostitis.
- (2) Acute purulent inflammation in the mastoid cells (acute mastoiditis).
- (3) Caries, necrosis, and other changes in the osseous framework.
- (4) Desquamative and cholesteatomatous collections.

II. Labyrinthine suppuration.

III. Facial Paralysis.

I. AFFECTIONS OF THE MASTOID PROCESS, INCLUDING THE ANTRUM MASTOIDEUM AND ATTIC OF THE TYMPANUM.

Under this heading will be included :—(1) Acute mastoid periostitis ; (2) Acute purulent inflammation in the mastoid cells ; (3) Caries, necrosis, and other changes in the osseous framework ; and (4) Desquamative and cholesteatomatous collections.

(1) ACUTE MASTOID PERIOSTITIS.

SYN.—PERIOSTITIS MASTOIDEA ; MASTOID OR SQUAMO-MASTOID ABSCESS.

Causes of Mastoid Periostitis. This disease has its origin, in the great majority of cases, in purulent inflammation of the middle ear. It may occur in almost any stage of the disease. If primary in its origin, which is rarely the case, it is likely to be due to an injury. The writer has seen a severe form of the disease excited in a boy by

a man laying hold of the boy's ears and lifting him by them from the ground; in another by a blow on the mastoid inflicted with a poker. It is also occasionally found as a complication of furunculi in the external meatus, the periosteal lining of which is directly continuous with that covering the mastoid region behind the auricle. Much more frequently, however, it is due to the extension of inflammatory disease, or the migration of pathogenic organisms, previously existing in the interior of the mastoid cells, to the periosteum covering the outer shell, either directly through the osseous tissue or by the connective tissue, vessels, etc., which penetrate the cortex. The gaps or fissures in the bone, often existing in childhood, especially the *squamo-mastoid fissure*, also facilitate the extension of inflammation from the interior to the exterior of the mastoid process.

Symptoms of Mastoid Periostitis. The first symptom is usually pain in the mastoid region, frequently of a very intense character,

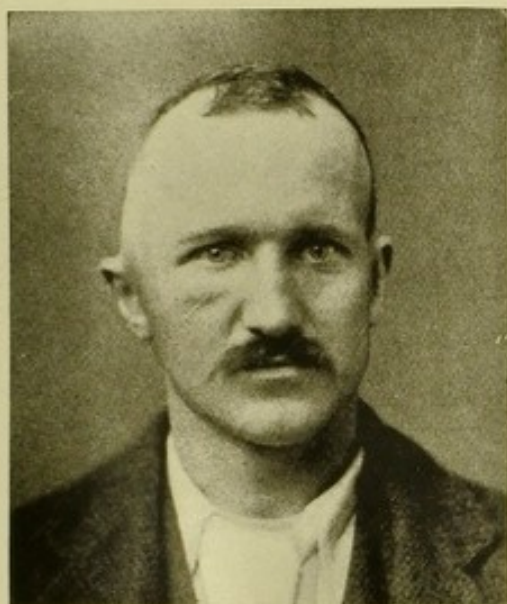


FIG. 168. — Anterior view of auricle and side of head in squamo-mastoid periostitis of right side.

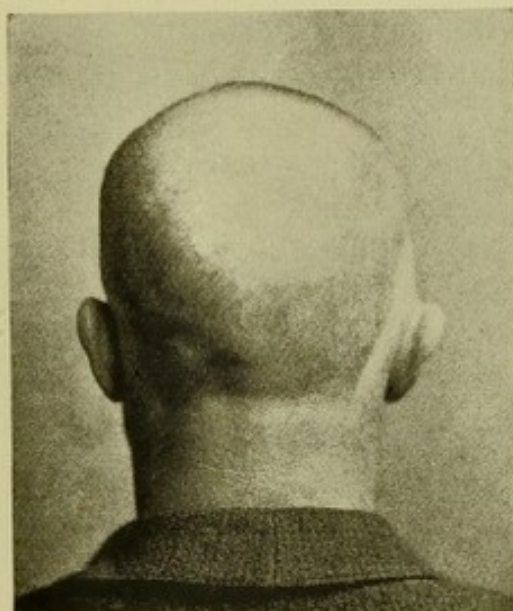


FIG. 169. — Posterior view of auricle and side of head in squamo-mastoid periostitis of right side.

which shoots along the neighbouring parts of the head; the surface of the mastoid process is also extremely tender on pressure. The patient may be unable to sleep for nights together. The soft parts soon become red, swollen, and œdematous, and the œdema may extend a considerable distance beyond the mastoid region. In consequence of the swelling of the tissue behind the concha the auricle juts outwards, downwards, and forwards from the side of the head. This is strikingly seen when we look at the head from the front or from behind (Figs. 168 and 169), but it may escape notice if we look at the ear laterally. There is usually considerable feverish disturbance.

Course and Consequences. In a few cases the inflammatory symptoms subside without suppuration; but generally in the course of

from a few days to two weeks pus forms between the periosteum and bone. When there is only a small quantity of matter, fluctuation may be absent; but, on the other hand, fluctuation may apparently exist, and yet no pus may be found on incision. The swelling is often most pronounced *above the auricle*, over the squamous portion, and large purulent formations may be found in the squamo-mastoid region. When these abscesses are incised a very considerable area of bone may be found denuded of periosteum, and yet there may be no caries or necrosis. In some cases we find a condition of osteo-myelitis with extensive destruction of bone; in other cases (especially tuberculous infants) there is found extensive necrosis and caries, with perhaps exposure of the dura mater and lateral sinus.

The *spontaneous* opening of the abscess is in many cases long delayed, perhaps for several weeks. The opening generally takes place behind the auricle; but it may occur in the external meatus either at the postero-superior wall of the osseous portion, or through the cartilaginous part of the canal. In this case, on pressing the bulging over the mastoid process, matter may be seen to issue from the meatus. If there is no caries or necrosis, or intra-mastoid suppuration, recovery soon follows the complete emptying of the abscess.

But there is frequently caries or necrosis of the outer shell of bone. If frequent relapses of the mastoid inflammation take place, there is reason to suspect caries or necrosis. The probe will, however, decide the question. It is to be remembered that *a purulent collection over the mastoid is often simply the result of the escape of pus from the mastoid cells* through a carious erosion in the cortex, or, in the young child, through the unclosed squamo-mastoid suture. In such cases simple incision of the abscess will not prove sufficient; free operation on the mastoid itself will be necessary (see p. 116).

Diagnosis and Prognosis. We must not confound with this disease the œdema, swelling, and even redness not unfrequently seen over the mastoid process in connection with furunculi of the posterior wall of the external meatus. The intensity of the pain and the greater redness and swelling of true periostitis are usually sufficient to distinguish this disease. It must also be remembered that swelling and tenderness of the *glands* over the mastoid process, sometimes with pus formation, are not unfrequently seen in purulent disease of the middle ear, and must not be mistaken for periostitis.

Periostitis of the mastoid process without implication of the bone usually terminates in complete recovery.

Treatment of Mastoid Periostitis. In the milder cases, attended by little pain, we should employ the tincture or ointment of iodine over the mastoid region, and at the same time ensure that there is

thorough drainage from the middle ear. Warm fomentations applied over the mastoid region have generally a marked effect in relieving the pain. In Germany, however, the *use of cold* has for some years been practised in these and other acute inflammations of the ear, although it is not so generally adopted in this country. Cloths dipped in iced water applied over the mastoid region and frequently changed, or Leiter's cooling apparatus, six coils of the tube being placed behind the auricle and three in front, are suitable means of applying cold. In employing Leiter's apparatus a piece of lint should intervene between the skin and the metallic tubes. By this mode of treating mastoid inflammation at *an early stage* and when the symptoms are very acute, great relief is often obtained, and there is reason to believe that the inflammation may in this way sometimes be cut short and suppuration prevented. If subsidence of the inflammatory symptoms does not quickly follow upon the foregoing treatment, *local blood-letting* over the mastoid region by means of leeches may be carried out (see p. 83).

When no marked improvement takes place in two or three days, even although there is no evidence of an abscess, *a free incision must be made* (see Wilde's incision, p. 115), and this will be found essential in most cases.

(2) ACUTE PURULENT INFLAMMATION IN THE MASTOID CELLS.

SYN.—ACUTE MASTOIDITIS; ACUTE MASTOID EMPYEMA; ACUTE PURULENT COLLECTION IN THE MASTOID CELLS.

The purulent affections of the middle ear, which have been already described, nearly always involve the mastoid cells, especially the antrum, to a greater or less extent, by continuity of mucous membrane, and by the secretion, with pathogenic organisms, making its way from the tympanic cavity into the antrum when the patient is lying on his back. Only in a certain proportion, however, is this attended by septic inflammation in the mastoid cells or in their bony walls.

Acute inflammation in the mastoid cells and their bony walls usually comes on in the course of the acute stage of purulent otitis media, and is attended in most cases by rapid formation of pus in the *vertical* cells behind, below, and more superficial than, the antrum, between which and the purulent collection *there may be no apparent communication*. Beginning in the muco-periosteal lining of the cells the osseous tissue soon shares in the inflammatory process. After a time the cells become filled with purulent or muco-purulent secretion; granulation tissue also forms in their interior with cario-necrosis of the septa between the cells.

Causes. While this disease is *frequently associated with epidemic influenza*, it may be excited (1) by obstruction to the proper drainage of pus from the middle ear; (2) by irritating applications or forcible or injudicious syringing; (3) by the action of cold; (4) by an injury. In some cases there seems to be no direct macroscopic continuity between the inflammation in the tympanum and that in the cells; probably the fresh septic centre is established behind by microbial migration from the tympanic cavity.

Subjective Symptoms. In many cases the subjective symptoms are comparatively mild, pain being only elicited by pressure, especially in front of the lower part of the mastoid, or less frequently behind the mastoid. Exceptionally there is violent pain in the mastoid region, which is very tender on pressure or percussion, and it may shoot down the neck and extend as far back as the occiput. There may be feverishness of an intermittent kind, although the writer has seen many cases with little or no rise of temperature; intermittent headache, however, is usually complained of. Giddiness is occasionally a marked feature of the disease.

Objective Symptoms. There is usually *very profuse* purulent discharge from the ear, syringing being almost immediately followed by fresh discharge; the quantity being usually such as to suggest a larger purulent reservoir than the tympanic cavity. The roof of the meatus at its inner end is often seen to be much swollen, with sagging of the cutaneo-periosteal lining. The soft tissues over the mastoid are usually unaltered, but on close scrutiny some bulging of the bone may be observed, with fulness at the junction of the mastoid with the occipital bone. The disease may, however, extend through the bony cortex to the periosteum and superficial structures, when the aspect becomes very much that of mastoid periostitis. The glands below the ear are usually tender and more or less swollen.

Course and Consequences. While, in the slighter varieties, the inflammatory process may subside and pass away without suppuration, much more frequently a collection of pus forms, which, if not operated upon, may eventually make its way either through the outer shell of bone behind the auricle, or, much less frequently, through the osseous wall of the meatus, leaving a carious opening in either of these places. The collection of matter may occupy a large part of the interior of the mastoid process, extending in some cases as far back as the sinus, and as far down as the apex, the whole of the vertical cells being converted into an abscess cavity with pus, granulation tissue, and cario-necrotic debris. The pus may burst through the inner surface of the *lower part* of the mastoid process into the digastric groove and form a deep-seated burrowing abscess (Bezold's abscess) under the muscles and deep fascia in the neck below the

mastoid region. In children the rupture of the abscess through the cortex of the mastoid at the antero-superior part is much more easy than in the adult, owing partly to the fact that the outer wall of the antrum mastoideum is much thinner in the child, but also to the presence in the child of a suture—the squamo-mastoid—in the outer wall. When a carious opening has thus formed in the outer shell of bone, the course is that described as Caries of the Mastoid (see p. 296). In tuberculous mastoiditis in infants there may be extensive necrosis with sequestra, involving even the petrous part of the temporal bone.

Diagnosis and Prognosis. When the superficial soft parts are involved in the inflammation, we may not be able to distinguish this disease from mastoid periostitis, until after Wilde's incision has been made. When no change is perceptible in the tissues outside the bone, the symptoms being only of a subjective character, we can exclude the possibility of mastoid periostitis. If, in the course of a case of acute purulent otitis media, originating in influenza, with profuse discharge from the meatus, which is practically unaffected by treatment, while there is sagging of the inner end of the upper wall of the meatus and pain on pressure (it may not be great) in front of the lower part of the mastoid, even although the temperature is normal, we have very probably to do with mastoid empyema. From the absence in many cases of marked subjective symptoms the true nature of this disease may be readily overlooked. The *prognosis* is very favourable if the condition be recognized and the mastoid operated upon. Otherwise the patient is placed in danger from extension to the sigmoid sinus or interior of the cranium. This danger is much increased when there is an insuperable impediment to the escape of matter from the tympanum, as by exostosis or closure of the external meatus.

Treatment of Acute Mastoid Empyema. In the early stage, when we may be in doubt as to whether it is simply mastoid periostitis or a purulent collection in the cellular spaces, the treatment for mastoid periostitis (p. 288) is appropriate. When, however, it is evident that we have to deal with a purulent collection in the mastoid, we must not delay operating, as this will usually be attended by *the most satisfactory results*. See description of the operation at page 116.

(3) *CARIES, NECROSIS, AND OTHER CHANGES IN THE OSSEOUS FRAMEWORK.*

Under this designation are included *caries and necrosis, hyperostosis and sclerosis, leading to dilatation of the antrum, or to contraction of the antrum and obliteration of the cellular spaces.*

Disease of the osseous framework of the middle ear is in nearly all cases the consequence of purulent otitis media, especially when associated in its origin with scarlet fever or tuberculosis. Just as we find in other bones of the body that caries or necrosis is usually secondary to inflammation of the periosteum or soft parts over the bone, so in the temporal bone, caries or necrosis is usually the result of inflammation either of the mucous membrane (the deeper layers of which perform the functions of periosteum) lining the middle ear, or of the periosteum covering the outer cortical part of the mastoid process. It is most common in childhood; in infancy caries and necrosis are frequently based upon tubercular disease of the temporal bone.

Sequestra. Considerable portions of the temporal bone are sometimes exfoliated in a necrosed state (Fig. 170). The annexed engraving (Fig. 171) shows the annulus tympanicus, with a portion of the mastoid process, exfoliated from a child, a patient of the writer, who suffered from purulent disease of the middle ear,



FIG. 170.—Sequestrum removed from mastoid process.

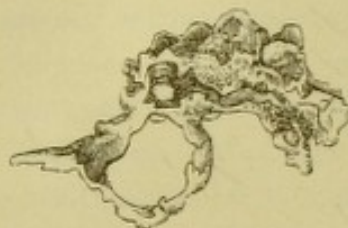


FIG. 171.—Sequestrum from a child.

originating in scarlet fever a year before. Cases are recorded by various writers of large portions of the temporal bone being exfoliated, such as the whole of the mastoid process, with the groove for the lateral sinus on its inner surface. The cochlea, from its more intimate relation to the tympanum, is necrosed more frequently than either the vestibule or the semicircular canals, and sequestra of portions of the cochlea are not very uncommon. Toynbee, Wilde, Voltolini, and others relate instances in which the whole osseous labyrinth came away as a sequestrum. The writer removed from a boy a sequestrum which included almost



FIG. 172.—Outer aspect of sequestrum of osseous labyrinth. *a*, Superior semicircular canal; *b*, horizontal semicircular canal; *c*, opening of fenestra ovalis; *d*, opening of fenestra rotunda; *e*, the outer wall of the cochlea.



FIG. 173.—Inner aspect of sequestrum of osseous labyrinth. *a*, Superior semicircular canal; *b*, horizontal semicircular canal; *c*, cavity leading into the vestibule and scala vestibuli; *d*, aperture common to the superior and posterior semicircular canals.

the whole of the osseous labyrinth (Figs. 172 and 173). It is to be noted that, while a small carious aperture in the roof of the middle ear may have a fatal issue, large portions of the osseous framework of the ear, in the form of sequestra, may be exfoliated without a fatal result.

Most frequent situations of Caries and Necrosis. Diseased bone is met with most frequently in the *mastoid region*, especially in the convex outer wall, and (although not so commonly) in that part of the mastoid forming the posterior wall of the osseous meatus. This frequency is no doubt due to the action of the micro-

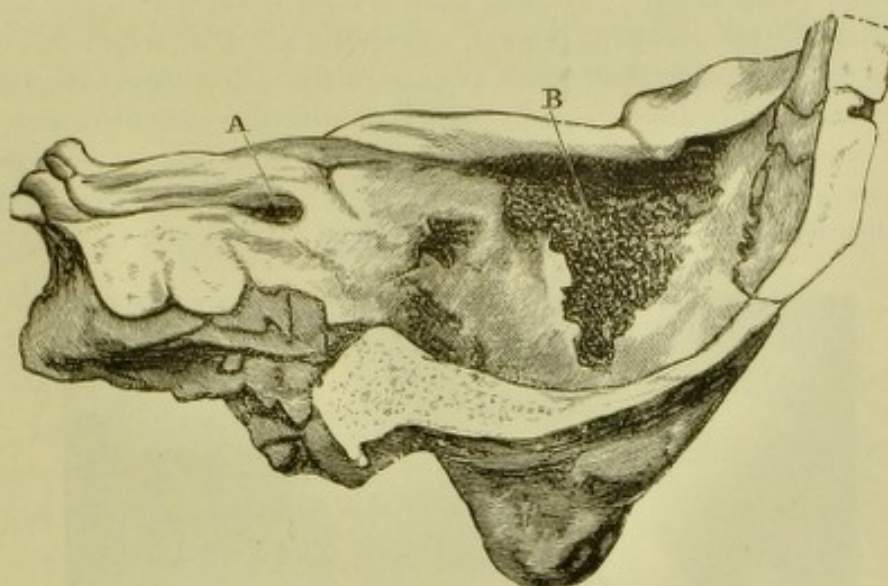


FIG. 174.—Cariou erosion of groove for lateral sinus, consequent upon suppurative disease of middle ear. A, Internal auditory canal; B, carious disease in situation of right lateral sinus.

organisms in the purulent matter which is so likely to collect and be retained in the antrum and mastoid cells. The inner or *sigmoid wall of the antrum* and neighbouring mastoid cells may be found perforated or even destroyed by caries in persons having extra-dural abscess or septic thrombosis of the sigmoid sinus (Fig. 174). On the *inner tympanic wall* there may be circumscribed carious spots

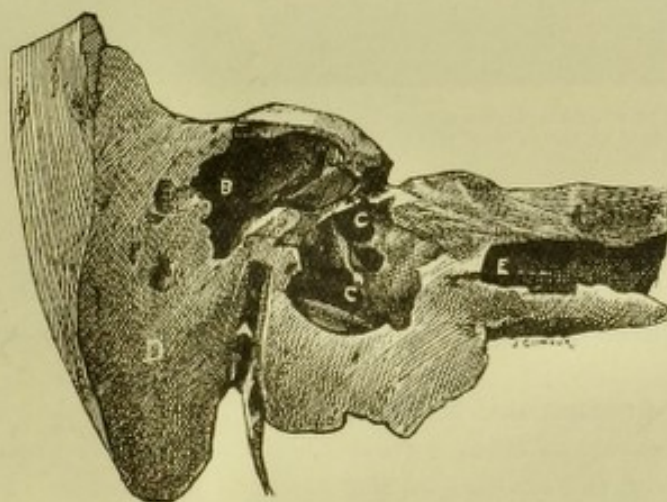


FIG. 175.—Inner half of temporal bone, showing facial nerve denuded of its bony covering above and behind in the tympanic cavity. The nerve was embedded in granulation tissue. A, Lower part of facial nerve; B, antrum; C, carious apertures in inner tympanic wall; behind and above C is the exposed facial nerve; D, mastoid process (sclerosed); E, carotid canal.

or even apertures leading into the labyrinthine cavities (Fig. 175). The walls of the *facial canal*, above and behind the pelvis ovalis, may be eroded or destroyed, giving rise to facial paralysis (Fig. 175). The *roof of the middle ear*—the tegmen tympani and tegmen antri—is often perforated by caries in cases of cerebral

abscess (Fig. 176). The *outer wall of the attic*, especially at its lower edge, may be softened from caries in purulent affections of the attic.

The **ossicula** are frequently affected with caries. The disease may be limited to a small carious spot on one of them, or the whole of the ossicula may be disarticulated and swept away. This may happen even as early as a few weeks after the beginning of the purulent process, especially when it originates in scarlet fever. It is not surprising that, when, as in purulent collections in the tympanum, the delicate small bones are constantly saturated with pus or loaded with granulation tissue, and thus exposed to the action of more or less virulent pathogenic organisms, erosion or necrosis should take place. Of the three ossicula, the stapes is least frequently lost; and its foot-piece generally remains, even after the head

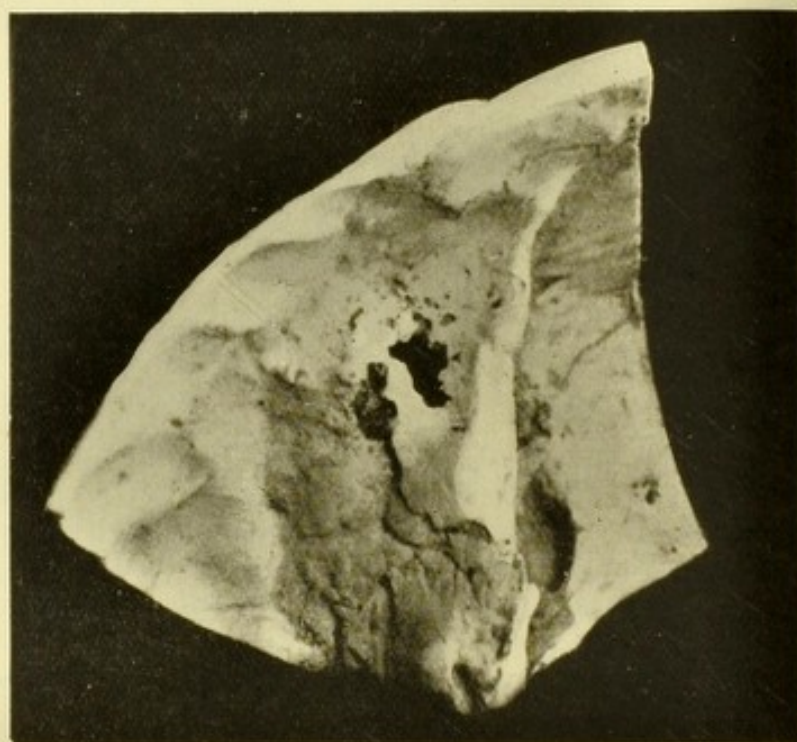


FIG. 176.—Upper and anterior surface of petrous portion of temporal bone, showing carious apertures in the roof of the middle ear, from patient who died from cerebral abscess.

and crura are gone. The long process of the incus is particularly liable to carious destruction, owing to its length and slenderness. In disease of the attic the body of the incus is often affected with caries, along with the head of the malleus; the handle of the malleus is frequently shortened by carious erosion of the lower end.

Changes in the Antrum and Mastoid Cells. As the result of absorption by caries, or by the pressure of cholesteatomatous masses, or the removal of sequestra, great *enlargements* of the cavities of the ear may take place. The antrum mastoideum may be greatly widened, and the partition between it and the external meatus destroyed or perforated. In such cases the enlarged cavity is usually occupied by cholesteatomatous masses, granulation tissue, and cario-necrotic debris. The accompanying woodcuts (Figs. 177 and 178) show examples of these effects. In the case from which these sections were taken there was also carious erosion of the inner or sigmoid wall of the antrum, and the sigmoid sinus was obliterated, leaving behind simply a fibrous cord. The mastoid cells proper were converted into dense ivory-looking bone. On the other hand, caries or necrosis may be associated with new-formation of dense osseous tissue. The mastoid cells may

then be converted into ivory-looking bone (see Figs. 177 and 178, *b*), and the antrum may be much *diminished* in size or even *obliterated* by such hyperostotic growth resulting from caries or necrosis.

Symptoms of Caries and Necrosis. The *subjective* signs of caries or necrosis are very much the same as those of purulent disease of the middle ear. In extensive necrosis the discharge is usually very profuse and fetid, while the deafness may be total if the osseous labyrinth be involved, when there is defective or lost perception by osseous conduction. Cases are recorded in which convulsions, presumably caused by the presence of necrosed bone, disappeared on its removal. While there may be complete absence of pain, there are, on the other hand, cases in which intense pain both in the ear and side of the head is complained of.

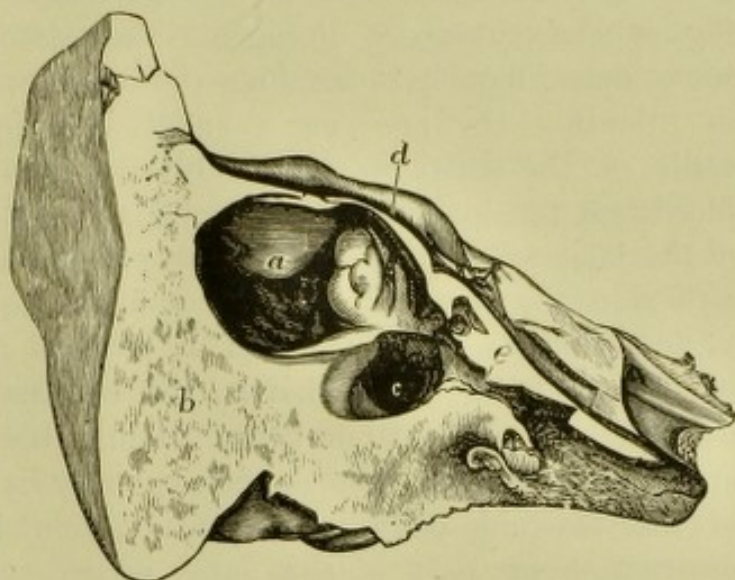


FIG. 177.—Inner half of section of temporal bone from a man who died of purulent meningitis consequent upon chronic suppuration of middle ear. *a*, Inner wall of enlarged antrum mastoideum; *b*, mastoid cells converted into ivory-looking bone; *c*, tympanic cavity; *d*, roof of antrum mastoideum; *e*, inner wall of osseous part of Eustachian tube.

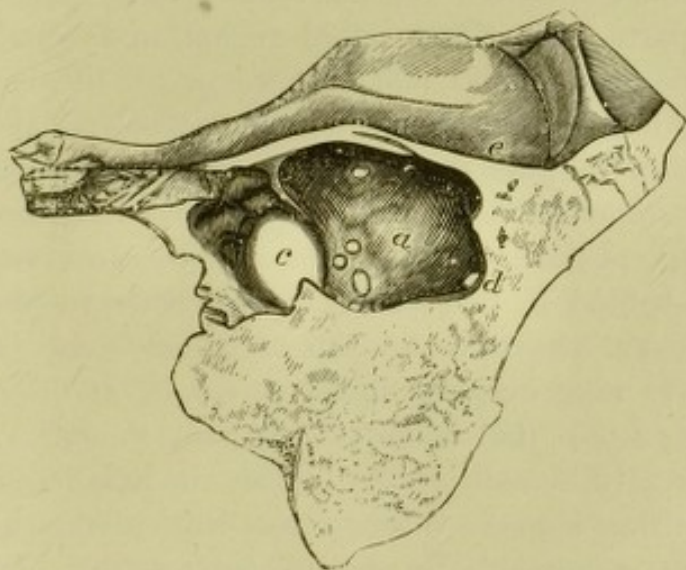


FIG. 178.—Outer half of the same bone. *a*, Outer wall of enlarged antrum, with carious perforations; *b*, mastoid cells converted into ivory-looking bone; *c*, lumen of external auditory canal; *d*, carious opening penetrating outer wall of antrum; *e*, dura mater.

The *objective* signs are more important. In caries of the osseous walls or ossicula of the tympanum, not exposed to view or accessible to touch, the objective appearances may be in no way different from those of chronic purulent otitis media (see p. 252), unless in the frequent *presence of granulation tissue*, which has a marked tendency to recur after removal. If the tympanic membrane be destroyed, the

cautious use of the probe may reveal bare bone or even a sequestrum on the inner wall of the tympanum. In the *external meatus* there

is sometimes found a saccular or elongated bulging, which may be so large as to close the canal, caused by a collection of matter over the diseased bone under the periosteum. After this swelling bursts or is artificially opened, a permanent opening is left, over which granulation tissue sprouts, and with the probe we usually detect carious or necrosed bone or a sequestrum. Owing to diffuse swelling of the cutaneous lining of the cartilaginous meatus there is sometimes difficulty in reaching the deeper parts of the ear, especially in infants. On pressing a small speculum between the swollen walls of the canal we may only see red granulation tissue, which bleeds on touching with the probe, the latter revealing the existence of the bone mischief (very extensive in tuberculous disease in infants) either in the form of caries or a loose sequestrum.

In the mastoid process caries or necrosis more frequently manifests itself behind the auricle than in the external meatus, although it may exist in both parts at one time. It may begin on the surface from an attack of periostitis, but more frequently it originates in the interior of the mastoid cells from inflammation leading to cario-necrotic destruction of part of the outer cortex. In either way a carious opening is the result, with or without the formation of a sequestrum. *An abscess generally forms* over the diseased bone behind the auricle from escape of the pus through the bony cortex into the external soft parts, or from an infective periostitis. It is important to remember, however, that this is not always the case, for there may sometimes be no external change, and yet, on cutting down, *extensive destruction of bone* may be found on the outer mastoid cortex. When an abscess forms, the soft parts over the mastoid region, and sometimes extensively over the squamous and other parts in the neighbourhood, are more or less red, swollen, and œdematous at the early stage, or soft and fluctuating at the stage of purulent formation. The auricle usually projects outwards and forwards from the side of the head, being pushed out by the abscess and the swollen tissue immediately behind it (Fig. 168). The bone in the neighbourhood, especially over the root of the zygoma, may be thickened, and carious centres may even be found there or at other parts more or less distant from the mastoid process. When an abscess forms, there will usually remain behind, after it has burst, one or sometimes two or three sinuses through the soft parts, the openings of which may be concealed by granulation tissue and surrounded by more or less swelling, or covered with scales or crusts of dry secretion. A probe may require to be introduced to a considerable depth before it comes upon the diseased and perforated bone. The most common situation for the external opening of a sinus is the upper part of the mastoid process; but it may be

at the lower part or even below the auricle from the sinking of the abscess.

The glandular structures below and in front of the ear are often seen to be involved, especially in young children suffering from caries and necrosis of the mastoid, frequently of a tubercular nature; in the latter the glandular tissue may become much enlarged, and may be the seat of tubercular infiltration or of purulent formation.

In the same class of cases *facial paralysis* is very common from involvement of the Fallopian canal.

Course and Consequences of Caries and Necrosis. The *Course* is sometimes very rapid. A large sequestrum may be formed in a few weeks from the beginning of the purulent disease, or, in as short a period of time, the whole of the ossicula may escape from the ear. The course is, however, most frequently slow, extending over a period of many months or years. The opening behind the ear sometimes appears closed for a time as if recovery had taken place; but soon the discharge again appears, the closure having been due either to a scab or a very thin bulging cicatrix. The exfoliation of a sequestrum is usually attended by distinct improvement in the purulent process. Severe inflammation, accompanied by intense pain, may attack the mastoid region during the course of the disease, from the pressure of cholesteatomatous masses, fresh microbic infection, retention of secretion, irritating applications, or cold. When the disease over the mastoid process terminates in recovery, there is left a depressed firm cicatrix adhering to the bone. On examining this cicatrix with the finger, we usually find a distinct hollow in the bone.

The *Consequences* of the disease upon the cavities of the ear have been already spoken of. We shall further on (Chapter XIV.) have to describe more fully the danger to life which may result from caries or necrosis. This danger is especially serious when the disease is situated *in the osseous partitions which separate the dura mater and large vessels from the middle ear, at the roof and the inner wall of the tympanum and at the posterior and inner walls of the antrum.* Facial paralysis, when due to purulent disease of the middle ear, is frequently brought about by caries or necrosis involving the osseous walls of the Fallopian canal. There has also to be mentioned the possibility of *lardaceous disease of the internal organs*, such as the liver or kidneys, being caused by long-continued suppuration with caries of the walls of the middle ear.

Diagnosis of Caries and Necrosis. If the carious or necrosed part is within the field of vision, the practised eye may detect it.

The use of a probe, however, is often essential, and the sensation of roughness, and perhaps of mobility, may give positive evidence of the

presence of necrosed bone or of a sequestrum, while the sensation conveyed by the touch of the probe on a gritty, soft, and depressed carious part, gives an indication of the nature of the disease. In using the probe, where caries of the tympanic walls or ossicula is suspected, great caution and gentleness should be exercised. We must on no account examine the tympanic structures with the probe without illuminating the interior of the ear, so that the eye may guide the hand. By the incautious use of the probe the tympanic membrane may be perforated, and the interior of the labyrinth, or even of the cranium, broken into. There is less danger in using the probe to the outer wall of the mastoid or the walls of the external auditory canal, except the upper wall, where, in consequence of the juxtaposition of the cranial cavity, only slight pressure should be exerted on any carious part.

The character of the discharge may sometimes yield information. It is often thin, brown, and *copious*, especially when a sequestrum exists. If it is frequently or persistently sanious, in the absence of granulations or polypi, there is ground for suspicion of diseased bone. An offensive odour from the discharge is not, as is believed by some, trustworthy evidence of the existence of bone disease. Fœtor of the discharge is, in most cases, merely an evidence of want of thorough cleansing, although, if the fœtor persist, in spite of repeated careful antiseptic cleansing, there is greater reason for suspecting caries or necrosis. Such fœtor may be also due to cholesteatomatous masses, which often at the same time occupy the attic and antrum.

The presence of *osseous particles* in the discharge shows the existence of caries or necrosis. These particles may be known to be present by a gritty feeling, when the pus is pressed between the fingers. The *cytological examination* of the discharge promises to give valuable aid in the diagnosis of bone disease (see p. 55).

Exuberant granulations, or polypoid growths, are frequently found associated with caries or necrosis. So long as carious disease exists, or a sequestrum remains, these growths, although removed, *quickly recur*. The cure of the caries, or removal from the ear of the sequestrum, is, however, generally followed by spontaneous disappearance of the granulations or polypi. The ossicles may be embedded in granulation tissue, which often also occupies the attic, aditus, and antrum along with cario-necrotic debris and cholesteatomatous material.

The prognosis of caries and necrosis must be considered in view of all the possible consequences. While, in some of the situations mentioned, caries or necrosis is fraught with danger to life, experience has shown, on the other hand, that carious disease may exist for many years, even from youth to old age, without any serious conse-

quence, the patient dying from another disease altogether. In children there is a greater likelihood of recovery both from caries and necrosis than in adults. The presence of a markedly scrofulous, tubercular, or syphilitic diathesis has, of course, a very unfavourable influence. Operative treatment, however, is usually very successful in removing the disease.

TREATMENT OF CARIES AND NECROSIS.

This is, in many respects, the same as that of the secreting stage of purulent inflammation of the middle ear (see p. 272).

Cleansing and Antiseptic Remedies. The thorough cleansing away of accumulated or retained secretion, and the employment of antiseptic remedies, are of the first importance; and their prolonged use may act very beneficially on the osseous disease, and avert the need of operation when the disease is limited and superficial. If there be swelling of the walls of the meatus, efforts must be made to dilate the canal, either by introducing a series of cotton plugs, smeared with a suitable ointment (Formula 87), and gradually increasing in thickness, or, if necessary, by incising the most bulging portion of the swelling in the walls of the canal.

Sequestra in the Meatus should be removed. Repeated antiseptic syringing may suffice with small sequestra or exfoliated ossicula, and such syringing will often assist the separation of a sequestrum. If a long thin piece of necrosed bone lie across the canal, forcible pulling with forceps may thrust the points of the thin bone into the walls. To avoid this, sequestra of such a shape and in such a position should first be crushed with strong forceps, after which removal becomes easy and safe. The remarks on the removal of foreign bodies (see p. 216) from the ear may here be referred to, and the instruments there recommended are also useful in removing pieces of necrosed bone. If the sequestrum be in the interior of the mastoid process, the radical mastoid operation is the best and safest treatment. The question of removing the malleus and incus in certain cases has already been considered (see p. 111).

Carious bone may be scraped with a sharp spoon or curette from the posterior and inferior walls of the meatus, or from the outer wall of the attic, with advantage and safety, but on the inner tympanic wall this method of treatment should be done with special care. The galvanic cautery is sometimes employed to arrest a carious process of limited extent. After scraping or burning, iodoform gauze is a good dressing.

More extensive operative treatment is, however, generally necessary, and the most frequent situation in which we have to operate

is the *mastoid process*. If an abscess has formed either over the mastoid or squamo-mastoid area or in the posterior wall of the osseous portion of the external meatus, it should be freely incised, and an examination then made with the probe in order to ascertain the state of the bone. If we find, with or without abscess, a carious opening behind the ear, leading into the vertical mastoid cells or antrum, and if the condition be an acute one and not based on a chronic disease, the thorough removal of cario-necrotic debris, pus, and granulation tissue, with subsequent dry dressing (see p. 116), will usually prove very successful. *When based on a chronic condition the radical mastoid operation is indicated* (see p. 126).

When there is reason to suspect caries of the bony partitions separating the middle ear from the cranial cavity—such as in the tegmen or at the sigmoid groove—it *must also be dealt with by the radical mastoid operation*. The student is referred to “Indications for the radical mastoid operation,” p. 139.

Constitutional treatment. Any constitutional defect or cachexia must be treated by appropriate remedies. We usually find that such remedies as iron and cod-liver oil, with country air and nutritious food, are useful aids to the local treatment. Iodide of potassium in quantities of from 8 to 15 grains daily is said by Politzer to be of great service in relieving the pain sometimes associated with caries.

(4) DESQUAMATIVE AND CHOLESTEATOMATOUS COLLECTIONS.

Epithelial Collections. Another consequence of chronic purulent disease of the middle ear is the formation of white or yellowish masses, partly the products of changes in the purulent secretion which has lain there for a great length of time, and partly the results of the desquamation of epithelium. These collections are found chiefly in the attic and antrum mastoideum; but they may exist throughout the whole middle ear and in the external meatus; they are often associated with caries or necrosis. A large number of the cases operated upon by the radical mastoid operation show the presence in the cavities of the middle ear of these masses. They may form during the existence of the discharge from the ear (especially if there is any obstruction to the discharge) or after the discharge has ceased. The excessive production and exfoliation of epithelial cells is often due to the extension of the epidermis of the meatus, especially when it has a desquamative tendency, through a marginal perforation especially one situated postero-superiorly or in the membrana flaccida. The mucosa of the middle ear may thus undergo a complete dermic change. Cheesy-looking, bad-smelling, and semi-fluid material in the attic or antrum is often found along with these desquamative collections.

Cholesteatomatous Masses. Lying stagnant in the middle ear spaces for a long period of time the purulent secretion may undergo a fatty change with the formation of cholesterine, and, gradually inspissating, become converted into a substance like butter. Meanwhile from the dermic lining (matrix) of the cavities, increased by the irritation caused by the pressure of the mass, there is a rich proliferation and desquamation of epithelial cells, and, while the centre of the mass is formed of caseous-looking matter which is gradually drying, the outer or peripheral parts become changed into a more or less firm mass composed of stratified layers of large flat cells, to which a glistening, mother-of-pearl appearance is imparted by the presence of crystals of cholesterine. These masses, from the firm consistence which they sometimes present, have been mistaken for real tumours, the *sebaceous* or *molluscous tumour* of Toynbee, and the *perl-tumour* of Virchow. But they are not true tumours—they are really altered pus, with exfoliated epithelial cells. The osseous cavities containing these masses are lined with a layer of firmly adhering squamous cells—the matrix—which is firmly united to the bone.

The epithelial masses may break down into foul-smelling discharge or, enlarging peripherally, exert gradually increasing pressure on the walls of the middle ear, until the spaces of the middle ear, especially the antrum mastoideum, may become much enlarged from thinning and absorption of the walls. In some cases they extend beyond the confines of the middle ear into the external meatus on the one side; or, by pressure upon the roof and inner wall of the middle ear, the masses may even force their way into the middle or posterior fossa of the skull, and bring about a fatal issue. A fatal issue may also result from the retention of pus, owing to such masses obstructing all means of outlet. They are found to swarm with streptococci and other micro-organisms.

The Symptomatology is pretty much that of chronic purulent otitis media with caries and necrosis. Objective examination often shows the masses filling the osseous part of the meatus, and the perforation is usually found to be in the membrana flaccida or the postero-superior quadrant of the membrane. There is sometimes only a very little discharge, which has usually a peculiar cheesy smell. Severe headaches and persistently recurring giddiness are not uncommon symptoms, while great pain in the ear may arise from softening and swelling of the masses. Whitish epithelial masses are often seen in the perforations from which they may be partially removed with a small spoon.

The treatment of desquamative and cholesteatomatous masses in the antrum and other middle ear spaces usually involves the radical

mastoid operation. Short of this, in the absence of urgent symptoms, and with indications of the limitation of the disease to the attic of the tympanum, the treatment suitable for attic disease might be tried in the first place (see p. 281).

The student is here also referred to "Indications for the radical mastoid operation," at p. 139.

II. LABYRINTHINE SUPPURATION.

During the last decade the subject of suppuration in the labyrinth, secondary to purulent disease of the middle ear, has received greatly increased attention from otologists, both in Europe and America. In this country we are indebted to Milligan, Lake, West, and Scott for important and original work, and on the continent Hinsberg, Friedrich, Siebenmann, and others have published many instructive papers bearing on this important subject.

Acute Infective Labyrinthitis. In the acute form the disease is generally diffuse but may be localized at the commencement to the membranous labyrinth, which is much injected and filled with bloody exudate; soon, however, the bony capsule is involved, leading, as in acute inflammation of bone elsewhere, to more or less extensive necrosis. The brain or meninges are very liable to be infected owing to the direct channels of communication existing between the internal ear and the cranial contents; also, owing to the acuteness of the inflammatory process, those barriers to a further advance of the infection, which in the chronic variety constitute an important safeguard, have not had time to form. Given free drainage, the suppuration may cease, with consequent cicatrization and permanent loss of hearing; or the disease may become chronic.

Chronic Infective Labyrinthitis. The disease may be chronic from the commencement, beginning as a slowly extending localized focus, such as one sees on the external semicircular canal; or it may follow an acute labyrinthitis, when it will be more diffuse. The involved bone may be soft and crumbly, or it may be the seat of extensive necrosis resulting in sequestra of varying sizes, even to the extent of the whole osseous labyrinth. Exuberant formation of granulation tissue is generally a feature, and the edges of erosions or the lips of sinuses exhibit, in most cases, pouting masses of granulation tissue, which recur quickly after removal. The disease may be localized to the semicircular canals, or even one of them, or it may extend to the vestibule, but the cochlea may escape entirely, or be only partially involved. The part of the labyrinth involved depends upon the position on its outer bony wall of the breach made by the infective process in the middle ear. The danger of an extension to

the meninges or brain is, owing to barriers of granulation tissue, not so great as in acute labyrinthitis. Injudicious or unskilled operative interference may, however, cause a definitely localized and almost inoffensive lesion to flare up, resulting in a violent and diffuse labyrinthitis ending fatally in a few days from purulent leptomeningitis.

Paths of Infection. There are certain well-recognized points upon the outer labyrinthine wall at which infective germs may gain access to the internal ear. These are, in order of frequency, the external semicircular canal, the foramen ovale, the promontory of the cochlea, and the foramen rotundum. While West and Scott found that infection took place through a fistula of the external semicircular canal in 14 out of 26 cases, Bezold and Siebenmann place the oval and round windows as the most frequent pathways, and they indicate that tuberculous disease has a predilection for invading the labyrinth through the foramen rotundum. With symptoms pointing to a labyrinthine involvement it is our duty, therefore, whilst performing the radical mastoid operation, to scrutinize closely these regions; the external semicircular canal and promontory for erosions, and the oval and round windows for buds of granulation tissue.

Causation. In the large majority of cases infective labyrinthitis is secondary to purulent disease of the middle ear. Acute purulent otitis media is rarely responsible for suppurative labyrinthitis; but, when such is the case, it is generally secondary to scarlet fever or measles. It is much more frequently a complication of chronic middle ear suppuration; Milligan and Hinsberg give the frequency as 1 per cent., and the variety in which cholesteatomata are present seems to be particularly liable to labyrinthine involvement. Tuberculous disease of the mastoid in infants is responsible for a large number of cases, and in this variety sequestration of a part or even the whole of the bony labyrinthine capsule is not very uncommon. In epidemic cerebro-spinal meningitis infective labyrinthitis occurs frequently as the result of an extension outwards, commonly along the auditory and facial nerves, of the purulent process inside the skull.

Symptomatology. The most frequent, though not constant, symptom is *vertigo*, which presents certain features peculiar to labyrinthitis. It is generally rotatory, the plane of rotation being in the majority of cases horizontal, and the tendency is for the sensation of movement of external objects to be from the diseased to the healthy side. In attempting to walk in a straight line, the inclination is to deviate to the affected side, and in standing with the eyes shut the tendency is to fall to the affected side. Vertigo may be of short duration, or it may persist with varying intensity for months. It is generally most marked in the early stages or during the height of an acute

inflammation, but it may in some cases be absent altogether. In many cases, where it has seemingly never been present, careful cross-questioning will frequently elicit a history of giddiness years before, lasting, it may be, only a few days.

The hearing power varies with the amount and locality of the disease. In extensive disease absolute deafness is the rule, but a certain amount of hearing may remain if the cochlea escapes. The tuning-fork tests may give some information as to the locality of the disease; for instance, marked diminution of the perception of high tones, as tested by tuning-forks or Galton's whistle, would indicate interference with the first turn of the cochlea, and therefore a probable invasion through the oval or round window. *Tinnitus* is not always present nor so marked a feature as in some other labyrinthine diseases.

Vomiting may accompany the giddiness. Severe *earache*, especially of a deep-seated character, is sometimes complained of, and *headache*,

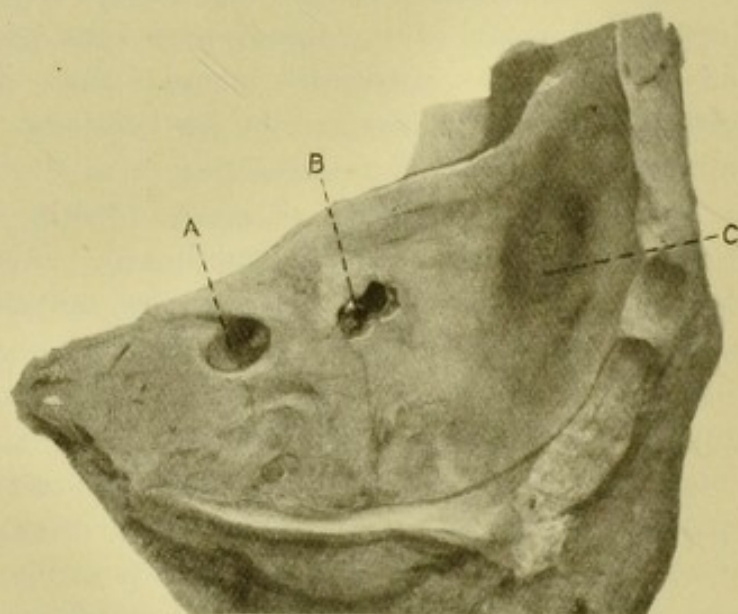


FIG. 179.—Posterior surface of pars petrosa from patient with labyrinthine suppuration who died from lepto-meningitis; labyrinth infected through the foramen ovale which was occupied by granulation tissue. The cerebellar fossa (pia mater) was infected from the labyrinth through the carious aperture (B) and also by the extension of pus along the internal auditory meatus (A); C, the sigmoid groove for the lateral sinus.

frontal, vertical, or occipital, may be present. *Nystagmus* is frequently observed. The conclusions of Drs. Neumann and Barany, of Vienna, who have devoted much attention to this symptom, are that in labyrinthine disease nystagmus occurs more markedly on directing the eyes towards the healthy side. They also state that this phenomenon is more marked in the early stages, becoming gradually less as the disease advances, until, when the whole labyrinth is destroyed, it disappears entirely. Barany has also experimented to determine the effects upon nystagmus of syringing the ear with liquids of different temperatures, but further investigation is required before definite

importance can be placed on the behaviour of nystagmus in these circumstances. *Facial paralysis* is usually present if the bony labyrinth is extensively involved.

Prognosis. The danger of labyrinthine suppuration ending fatally, by invading the cerebellar fossa, is very great. Of 198 cases collected by Hinsberg 104 ended in death, and in 60 of these lepto-meningitis was responsible for the fatal ending. Cerebellar abscess is the next most frequent intracranial complication. The liability to infection of the cranial contents is probably due to the fact that the labyrinth communicates directly with the sub-dural space through the internal auditory meatus and the aqueductus cochleæ, and with the extradural space (sacculus endolymphaticus) by means of the aqueductus vestibuli. In addition to these three pathways perforation of the bone on the posterior surface of the pars petrosa may lead to a pachy-meningitis, followed by cerebellar abscess or lepto-meningitis (Fig. 179).

Treatment of Labyrinthine Suppuration. This is operative and is taken up in connection with the radical mastoid operation at page 130.

III. PARALYSIS OF THE FACIAL NERVE.

We have included this among the consequences of purulent disease of the middle ear, because, when paralysis of this nerve is caused by an affection of the ear, that affection is most frequently purulent, especially when associated with caries or necrosis of the osseous walls of the Fallopian canal. Occasionally it is a consequence of non-purulent inflammation of the middle ear. Facial paralysis may be the result of operation, especially the radical mastoid. It is very common in infants with tubercular disease of the temporal bone.

The intimate relation, both topographically and through the vascular supply, between the mucous membrane of the middle ear and the nerve, as it lies in the Fallopian canal (see p. 241), explains how it may become involved in inflammatory diseases of the middle ear. When the paralysis is caused by a non-purulent disease, it is due to hyperæmia of the sheath of the nerve, or to the pressure of exudation, or to secondary contraction of the nerve; when caused by a purulent disease, it may be due to any of these, or to the pressure of necrosed bone, or to partial or complete destruction of the nerve.

Signs of Facial Paralysis. It may come on suddenly, or there may first be twitchings in the affected muscles. The symptoms produced by pronounced paralysis are well known, and are chiefly due to the inaction of the facial muscles on the affected side. There is partial or complete inability to close the eyelids; drawing of the mouth to the normal side during facial movement; obliteration of the normal folds and furrows of the affected side of the face, especially

the folds of the brow and the naso-labial furrow. These peculiarities are of course most marked during active facial movement (Fig. 180), as in laughing or crying, when the blank expression of the paralyzed side is very striking. Minor degrees of facial paralysis, such as a less distinct naso-labial furrow, associated with ear disease, are probably much more common than is usually supposed. Different fibres of the nerve, having different areas of distribution, may be unequally affected; thus the brow and the eyelids may be more



FIG. 180.—Left-sided facial paralysis, due to purulent middle ear disease, with necrosis of the mastoid from which a sequestrum was removed.

markedly affected than the mouth or cheek, or *vice versa*. When the nerve-trunk is completely destroyed, the paralysis is complete and permanent; on the other hand, if due to congestion or pressure, it is usually less complete and temporary.

The *uvula* is sometimes found to deviate to one side, while on the paralyzed side there may be defective movement of the velum palati during phonation. This is seen probably when the lesion of the nerve is situated above the geniculate ganglion, from which nerve twigs pass to the sphenopalatine ganglion, and thence to the uvula and soft palate. This symptom is, however, by no means constant. Besides, it may be found without facial paralysis, because

impaired movement of the soft palate may be due to nasal and pharyngeal catarrh, and the uvula is frequently a little to one side even in health.

When the lesion of the nerve is situated above the origin of the twig for the stapedius muscle, there may be dulness of hearing and tinnitus, caused by inaction of the stapedius muscle. The stapes is, in this case, pressed abnormally inwards, owing to the tensor tympani being no longer antagonized by the stapedius.

Bilateral Facial Paralysis is occasionally met with in connection with ear disease. The cases seen by the writer have been due to syphilis attended by very serious or total deafness, and in one instance ushered in by Ménière's symptoms (Fig. 181). The pathology of such cases is obscure.

The Course and Consequences of Facial Paralysis depend on the extent and character of the lesion. When due to congestive processes or to the pressure of exudation, it is likely to pass off in a few weeks. Even in these cases, however, it may remain either in a partial or complete degree permanent, owing to gradual thickening, contraction, or atrophy of the nerve or its neurilemma. If the paralysis prove permanent and complete, there may ensue in course of time atrophy of the facial muscles on the affected side, and even sometimes of the bones of the face.

Diagnosis and Prognosis.

The *diagnosis* of unilateral facial paralysis is usually made at first sight. If facial movements are attempted, such as in laughing or whistling, even slight forms are readily distinguished.

If caries or necrosis exist, the *prognosis* is unfavourable, although the paralysis is even then not necessarily incurable. Recovery sometimes takes place after the removal of a sequestrum from the ear or after the radical mastoid operation. When connected with a non-purulent disease, the prospects are much more favourable—the paralysis usually coming on more gradually, being liable to fluctuations, and passing gradually away with the cure of the tympanic affection. If the lesion consist of actual destruction of the nerve trunk, as may happen in a purulent disease, or from operation, the paralysis usually comes on suddenly, is very complete, and, while there is sometimes improvement, the nerve rarely or never recovers its normal function.

The effect of the *electric current* upon the nerves and muscles of the paralyzed side of the face is important in prognosis. At first the irritability for both the galvanic and faradic current is diminished; after a week or two, however, the galvanic reaction is heightened, while the faradic continues diminished. As recovery takes place, the neuro-electric effect becomes less, while the myo-electric effect becomes greater. If there be no response to faradic stimulation, the paralysis may be looked upon as serious. It has to be mentioned that the

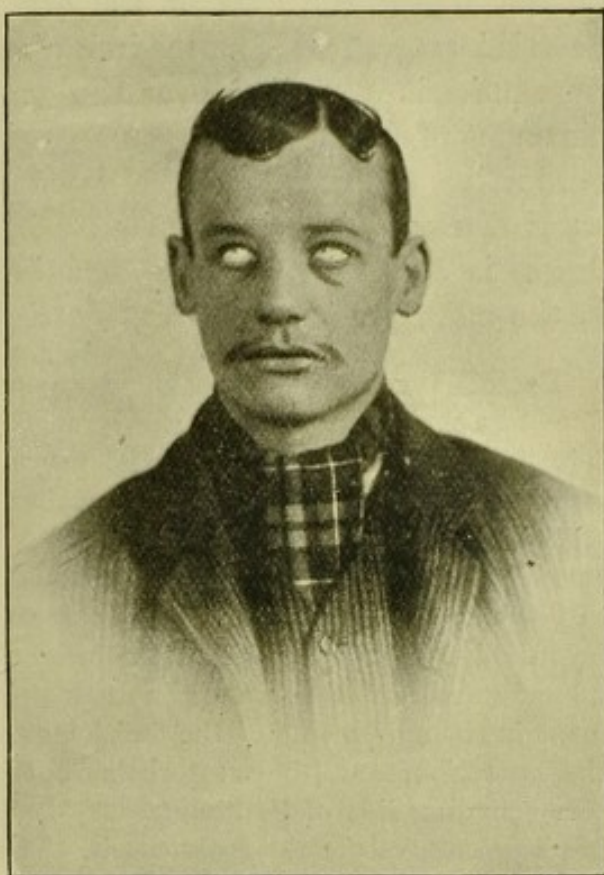


FIG. 181.—Bilateral facial paralysis (attempting to furrow the brow) in a man totally deaf from a central affection of the auditory nerve.

appearance of facial paralysis in connection with ear disease is sometimes the precursor of a fatal cerebral complication. In these cases it is usually intra-cranial in origin, partial and erratic in character, and *occurring on the opposite side from the ear disease.*

Treatment of Facial Paralysis. This must be directed chiefly to the removal of the ear disease, which is the cause of the paralysis. With this object in view, catarrhal or purulent disease or disease of the bone must be properly treated. If recovery from the paralysis do not follow the cure of the ear disease, faradic electricity should be tried as well as counter-irritation by means of repeated vesication by cantharides applied over the mastoid process, or the liniment or ointment of iodine to the same region. Electricity is, in some cases, productive of benefit in the later stages of facial paralysis due to aural disease. The internal use of iodide of potassium (5 to 10 grain doses) is also said to have sometimes a beneficial effect, and should, in the more persistent forms, be tried.

Facial Nerve Anastomosis. Many attempts have been made in recent years to restore the function of the paralyzed facial nerve by linking it up to either the spinal accessory or the hypoglossal nerve. Whilst the results of such operative attempts have not been very encouraging, the anastomosis of the peripheral end of the facial nerve to the hypoglossal has so far met with most success. The operation should, if possible, be performed before the facial nerve has quite ceased to respond to electrical stimuli. In cases of long standing the expectation of a favourable result is very slight, the facial nerve in such cases being often shrivelled up and unrecognizable. Even in cases attended by some success, definite improvement in the movements of the facial muscles may not be noticed for months after the operation, and to counterbalance slightly improved facial expression the corresponding side of the tongue may become atrophied if the hypoglossal nerve has been selected for the anastomosis. The spinal accessory nerve is now regarded by most surgeons as unsuitable for this purpose on account of the distressing association of the facial movements with violent contraction of the shoulder muscles.

CHAPTER XIV.

INTRA-CRANIAL AND VASCULAR INFECTIVE COMPLICATIONS OF PURULENT INFLAMMATION OF THE MIDDLE EAR.

WHEN we study the anatomy of the middle ear (see p. 229), we can understand what a ready means for the extension of septic inflammatory disease is provided by the peculiar position and relations of the various parts of the interior of the ear, and how the structure of the temporal bone favours the accumulation and decomposition of purulent matter, the pathogenic micro-organisms in connection with which may invade the interior of the cranium or the general circulation.

It is important to remember that these intra-cranial and vascular complications originate much more frequently in *chronic* purulent disease of the middle ear than in the acute stages of the disease.

Mortality in Purulent Disease of the Ear. Statistical authorities underrate the mortality because we know that up till recently the ear was very little examined, either in the clinical wards or in the *post-mortem* room. We know also that purulent disease may exist in the middle ear without the knowledge of the friends of the patient, or even of the patient himself. The writer is confident that persons die from intra-cranial disease originating in the ear, without the aural origin being known, because the friends of the patient may not be aware of the state of the ear, or may not deem the so-called "running ear" worthy of being mentioned to the medical attendant. Judging from the numerous cases scattered through medical literature and published within the past ten years, during which more close attention has been given to the ear in such cases, and also from the experience of our own hospitals, we are justified in attributing *the great majority* of cases of abscess in the brain to purulent disease of the ear. As time goes on, and as medical men come to use the ear speculum in every case presenting symptoms of cerebral disturbance, the frequency with which ear disease leads to a fatal issue will be found to be greater than has hitherto been suspected. In looking over the Registrar-General's annual reports, the writer finds that the number of deaths in London attributed to otorrhœa, most of which would be due to intra-cranial infection, in one year was eighty-six; and in the eight principal towns of Scotland the number for one year was twenty-six. We are however entitled to conclude that these

numbers, considerable as they are, do not express anything like the real number of victims to this disease who perish annually in London and the eight principal towns in Scotland.

The Pathways of Infection. There are two main directions in which extension takes place from the focus of infection in the temporal bone: first, through the *roof of the tympanum and antrum mastoideum* (Fig. 182), to the middle fossa of the cranium, and the temporo-sphenoidal lobe of the cerebrum above; and, second, through

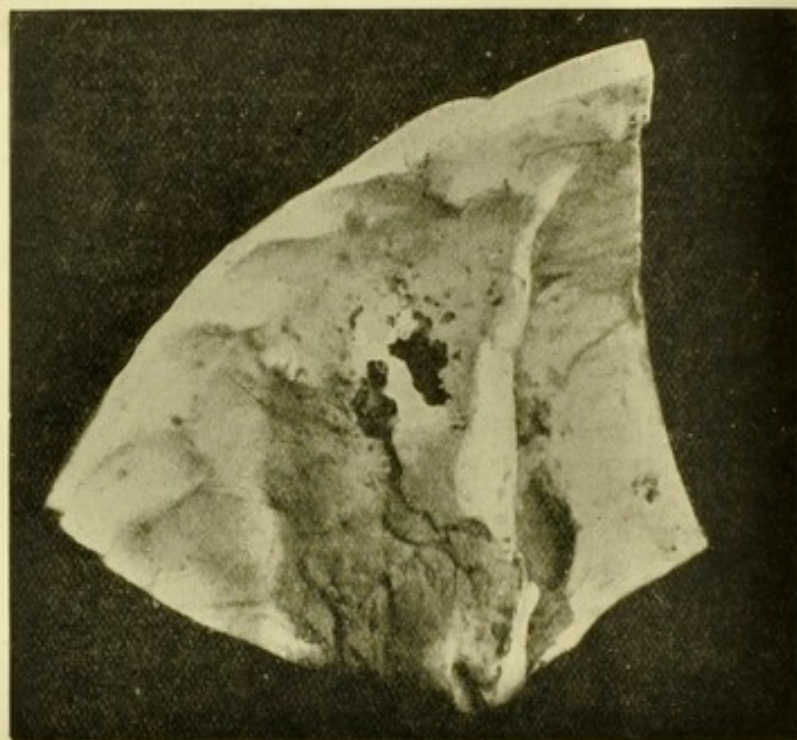


Fig. 182.—Carious apertures in roof of tympanum and antrum in a case of death from temporo-sphenoidal abscess.

the inner and posterior wall, *at the concavity for the groove of the sigmoid sinus* (Fig. 174), which separates the antrum and adjoining mastoid cells from the sigmoid sinus and adjoining dura mater. As shown by the records of cases, these, especially the latter, are the most frequent pathways by which the disease invades the interior of the cranium. In these situations the septic purulent focus is separated from the dura mater and sigmoid sinus by osseous partitions which are never thick, indeed frequently so thin as to be transparent, and which are always perforated by apertures for connective tissue, vessels, and nerves. Gaps are not unfrequently found, and at these the dura mater and the mucous membrane of the middle ear are in direct contact; while in childhood a very distinct fissure often exists at the tegmen tympani, the squamo-petrosal, through which a process of dura mater, with vessels and nerves, passes down and becomes continuous with the mucous membrane

lining the tympanum. By simple continuity and contiguity, therefore, even without a carious aperture, the pathogenic organisms may readily reach the dura mater and brain.

Infection through the Labyrinth and Fallopian Canal. But, as has been already said, there is another pathway, by which the infective process may pass to the intra-cranial cavity at the cerebellar fossa, namely, through the interior of the labyrinth (Fig. 175). The cochlea may be invaded through the fenestra rotunda, or through a carious aperture in the promontory. The vestibule may be broken into by ulcerative disease, extending through the structures closing the fenestra ovalis. Caries of the extreme upper and back part of the inner wall of the tympanum may convey disease to the interior of the horizontal semicircular canal. The disease, having reached the interior of the labyrinth, is separated from the dura mater at the *internal auditory canal* only by the perforated lamella of bone, through which pass the fibres of the auditory nerve. Instances are also recorded in which the disease extended from the tympanum to the internal auditory canal by the *Fallopian canal* and sheath of the facial nerve. *The area of bone on the posterior surface of the pars petrosa*, extending from the sigmoid part of the lateral sinus to the internal meatus, and from the upper border of the petrous to the lower, is probably also a much more common path of infection than is usually considered. In this direction the course taken is by way of the labyrinth, through the wall of bone, or through the aqueduct of the vestibule to the extra-dural space or through the aqueduct of the cochlea to the sub-dural space, producing cerebellar suppuration or purulent pachy- or lepto-meningitis. Cerebellar lesions are sometimes overlooked through inattention to this pathway of infection (see Fig. 179).

Septic infection may also be conveyed to the *internal carotid artery*, contained in the carotid canal, which lies on the median side of the inner wall of the tympanum and osseous part of the Eustachian tube. Still more important (as exposing the patient to the risk of septic infection) is the position of the *internal jugular vein* at its bulb exactly under the floor of the tympanic cavity; while of less, but yet of considerable, importance is the proximity of the *superior and inferior petrosal sinuses*, which are adjacent to the middle ear and are tributaries of the lateral sinus and internal jugular vein. The emissary veins, the most important of which is the mastoid vein, are also important channels for transmitting infective germs.

Obstacles to Infection. Probably more frequent extension of infective middle ear disease to the dura mater and brain would take place, but for two causes:—(1) The resistance offered to the microbial attacks by the strong fibrous tissue composing the dura mater; the power of resistance being often increased by a process of thickening

of its tissue over the diseased ear, or by adhesion of the dura mater, pia mater, and brain at the carious perforation, or by the *formation of granulation tissue*. (2) The thickening of the lining membrane and osseous walls of the middle ear, by which the morbid process may, in the absence of caries, become circumscribed, and a barrier be provided against bacterial infection. Post-mortem examination has not unfrequently proved that caries and necrosis may exist immediately underneath the dura mater for a considerable time without producing more than a partial thickening of it. It is noteworthy that the bony wall forming the outer cortex of the mastoid cells is considerably thicker than the partitions separating the cranial cavity from the mastoid and tympanic spaces.

Modes of Infection. In one or all of these directions there may be septic infection by *direct contact*, as in the case of a carious perforation, leading first to infective inflammation of the dura mater or wall of the sinus, and then of the pia mater and brain. There is reason to believe that abscess in the cerebellum is often the result of direct extension of the infective inflammation from the sigmoid sinus, in a state of purulent thrombosis, to the part of the cerebellum in contact with it, or in a case of labyrinthine suppuration from a carious aperture on the posterior wall of the *pars petrosa*. In many cases, however, no caries exists, and no visible track is seen between the septic focus in the ear and the infective lesion in the interior of the cranium. The mode of infection may then be either through the foramina, fissures, or defects frequently found in the osseous partitions, or *through the medium of the blood-vessels or lymphatics*.

Infection through the Blood-vessels plays a very important part.

As is well known, phlebitis and thrombosis are very apt to be set up in the vessels of a tissue which is the seat of septic purulent inflammation. The venous channels of the cranial bones and of the dura mater are especially liable to the formation of coagula in their interior. In consequence of this tendency, wounds of the scalp, followed by purulent inflammation, are regarded by surgeons as fraught with especial danger. Here, in the interior of the temporal bone, we have frequently the very conditions which are liable to give rise to changes within the blood-vessels of which the formation of thrombi is the initial stage. These conditions are necrosis of the soft parts or of the bone, and the presence of decomposing pus with bacterial organisms in the immediate neighbourhood of great vascular trunks. The peculiarity of the circulation in the osseous partitions, between the dura mater and the mucous membrane of the middle ear, favours these changes. The blood supply to the bone is derived partly from the dura mater and partly from the mucous membrane, while the venous blood, including that from the *venæ diploicæ*, is discharged partly into the veins of the dura mater and partly into those of the mucous membrane. In these ways free inter-communication takes place in the interior of the bony partitions between the vessels of the dura mater and those of the mucous membrane of the ear, so that morbid changes in the walls or contents of either set of vessels are pretty sure

to be propagated to the other set. Hence, if phlebitis or thrombosis exist in the vessels of the diseased walls of the middle ear, it is very apt to be propagated by means of the vessels in the interior of the bone to the dura mater or its sinuses, especially to the sigmoid sinus. Indeed, probably some degree of phlebitis of that sinus is *a not unfrequent complication* of purulent disease of the middle ear. The mischief may, however, be limited to some thickening of the walls of the sinus, and to a consequent diminution of its lumen.

The Lymphatic Vessels may be the Medium of Absorption and Transmission, especially in tubercular disease of the middle ear or its bony walls. The blood-vessels of the brain are accompanied by these lymphatic vessels, or, as they are called, perivascular sheaths. The internal auditory artery (the terminal branch of the basilar which ramifies in the pia mater close to the favourite seats of the tubercular deposits) inosculates freely with the stylo-mastoid artery, which furnishes the main arterial supply to the mucous membrane of the middle ear. In this way there is a ready lymphatic connection between the middle ear and the pia mater.

The great richness of the pia mater in lymphatic vessels must render it a particularly likely place for *tubercular deposition*. The infective agent, carried by the lymphatics from the ear, acts as a specific irritant upon the endothelium of the lymphatic vessels, and we have, as a result, infective inflammation, or, in the case of the tubercle bacillus, the formation of miliary tubercles. In the frequency of tubercle in the middle ears of children, intimately connected with and close to the base of the brain, may we not have an explanation of the otherwise mysterious preference of tubercle for the base of the brain?

There is a channel, therefore, be it by blood-vessels or by lymph-vessels, through which infective matter absorbed in the ear may reach the brain, even when healthy tissue intervenes.

Under the designation **Intra-cranial and Vascular Complications of Purulent Inflammation of the Middle Ear** are included the following:—(1) Abscess in the brain (cerebral and cerebellar); (2) Meningitis (purulent lepto-meningitis, serous meningitis, pachymeningitis); (3) Septic thrombosis of the sigmoid and other intra-cranial sinuses (septicæmia, pyæmia, emboli, metastatic abscesses); (4) Tuberculosis, hæmorrhage.

ABSCESS IN THE BRAIN (CEREBRAL AND CEREBELLAR).

Abscess in the brain is most frequently met with in persons between ten and thirty years of age, that is, when purulent disease of the ear mostly prevails. No doubt the great majority of cases of brain abscess originate in the ear.

The most frequent situation of the Abscess is a very important question. Körner collected records of a hundred cases. Of these the abscess was in the temporo-sphenoidal lobe in 63%, in the cerebellum in 31%, and in both cerebrum and cerebellum in 6%. Ballance says that, in his experience, cerebellar abscess is more frequent than temporo-sphenoidal. The abscess is usually on the same side as the ear disease, and near to the seat of it. Rare cases have been recorded of the abscess being on the opposite side; when this is the case it is generally regarded as metastatic, and then there may be several small abscesses. The

abscess is usually pear-shaped and involves chiefly the white substance of the brain.

State of the Intervening Structures. The dura mater and brain substance intervening between the abscess and the source of the disease in the ear may appear quite healthy; more frequently, however, the brain cortex is dark, softened, or even necrosed, and the dura mater soft and pulpy. Over the roof of the middle ear the brain substance, dura mater, and bone may be firmly adherent to one another. The osseous partition between the middle ear and the dura mater is also usually dark in colour from the action, probably, of the *bacillus pyocyaneus*. If a carious opening exist, the dura mater over it may be simply soft, thick, and pulpy, or it may be perforated with small holes. Abscesses in the brain, where apparently healthy tissue intervenes between the abscess and the ear, probably owe their existence, as has been already explained, to the transference of bacteria from the ear by means of the blood and lymphatic vessels, or by a septic embolism originating in a thrombus in the vessels of the ear.

In some cases there is found a fistulous communication between an abscess in the brain and a carious opening in the roof of the middle ear, when, by syringing the ear, liquid may be forced into the interior of the cranium. It was at one time believed that in such cases the abscess in the brain was the primary condition, and that, after making its way through the roof of the middle ear, it reached the external meatus, giving rise to the so-called "*otorrhœa cerebialis*." There is little doubt, however, that in all such cases the brain abscess is a secondary condition, resulting from purulent disease in the middle ear. The writer examined the ear of a child, with copious purulent discharge from the ear, who presented symptoms of cerebral abscess, and found, each time after syringing and drying the ear, that pus oozed from the direction of the roof of the tympanum in such quantity as almost immediately to fill the canal of the ear. The skull was trephined and a temporo-sphenoidal abscess was found, but the child unfortunately died. It was then discovered that the pus cavity in the brain communicated, through an aperture in the roof of the middle ear, with the cavity of the tympanum.

The Contents and Walls of the Abscess. The contents are usually of the nature of dirty, greenish, decomposing pus, emitting a most offensive odour, probably due to the *bacillus pyogenes fœtidus*. In the acute cases the brain substance in the neighbourhood is often much softened, dark in colour, and necrosed. In the chronic *latent* forms there may be a *thick* pyogenic lining, encapsulating the abscess. The formation of a thick capsule is probably dependent upon the type or virulence of the organisms present. According to Neumann diplococci favour the formation of a pyogenic membrane, while with anærobic organisms present a capsule is seldom seen. The weaker the virulence of the organism the more likely is the abscess to be encapsuled. These encapsuled abscesses no doubt sometimes undergo calcification, or the contents may become absorbed. Surrounding this, however, when death occurs from the abscess, there is often encephalitis, with softened, broken down, necrosed tissue due to the acute process which ultimately brings about the fatal result.

Exciting Causes of Abscess in the Brain. In addition to the purulent disease in the ear there is often an exciting cause which provokes the mischief in the brain. An injury, such as a blow upon the head or ear, or an irritating influence acting upon the ear, is frequently found to immediately precede the pain in the head and the vomiting which usher in the graver illness. In nine of

the writer's cases, one followed a box on the affected ear; one was due to a blow on the back of the head inflicted with the open hand; in another, the act of diving in the sea, and the consequent rush of cold water into the affected ear, immediately preceded the head symptoms; in two, the symptoms followed within two or three days of surgical manipulation in the ear; while, in the case of a boy, the exciting cause was probably connected with his fondness for "headers" in playing at football. In a certain proportion of such cases there may have been really a cerebral abscess in the latent form, existing perhaps for months or years, manifesting itself by no definite symptoms until the blow or fresh microbic invasion aroused a new and energetic process in the direction of increased formation of pus or of a fresh inflammation in the walls or in the vicinity of the abscess.

SYMPTOMS OF ABSCESS IN THE BRAIN (CEREBRAL AND CEREBELLAR).

In the latent or chronic form, in which the abscess may be encapsuled for months or even years, there may be, previous to the acute phenomena attending the later stage, few symptoms to indicate the presence of the abscess. In one of the writer's cases the patient, a young man, was on holiday climbing the hills on the west coast of Scotland up to the onset of the acute symptoms, which ended fatally two weeks afterwards. From the character of the encapsuling membrane the late Prof. Joseph Coats, of Glasgow, believed that the abscess had existed for many months at least.

Condition of the Ear. *The practitioner should not fail to examine the ears for signs of present or past purulent disease.* In the presence of symptoms indicative of intra-cranial mischief, we should not trust to merely *inquiring* of patients or their friends as to the existence of such. Their statements are most untrustworthy, and we should be satisfied with nothing short of a careful objective examination. A purulent condition may exist long after the patient has regarded it as cured, and he may even have forgotten that such ever existed; while the nearest friends are often quite ignorant that the patient has, or ever had, a discharge from the ear. An inquiry regarding the *condition of the hearing* may be more likely to elicit the fact that the ear is affected. We generally find, on inspection of the ear, purulent secretion, usually fetid in character, in its interior, with more or less destruction of the tympanic membrane. The tympanum may, in some cases, be dry at the time of examination, with evidence, however, in the form of a perforation, of a past purulent process; in very rare cases, especially in young children, there may be no perforation. The situation of the perforation may yield important information. If it is above the short process of the malleus, showing the source of the matter to be in the attic or antrum, we know that the danger of intra-cranial complication is greater, and that probably the middle

cranial fossa is the seat of the lesion. The inner wall of the tympanum should also be examined for caries or other signs which might indicate the co-existence of labyrinthine suppuration, in which case the posterior cranial fossa is most probably the region involved. We should take note if pus comes profusely from the upper part of the tympanum. The mastoid region must be carefully examined. *Frequently nothing abnormal is found there as far as the external condition is concerned.* In some cases, on the other hand, there may be swelling, pain on pressure, or a fistulous orifice. These, however, do not necessarily point to intra-cranial mischief. Pain over the mastoid on pressure or percussion is more often due to mastoid or periosteal inflammation than to intra-cranial mischief. For the various conditions in which we may find the ear the reader is referred to page 251. *Both ears should be examined.*

Pain in the Ear and Head. The first link in the chain of symptoms (symptoms due in the main to excessive intra-cranial pressure) is usually that of a severe *pain in the ear*, continuing it may be for days, and shooting over the side of the head, merging into *pain in the head of a very severe character.* This is one of the most constant as well as distressing symptoms of abscess in the brain. The pain is often frontal, or it may be over the side of the head above the affected ear, when it may be increased by pressure or especially by percussion. In cerebellar abscess the pain has frequently its seat in the occiput or behind the mastoid region. While in brain abscess the pain is usually most intense and continuous for the first few days or week, it rarely disappears entirely while consciousness lasts.

The Digestive System is disturbed; the tongue is coated and the bowels are constipated. *Vomiting is rarely absent* in the early stage, and continues for several days. It is not accompanied by nausea, and it has the usual character of cerebral vomiting, in that it is not specially associated with the taking of food. In cerebellar abscess the vomiting is usually very persistent and severe. An offensive odour from the breath, which may be similar to the odour of the discharge from the ear, is frequently perceived.

Shivering is by no means so marked or prominent a feature in brain abscess as in infective thrombosis of the sigmoid sinus. In rare cases it may be so violent as to appear convulsive to the inexperienced observer. On the other hand, it frequently amounts only to a sensation of creeping cold in the back or to a slight and not long-continued shiver with, it may be, cutis anserina; if severe rigors take place, we should suspect the co-existence of intra-venous infection, probably thrombosis of the sigmoid sinus, or the beginning of a fresh abscess centre, or, it may be, the escape of the abscess into the ventricles or sub-dural space.

The Temperature is very significant of brain abscess. It is at first somewhat elevated, then it *becomes normal or even sub-normal* or only slightly elevated in uncomplicated cases, until near death, when perhaps owing to the bursting of the abscess into the lateral ventricle, or, in the case of cerebellar abscess, into the fourth ventricle, or the escape of its contents into the arachnoid cavity at the base of the skull, the temperature rises to a high degree. Politzer lays stress upon the importance of an increase of the temperature over the side of the head on which the abscess is.

The Pulse in typical cases tends to become *slow* after the first few days. This peculiarity, like the low temperature, is significant of brain abscess. It is probably due to intra-cranial pressure, and becomes more remarkable as the abscess in the brain develops and increases; the beats are sometimes as few as 40 or 50 in the minute. If the pulse is *slow* and the temperature *high*, there is probably meningitis with abscess. In the complications which usually attend the final stage, however, the pulse becomes very rapid and feeble.

The Respirations tend likewise to become abnormally slow, and in some cases irregular, *especially in cerebellar abscess*, when, as death approaches, respiration may entirely cease, probably from pressure on the pons, a considerable time before the heart-beat. Also in cerebellar abscess Cheyne-Stokes' respiration may be observed.

Giddiness is often experienced; in cerebellar abscess (see p. 320) it is generally a much more pronounced feature of the disease than in cerebral abscess. This symptom is, no doubt, often present in intra-cranial suppuration, especially cerebellar, and when severe, and associated with other symptoms of intra-cranial mischief, is a valuable point in localisation. It must be remembered, however, that vertigo is a very common symptom of an affection of the ear pure and simple. It may be present in almost any form of ear disease, and it may even be severe in the simplest forms. In the absence of other symptoms, although in the presence of an ear disease, vertigo is of little value as an indication of intra-cranial mischief.

Ocular Phenomena are rarely absent. Intolerance of light (photophobia) with contracted pupils, characterizes the early stage; further on, sluggishness and dilatation of the pupil on the side corresponding with the abscess, with inequality of the pupils, are often observed. The *third nerve* on the same side is frequently involved later on by the pressure of an abscess in the temporo-sphenoidal lobe, especially if the abscess be large, leading to paralysis of the muscles supplied by that nerve. This results in greatly dilated and fixed pupil, loss of accommodation (diplopia), ptosis, and downward and outward deviation of the eyeball—external strabismus. The pupil may only

act sluggishly to light and accommodation. There may be myosis (contraction of pupil) at an early stage, or mydriasis (dilatation of pupil) if the abscess be large. The eyeballs are frequently observed to roll underneath the upper eyelids and the eyelids are not quite closed.

Optic Neuritis may or may not be present, but it is more likely to develop in the later stages of a large cerebral or cerebellar abscess having a somewhat prolonged course. The papillitis is rarely such as to affect vision. It may be in both eyes and not necessarily worse on the affected side. It occurs earlier, more frequently and in a more intense form in cerebellar abscess.

It is important to note that optic neuritis may be observed where there are no other indications of intra-cranial or vascular mischief. As a result of an investigation, made by Dr. Rowan, of Glasgow, and the writer, into the frequency of vascular changes in the retinæ of patients suffering from purulent middle ear disease, it was found that in 164 patients, taken consecutively from those attending the hospital dispensary, there was pronounced optic neuritis in 6%, while there were vascular changes of a milder type in 20%. Most of the patients were examined twice, thrice, or even four times, at intervals of months, and the conclusions arrived at were: (1) that the cases associated with these vascular changes in the retina were specially severe, persistent and irresponsive to ordinary methods of treatment, as compared with others; (2) that they should be closely watched, and the persistence of the ocular changes should be regarded as an indication for the early performance of the radical mastoid operation; (3) that, if, on the other hand, these changes in the eye show a tendency to clear off, especially if along with improvement in the ear condition, or, if the fundus of the eye is normal to begin with and remains so, we may with more confidence look for a favourable response to conservative treatment.

Paralytic Phenomena of a general character are unusual. There is sometimes pronounced *hemiplegia* affecting the opposite side of the body. This is, however, by no means common, although a degree of paresis of the arm and leg is probably more frequent than distinct hemiplegia. As the abscess is usually outside the motor area, focal symptoms are not common, especially in small abscesses. When they do occur they help in the localization of the abscess. In this connection it is to be remembered that the motor centre involved may be not only the part occupied or destroyed by the abscess but also the surrounding zone of inflammation, while more or less distant centres or parts may be involved indirectly by pressure. Unilateral *facial paralysis*, partial or complete, is frequently seen at some stage of the disease. When due to implication of the Fallopian canal or internal auditory meatus, it is usually very marked, and is found on the side *corresponding* with the affected ear; if due to involvement of the cortex of the brain, the paralysis is on the *opposite* side, and is likely to be partial and fluctuating in character (paresis). The partially open

eyelids on the one side, observed while the patient lies drowsy or comatose, may be the first indication of this paralysis. There may be retention of urine; and paralysis of the sphincters generally precedes by a day or two the fatal termination.

General Convulsive Attacks are rare; but local stiffenings of certain muscles may be observed. In cerebral abscess there may be rigidity to lateral movements of the head, which Politzer believes to be very suggestive of temporo-sphenoidal abscess; in cerebellar abscess rigidity to backward and forward movements may be observed. General tremors, more like severe shiverings, but probably convulsive in nature, are not unfrequent. The writer attended a patient who died of otitic temporo-sphenoidal abscess, in whom one of the first symptoms was a severe convulsive seizure, followed by partial unconsciousness; death occurred a week afterwards. When convulsions do occur, they are usually the result of secondary irritation of the motor area or its conducting paths (Macewen).

Mental Symptoms. After a week or so the severity of the pain in the head usually diminishes and *the patient becomes drowsy*; even then, when interrogated, he complains of pain in the head. The friends say that the patient is very drowsy, but that he apparently does not sleep. He can be easily roused, and answers questions intelligently and correctly, although his answers are *slow of coming* ("slow cerebration") and *short*; he immediately falls again into a doze. Indeed, during the process of interrogation he tends drowsily to close his eyes. There is, in short, difficulty in sustaining attention, with some clouding of the intellect. As the disease advances, the drowsiness gradually deepens into *coma*. Sometimes there are intervals of consciousness followed by the comatose condition. Occasionally remarkable improvement appears to take place, rousing expectations of recovery. The writer has seen a case in which the patient, after being comatose, recovered so far as to walk about for several days, lapsing again into drowsiness and unconsciousness, succeeded by death.

Aphasia. In two of the writer's cases *aphasia* was noticed. In one of them, which was examined post-mortem, the convolution of Broca was not found involved directly in the abscess; but the pressure exercised on this lobe by the abscess in the immediate vicinity probably accounted for its function being disturbed. The naming centre in the left temporo-sphenoidal lobe is not uncommonly affected, resulting in the inability of the patient to name objects or persons.

Emaciation. Great and rapidly progressing emaciation and prostration, especially in cerebellar abscess, are striking features (striking in the absence of high temperature) in persons suffering from abscess in the brain.

Course and Termination. The duration of brain abscess usually ranges from two to four weeks; but it also sometimes runs an irregular course for a longer period. As has been observed, it may exist in the latent form for a considerable period of time previous to the manifestation of the acute symptoms, which may end in death within a few hours, days, or weeks. In uncomplicated cases *death* usually takes place by *coma*. In many cases, however, owing to the occurrence in the later stage of basal or general lepto-meningitis, due, it may be, to the escape of pus into the arachnoid cavity or into the spinal canal, or to rapidly extending encephalitis, acute delirious excitement, extreme restlessness, elevated temperature, vomiting and spasms, and other symptoms of meningeal inflammation may be the precursors of the fatal ending. If the abscess bursts into the ventricles there will be dilated pupils, twitching of the muscles, and rapid death. In cerebellar abscess failure of the respiration may precede death for many hours. A case of cerebellar abscess is known to the writer in which artificial respiration was carried on for 12 hours previous to death. In cerebellar abscess cerebro-spinal meningitis may precede the fatal ending. Rarely death may be due to metastatic abscesses in other organs, especially the lungs.

Distinctive Symptoms in Cerebellar Abscess. There is often *retraction of the head*. *Vomiting* may be more pronounced. The pain in cerebellar abscess is more likely to be behind the mastoid and in the direction of the occipital region. *Yawning* (mechanical) is a common symptom. In some cases clenching of the teeth is noticed. There may be *blindness with dilated pupils*, and *optic neuritis* is more frequent and severe than in cerebral abscess. When the purulent process involves the labyrinth, the cerebellum is more likely to be affected, as also when the lateral sinus is in a state of septic thrombosis, or when there is an extra-dural abscess in that situation. When there is manifest mastoid disease, the cerebellum is more likely to be involved. In cerebellar abscess there is often, as has been said, *slow respiration*, while *failure* of the respiration, either from direct pressure of the abscess on the respiratory centre, or from sudden œdema of the parts in the vicinity of that vital centre, may be the cause of death. *Disturbance of equilibrium* is more likely to be met with in cerebellar than in cerebral abscess. While too great diagnostic importance should not be placed upon the behaviour of the giddiness in cerebellar abscess, it may be stated that the tendency in cerebellar abscess is for the patient to fall towards the healthy side, and to deviate towards the sound side while walking with the eyes shut. This is the direct opposite to what one usually observes in the vertigo of labyrinthine suppuration. *Nystagmus* is frequently observed in cases of cerebellar abscess. Neumann and Barany of

Vienna, who have done valuable work in connection with the significance of this symptom, emphasize the almost constant presence of nystagmus in cases of cerebellar abscess. It may be observed when the eyes are turned towards either the sound or the affected side. It becomes gradually more marked until it constitutes a very striking symptom, much more so than is ever seen in cases of labyrinthine suppuration. According to Neumann and Barany, if the nystagmus, which has been evident only when the eyes are turned towards the healthy side, suddenly becomes very marked or is simply present when the eyes are directed towards the diseased side, the diagnosis of cerebellar abscess can be confidently made, and the possibility of there being labyrinthine suppuration can be excluded. There is as yet not sufficient clinical evidence to justify us in unreservedly accepting this rather sweeping statement. Important information as to the seat of the abscess (cerebral or cerebellar) may be obtained while performing the radical mastoid operation, by observing the pathways of infection. In brain abscess a blood count will probably show leucocytosis.

MENINGITIS (PURULENT LEPTO-MENINGITIS, SEROUS
MENINGITIS, PACHY-MENINGITIS).

*PURULENT LEPTO-MENINGITIS (INCLUDING SUB-DURAL
SUPPURATION).*

In Lepto-meningitis the infective inflammation passing through the dura mater affects chiefly the pia mater and arachnoid. It is frequently secondary to brain abscess or to sinus thrombosis. The inflammation may extend from the seat of the infection over the whole of the base of the brain and sometimes even over the convexity, lymph and pus occupying to a greater or less extent the meshes of the pia mater. The brain substance underneath is softened and infiltrated, and the ventricles are often filled with sero-purulent fluid. Usually the greatest amount of exudate is in the cisterna magna, but it is probable that in some cases the exudate may be restricted more to the anterior cisterna. From the cerebellar fossa, where it often originates, the inflammation generally extends to the spinal meninges.

Sub-dural Abscess. The purulent collection may be more localized, owing to surrounding adhesions of the meninges forming on the *inner aspect* of the dura mater, between it and the pia mater—this being termed *sub-dural* or *intra-dural* abscess. In these cases the brain substance corresponding with the abscess is usually softened, œdematous, and even superficially necrosed, while the dura mater may soften after a time, leading, perhaps, to perforation and escape of the pus through a carious opening into the middle ear.

Pus in the Arachnoid Cavity. Pus is sometimes found after death in the middle or cerebellar fossa of the skull in considerable quantity. This may have escaped from an abscess cavity in the interior of the brain through a perforation (Fig. 191). The pus in these cases may find its way into the spinal canal as far as its lower end. When a cerebral or cerebellar abscess escapes in this manner into the arachnoid cavity violent lepto-meningitis follows, and, as has been already said, many cases of brain abscess terminate fatally in this way.

SYMPTOMS OF PURULENT LEPTO-MENINGITIS.

In many respects the symptoms are those of abscess in the brain (with important differences) and we shall refer to these symptoms in the same order as in describing the former (see p. 315).

Condition of the Ear. See paragraph under this heading in connection with the symptoms of abscess in the brain (see p. 315).

Pain in the Head is an early, severe, and persistent symptom, as in abscess. It is often in the forehead, but extends in many cases over the vault of the head; at other times the pain is more local, and it may be limited to the side corresponding with the ear affected.

The Digestive System sympathizes, and there are generally great thirst and absence of appetite. *Vomiting is rarely absent*, continuing during the first three or four days; and, like the vomiting in abscess, it is not necessarily connected with the taking of food, the vomited matter usually consisting of mucus and bile. The bowels are generally confined, and the *abdomen is frequently retracted*.

Shivering or chilly creeping sensations are generally present at the beginning; but there are no such intense and frequently repeated rigors as in infective thrombosis of the sinuses.

The Temperature is persistently elevated, but its degree is variable. It is generally high, rarely below 102° F., but not liable to the violent fluctuations found in septic thrombosis, while it presents a striking contrast to the low temperature of brain abscess. There is often flushing of the face.

The Pulse, somewhat slow at first, becomes rapid and irregular, unless there is localized purulent formation, when there may be a slow pulse as in abscess; it does not present the extreme oscillations of septic thrombosis.

The Respirations are rapid, contrasting with the slow respirations of abscess. When the meningitis is in the cerebellar fossa the respirations may be slow and Cheyne-Stokes' in character.

Giddiness may be experienced in the early stages (see p. 317).

Tremors or Convulsions, with partial or complete unconsciousness and turning up of the eyeballs, may take place in the early or later stages of the disease. *Local rigidities* and spasms, such as stiffness of the muscles of the neck and *retraction of the head*, are often observed. When the spinal meninges are involved, there may be spasm of the muscles of the back, producing opisthotonos; the muscles of the jaws may also be affected, causing trismus. Tendon reflexes are exaggerated and Kernig's sign may be often elicited.

Paralytic Phenomena. Complete hemiplegia is present in some cases. Erratic paralysis of cranial nerves is much more frequent, especially of the facial and abducens.

Ocular Disturbance. *Optic neuritis* is a common but by no means an invariable phenomenon. The pupils may be sluggish, immovable, or unequal, and such conditions may affect both eyes. Squint of an erratic character is often noticed. There is usually marked intolerance of light (photophobia), and later on deep injection of conjunctivæ. Nystagmus of an erratic character is sometimes observed.

The Mental Functions in diffused lepto-meningitis become much affected and present a striking contrast to what is observed in abscess of the brain or septic thrombosis of the sinuses. There are delirium, sometimes even maniacal excitement, extreme restlessness, perpetual movement in bed, irritability, and hyperæsthesia of the surface. When the meningitis spreads over the vertex, delirium is usually an early symptom. When the inflammation is localised more to the cerebellar fossa, disturbance of the mental functions is usually of later onset. There may be drowsiness, but no sound sleep. Coma usually precedes the fatal ending.

Contrast with Brain Abscess. The general irritability, the delirious excitement, the high temperature, and the quick pulse and breathing contrast markedly with the deep drowsiness, the slow pulse, and the subnormal temperature of abscess. There is, as in abscess, *great prostration*.

Modified Symptoms. It is to be remembered that the *whole* of these symptoms may not be present in any individual case; and, owing to complications, they may be obscure. In extensive purulent lepto-meningitis, involving not only the base but the convexity, the symptoms are extremely pronounced. But meningitis may be associated with abscess of the brain, or with septic thrombosis of the lateral sinus; at other times the symptoms may be modified by pressure from an extra-dural or sub-dural abscess. The symptoms may therefore be modified in particular cases; there may be thus the slow pulse of abscess with the elevated temperature of meningitis, or there may be the rigors and high temperature of thrombosis with the delirious excitement of meningitis.

The Duration of the disease is variable. Some cases terminate fatally in from three to four days, while others extend over as many months. Probably most cases run their course in from three to four weeks.

While the **Prognosis** is usually extremely unfavourable, experience shows that recovery may take place, even when, in the course of a purulent disease of the ear, such alarming symptoms as fever, headache, convulsions, and coma show themselves. Such cases, however, *are usually connected with acute*, not chronic, processes in the ear, and are probably of the nature of serous meningitis not attended by purulent formation, or the meningitis may be quite localized. Some slight success has

followed in a few cases free incision of the dura mater with, in some instances, drainage of the lateral ventricle.

Diagnosis. This disease cannot always be distinguished with certainty from abscess in the brain or infective sinus thrombosis. Only in the typical uncomplicated cases can the distinction be made. Frequently, however, as has been already said, meningitis is complicated with one or both of the other intra-cranial conditions. It has been confounded at the earlier stages with enteric or typhus fever; but the progress of the disease and the history of the ear affection usually clear up any such diagnostic difficulty. The results obtained by lumbar puncture may be of considerable help in forming a positive diagnosis and in distinguishing serous non-purulent meningitis. If the fluid withdrawn is turbid or contains polymorphonuclear leucocytes, or, though clear, coagulates spontaneously, or if it contains pyogenic organisms we have probably to deal with a purulent lepto-meningitis. The absence, however, of these, does not necessarily exclude purulent lepto-meningitis. The presence of streptococci has the gravest significance; staphylococci are less serious (Körner).

Lumbar Puncture (Quincke) is carried out with a straight hollow needle, similar to what is used for tapping the chest. The usual place for the puncture is between the 3rd and 4th lumbar vertebræ, half an-inch to an inch to the side of the spinous process of the 3rd lumbar vertebra. The skin is first sterilised and, if necessary, anæsthetised by the injection of a few minims of a normal saline solution (Schleich); the needle (thoroughly sterilised) is thrust through the soft tissues into the sub-arachnoid space, with the point directed slightly upwards and towards the middle line. If the patient bends forwards, more space is obtained owing to the separation of the laminae. In children it is advised to make the puncture in the middle line between two spinous processes, pointing the needle slightly upwards. The escape of cerebro-spinal fluid indicates that the point of the needle is in the sub-arachnoid space. The fluid may escape in drops, or it may flow out in a continuous stream of some force. Valuable information can thus be obtained as to the amount of the cerebro-spinal fluid and the degree of intra-cranial pressure. If the puncture is carried out simply for diagnostic purposes, only fluid sufficient to admit of a thorough examination, bacteriologically and cytologically, and to determine the presence or absence of albumen, should be removed. Such organisms as streptococci, diplococci, staphylococci or tubercle bacilli may be found. We should examine for leucocytes, especially the polymorphonuclear variety, also for albumen, the presence of a large quantity of which is indicative of meningitis. The normal cerebro-spinal fluid contains at most only a trace of albumen.

SEROUS MENINGITIS (MENINGITIS SEROSA BENIGNA).

In this condition the sub-dural and ventricular spaces are occupied by clear serous fluid, often under considerable pressure, while the pia mater and brain substance are œdematous. Serous meningitis may

occur in the course of a simple middle ear suppuration (more often in the chronic than in the acute variety), but it is more frequently present when the purulent process extends to the labyrinth (infective labyrinthitis), or when an extra-dural abscess on the posterior surface or apex of the *pars petrosa* complicates the middle ear inflammation. There is reason to believe that some degree of serous meningitis accompanies most cases of brain abscess or venous thrombosis, and it may prove to be the precursor of purulent lepto-meningitis. The symptoms differ only slightly from the purulent form of meningitis, and consist most frequently of slight pyrexia at the commencement, followed by vomiting, headache, restlessness, stiffness of the neck, and in some instances delirium. Brain abscess may, however, be simulated when slow pulse, drowsiness and stupor are prominent symptoms. Optic neuritis is often present and marked, probably occurring more frequently than in any of the other intra-cranial complications. The writer believes that those transient attacks of headache and vomiting, with slight pyrexia, which sometimes occur during the course of a chronic middle ear suppuration, are to be explained by the occurrence of mild attacks of serous meningitis. In many such cases the fundi show evidences of slight optic neuritis. Occasionally a patient may succumb to an attack of meningitis in a few hours, and on post-mortem examination no purulent formation is found, the sub-dural space being filled with clear serous fluid. In this form of meningitis (meningitis serosa maligna) the toxin present is probably of such virulence as to inhibit pus formation.

The *prognosis* is much more favourable than in the purulent variety. Removal of the source of mischief in the temporal bone, such as by the radical mastoid operation, is often sufficient to cause the symptoms to disappear. When this is not so and the symptoms are pronounced, incision through the dura mater is justifiable and even necessary so as to allow the serous fluid, which is sometimes present in large quantity, to escape. Lumbar puncture may also be of service in relieving pressure and in aiding the diagnosis. The fluid removed by lumbar puncture is usually clear and free from pyogenic organisms or polymorphonuclear cells.

PACHY-MENINGITIS (EXTRA-DURAL ABSCESS).

In **pachy-meningitis** the inflammatory process is usually more localized in position, and it specially affects the outer surface of the dura mater (pachy-meningitis externa), although the inflammation may ultimately involve the pia mater and brain, in which case it spreads from the fine meshes of the inner layer of the dura mater. This extension would probably more frequently take place were it not that the frequent "soldering" of the dura mater to the arachnoid, pia mater, and brain presents a barrier to microbic extension.

Extra-dural Abscess. In external pachy-meningitis a collection of pus usually takes place between the dura mater and the bone, *most frequently in the situation of the sigmoid groove* (peri-sinuous abscess), but also over the roof of the middle ear on the floor of the middle fossa of the skull. It may likewise be found on the posterior surface of the *pars petrosa* between the sigmoid groove and the apex (Fig. 179) or even over the apex itself (Gradenigo), and rarely round the carotid artery in the carotid canal. In these situations purulent collections are termed *extra-dural abscesses*, which, when occurring in the situation of the sigmoid sinus, are often associated with thrombosis of that sinus.

There are two forms met with at the sigmoid groove: 1st, where bone, probably hard and sclerosed, presenting no visible track leading to the dura mater, intervenes between the middle ear cavities and the sinus; 2nd, where, on penetrating the mastoid cortex behind the auricle, we find a large cavity filled with pus, bony debris, and granulation tissue, on the removal of which the sinus wall and the neighbouring dura mater are found already denuded of their bony covering.

In extra-dural suppuration there is in most cases a considerable surface of the dura mater involved in the inflammation; the dura mater is usually covered with granulation tissue, on the removal of which it is in many cases found to be coated with fibrinous exudation, greyish-white in colour and even sloughy looking. There is no doubt that the pressure of the abscess may exist for a considerable time without perforating the dura or sinus. Indeed, there are cases in which the pressure of the pus leads rather to perforation of the bone itself and the formation of a sub-periosteal abscess outside. A cerebellar abscess may result from a purulent collection around the sigmoid sinus, especially if the latter is in a state of septic thrombosis.

SYMPTOMS OF EXTRA-DURAL ABSCESS.

Condition of the Ear. There is a prevailing idea that cessation of discharge from the ear precedes this and other forms of intra-cranial mischief; this is far from being always the case, especially in the second variety of extra-dural abscess, when there is more frequently an excessive outflow of pus from the ear, welling out immediately after syringing and drying. On the other hand there may not always be in the first variety a discharge from the ear at the time the patient comes under observation; only a hyperæmic state of the tympanic membrane or a dry perforation may be seen, the more marked inflammatory changes which had previously existed having passed off. See also paragraph on the condition of the ear in symptoms of abscess in the brain (p. 315).

Pain. In the first form of the disease, where solid bone still encloses the abscess, the symptoms are much more severe than in the other variety. The pain is usually a prominent feature and is situated generally in and behind the ear, especially in the region of the masto-occipital suture and further back. Pain may, however, be complained of more or less over the corresponding side of the head. The pain is generally increased by percussing. Pain on pressure depends on the thickness and density of the bone. As

to its significance we must be sure that there is no other source of pain such as a furunculus in the meatus, stenosis of the meatus, or mastoid periostitis, while it must not be confounded with neuralgia.

Sickness and Vomiting may occur, although not so constantly nor severely as in the intra-dural complications.

Shivering and High Temperature. In the cases occurring in the region of the sinus, with solid bone intervening, both rigors and high temperature may occur, even where there is no evidence that the interior of the sinus is in a state of purulent thrombosis.

The writer has had under his care two cases of extra-dural abscess, supervening on chronic purulent middle-ear inflammation, in which there was a firm wall of bone between the middle-ear cavities and the extra-dural abscess cavity. A special feature of each of the cases was the *occurrence of frequent and severe rigors with high temperatures*, although there was neither pain nor swelling over the internal jugular vein; neither was there, on exposure of the sinus, so far as inspection and palpation went, any evidence of plugging; while, finally, complete recovery took place after removing the purulent collection, without interference with the sinus or internal jugular vein. An important lesson to be learned from these two cases is that rigors and high temperatures may exist, along with notable inflammatory changes in the outer wall of the sinus, and yet complete recovery take place without opening the sinus or ligaturing the internal jugular vein.

We rarely find **delirium, paralysis** or **oculo-motor paresis**, although **optic neuritis** is found in a certain number of such cases. Paralysis of the sixth cranial nerve with optic neuritis seems to be specially associated with extra-dural inflammation or suppuration at the tip of the pars petrosa.

In temporal bones of a markedly pneumatic type, in which a large part of the *pars petrosa* may be occupied by numerous cells even as far as the apex (Fig. 183), infective disease may extend inwards from the middle-ear spaces to the cells at the apex. The sixth nerve lies very close to these apical cells in a space (Dorello's space) covered in by, and external to, the dura mater (Fig. 184). When the apical cells are the seat of purulent disease the dura mater covering in this space is apt to be infected, resulting in an extra-dural abscess which involves the sixth nerve. Gradenigo, who has brought forward fifty-three cases of paralysis of this nerve connected with purulent ear disease, has shown that

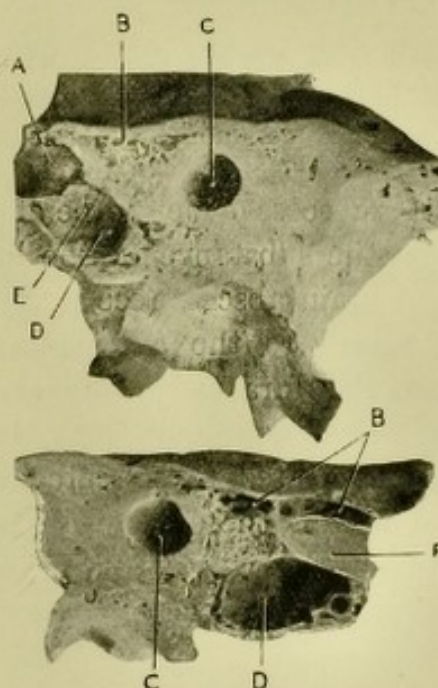


FIG. 183.—Sections of temporal bone, showing apical cells in pars petrosa. A, Carotid canal; B, apical cells; C, internal auditory meatus; D, cavity in bone, which at *post-mortem* examination was discovered full of pus; E, track leading into anterior part of tympanum; F, part of wall of carotid canal.

this form of paralysis is much more frequently associated with acute middle ear disease than with chronic, and that only in the latter and in the acute cases with mastoid involvement is operation necessary, recovery usually taking place spontaneously in the simple acute forms. The writer has operated upon two cases

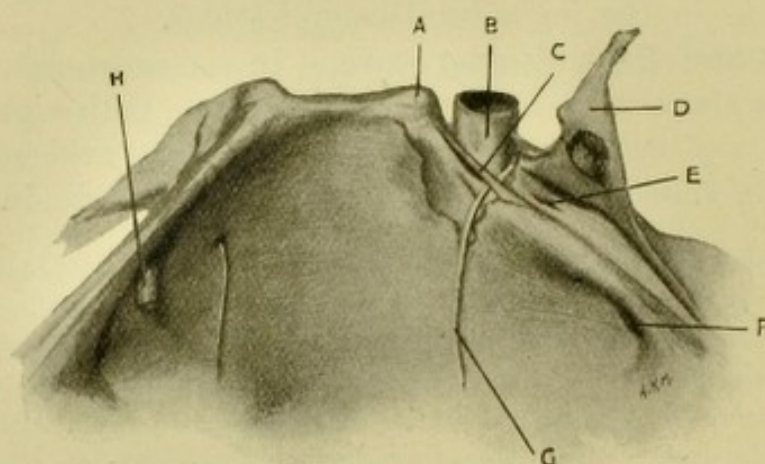


FIG. 184.—Dissection of space of Dorello. A, Posterior clinoid process; B, internal carotid artery; C, petro-sphenoidal ligament; D, dura mater reflected forward from space of Dorello, Meckel's ganglion shown in its sheath of dura mater; E, artificial opening into apical cells; F, internal auditory meatus; G, sixth cranial nerve; H, fifth cranial nerve.

connected with chronic disease with excellent results. Optic neuritis was also present in both and likewise passed off after operation; optic neuritis seems to be a pretty common attendant of this form of paralysis of the sixth nerve.

If the abscess comes to be of large dimensions the pressure exercised by it on the substance of the brain may lead to phenomena similar to those of brain abscess (see p. 315).

In regard to the *second* form, namely, where the bony partition between the dura mater and the middle ear has been destroyed by the disease, the symptoms may be comparatively mild. This form is usually associated with acute mastoid empyema and, in the cases seen by the writer, there have been neither rigors nor high temperatures throughout the whole course of the disease, while the pain has been but slight and generally only elicited by pressure over the back part of the mastoid.

This form is best illustrated by the following case treated by the writer. A man, 46 years of age, had normal ears, previous to the illness, which began with severe pain, first in the right ear and then in the left, followed in both cases by profuse discharge. The right mastoid was opened six weeks afterwards and a large cavity was entered, full of pus, with granulation tissue and cario-necrotic debris, while the *sigmoid sinus and neighbouring dura mater were found exposed on the back wall of the cavity*. The left mastoid was opened three weeks later, when a similar condition was found, with the exception that neither the sinus nor dura mater was exposed. There were neither rigors nor high temperatures throughout the whole course of the disease, while but slight pain was experienced on either side, and that only during firm pressure over the

back part of the mastoid. The purulent discharge from the ear in each case ceased almost immediately after operation, and the patient made an excellent recovery.

SEPTIC THROMBOSIS OF THE LATERAL AND OTHER INTRA-CRANIAL SINUSES.

(SEPTICÆMIA, PYÆMIA, EMBOLI, METASTATIC ABSCESSSES.)

This is probably the most frequent of all the intra-cranial complications of purulent ear disease.

Circumstances favourable to Phlebitis and Thrombosis. When, as is frequently the case, the lining of the antrum and mastoid cells is chronically inflamed, softened, or eroded, and these spaces are occupied by decomposing purulent products swarming with pathogenic organisms, it is not surprising that intra-venous infection should take place and that phlebitis and thrombosis with their effects should be set up in the sigmoid sinus, either by simple juxtaposition or through venous connections. Small thrombi, charged with infective organisms, may be carried inwards from the veins of the mucous membrane of the ear or of the bone, until they project into the sinus, where fresh formations may take place, until there may be a mural thrombus which may go on increasing until it plugs the sinus. The thrombi may form with or against the blood-stream and may at first be sterile at the new or advancing part. Thrombi may extend from the sigmoid sinus down the internal jugular vein, in some cases as far as the superior vena cava. But they may also extend upwards, either anteriorly through the superior petrosal sinus or inferior petrosal sinus to the cavernous sinus and ophthalmic vein, or posteriorly to the torcular and superior longitudinal sinus. The network of veins encircling the internal carotid artery in the carotid canal, and the superior petrosal sinus, which are in immediate relation with the mucous membrane of the tympanum, may also, in purulent diseases, be involved in phlebitis and thrombosis. From these veins the thrombi may pass to the cavernous sinus. It was suggested by Dr. Jas. A. Adams, of Glasgow, that thrombi with bacteria may be carried to the interior of the brain by the backward motion of the current of blood when the lateral sinus is obstructed or obliterated, giving rise to metastatic abscesses. Lastly, from the floor of the tympanum the septic process may directly reach the bulb of the internal jugular vein. In infants and young children the floor of the tympanum is usually very thin so that jugular bulb thrombosis is more common at that time of life.

Disintegration and Detachment of Thrombi. So long as the thrombus is firm and solid, obstructing the circulation, the danger of general blood infection may not be great; but, when it becomes infected, soft and disintegrated, with the blood stream going on, general blood infection is imminent. The disintegrated and purulent thrombi, detached by the current of blood and laden with pathogenic organisms, are detained and become emboli in some near or remote part of the body, giving rise to a fresh septic centre. In this way septic thrombi, swept on by the circulation, give rise to infarctions and metastatic abscesses, especially in the lungs. The kidneys, liver, spleen, joints, or subcutaneous connective tissue may, however, also be the seat of such infective abscess formations. Thus the general mass of the blood may be

infected, giving rise to the phenomena of pyæmia or septicæmia. From the sinus on its median aspect purulent basic lepto-meningitis may arise, or cerebellar inflammation with abscess. External to the sinus a purulent collection may form, separating the sinus from the osseous partition forming its groove, and leading to erosion of the bone with the formation of granulation tissue. Intra-venous local suppuration may take place at the sigmoid sinus, and may require to be dealt with as an abscess.

Both Lateral Sinuses may be involved. A woman, 56 years of age, who had had purulent discharge from both middle ears for many years, came under the writer's care with the following symptoms:—(1) Constant vomiting for a month; (2) rigors recurring daily for the same time, each followed by high temperature. The complexion was dingy; she was drowsy, the eyes were hollow, and speech was slow and hesitating. There were no indications of pulmonary mischief, and there was nothing abnormal in the fundus of the eye nor in the oculo-motor muscles. There being pain behind the *right* mastoid and in the neck below, the bone over the antrum on that side was removed, and pus in considerable quantity escaped, its source being evidently both antral and extra-dural. The bone over the lateral sinus was removed as far back as the torcular. The sinus seemed thrombosed in almost its whole extent, and the outer surface was sloughy. It was slit open, with the result of showing the interior to be occupied by purulent *debris* and whitish coagulum. The patient ultimately succumbed, and at the *post-mortem* examination no abscess was found in the cerebrum or cerebellum, and there was no lepto-meningitis, but, in addition to the extensive septic mischief in the lateral sinus on the right side, *the lateral sinus on the left side was found full of purulent thrombi as far back as the torcular and as far down as the beginning of the jugular.* On that side there was no extra-dural abscess nor change on the outer surface of the sinus to denote the serious condition of the interior of the sinus. There is little doubt that the involvement of the left sinus in this case was secondary, and due to an extension by the back current through the torcular from the opposite side.

Aseptic Thrombi. It is to be remembered that thrombi, if aseptic, may be absorbed, leaving behind, it may be, thickening, contraction, or obliteration of the sinus. In a case of temporo-sphenoidal abscess, observed by the writer, there was complete occlusion of the sigmoid sinus, the walls of which were converted into a fibrous cord.

Infection through the Arterioles. It is also possible that septic inflammation, originating in the *arterioles* of the mucous membrane of the ear, may be propagated along the walls of the vessels as far as main arterial trunks, such as the internal carotid, the internal auditory, or the middle meningeal, giving rise to infected coagula, which may be swept along by the blood current till an embolic purulent centre is formed in the terminal twigs in the brain. In a case reported by Sir W. T. Gairdner and the writer in the *Glasgow Medical Journal*, Vol. XXVIII., embolic lesions were found in the cerebrum connected with inflammation and thrombi in the internal carotid artery, traceable to purulent disease in the middle ear.

SYMPTOMS OF SEPTIC OR INFECTIVE THROMBOSIS OF THE LATERAL SINUS.

The symptoms of intra-venous infection are very much those which usually attend pyæmic poisoning, modified here by the situation of the source of the toxæmia.

Condition of the Ear. See paragraph under this heading at page 315.

Pain and Swelling in the Ear and Neighbourhood. Pain is often elicited by pressure or percussion over the posterior part of the mastoid, in the region of the sigmoid sinus or mastoid foramen, even when there is no evident mastoid disease. There is frequently also pain on pressure over the upper third of the posterior cervical triangle, in the situation of the condylar and deep veins of the neck. This part should always be examined, as the presence of pain here is distinctly significant. Over the upper part of the internal jugular vein pain is also often elicited by pressure; this is usually found earlier than the pain in the neck. At the same time, at the inner edge of the sterno-mastoid muscle a hard cord-like swelling may in some cases be felt, the thrombosed internal jugular vein. It is to be remembered, however, that general septic infection often exists without tenderness or swelling over the internal jugular, and probably the more prominent the thrombus in the upper part of the internal jugular the less, *for the time being*, is the danger of general septic infection. In like manner when an abscess forms, as is sometimes the case, at a late stage of the disease, around the internal jugular, there is less danger of systemic infection. Such an abscess is due to infection of the cervical glands and cellular tissue surrounding the vein and begins with a brawny swelling, and matting together of the tissues; the purulent formation taking place under the deep cervical fascia. This should be distinguished from the suppuration which takes place in connection with Bezold's abscess (see p. 290). *Edematous swelling*, caused by obstruction to the flow of blood through the emissary veins, is sometimes seen extending from the mastoid process to the back of the head and even to the temporal region. Such swelling over the mastoid, due to venous obstruction, must not be confounded with mastoid periostitis. The mastoid vein is in rare cases dilated. When the *internal jugular vein* is obstructed by a thrombus, the external jugular and the veins of the neck and cheek may be at first dilated, with, in some cases, swelling of the cheek and eyelids, owing to the over-distension. After a time this dilatation disappears, from the establishment of a collateral circulation diverting the blood to the opposite internal jugular. This venous stasis may also produce a colourless swelling, very tender to pressure, on the side of the neck along the inner edge of the sterno-mastoid muscle.

Headache is, in most cases, a prominent symptom, although it is usually neither so severe nor so long continued as in brain abscess or in meningitis. When, however, the disease is complicated with meningitis, the pain may be much more intense and continuous, but the rigors in this case may not be so marked.

The Digestive System is generally more or less involved. There is in the great majority of cases sickness or vomiting in the early stages, and there are cases in which vomiting may continue for weeks (see p. 330). The tongue is dry and coated, and the breath may have a fetid odour. There may also be severe *diarrhœa* with *abdominal pain*; the stools being very offensive. On account of the diarrhœa as well as other marked typhoid phenomena the disease may be regarded as enteric fever. On the other hand a case was sent into the Glasgow Hospital for Diseases of the Ear, Nose and Throat, for operation; the practitioner, owing to the existence of a chronic purulent middle ear disease, regarded the case as one of septic thrombosis of the lateral sinus. Enteric fever being suspected, which was confirmed by Widal's test, the patient was sent to the fever hospital, where the diagnosis of enteric fever was amply verified by the subsequent course.

Rigors. The most prominent and characteristic phenomena are frequently recurring, and severe rigors, followed, especially in the later stages, by profuse perspiration. These rigors may occur every day or several times a day, and each may continue as long as half-an-hour, during which the bed shakes and the teeth may be heard to chatter. It is right, however, to observe that rigors may be absent till a comparatively late stage of the disease; and in a certain proportion of cases, especially in children, there may be at no stage well-defined rigors. There is nearly always, however, in these cases a feeling of chilliness and coldness of the extremities; careful enquiry should be made for these, as the patient may not mention them.

A man, 30 years of age, came under the care of the writer after suffering from purulent middle ear disease for years. The patient had become affected with nausea accompanied by pain in the upper part of the posterior triangle of the neck and behind the ramus of the jaw, with temperatures varying from normal to 103° F. These symptoms had continued for three weeks without rigors; then a most severe rigor of half-an-hour's duration took place, during which the very window of the room shook, followed in a few hours by a second of less severity. On the evening of the same day the sinus was exposed by Dr. J. H. Nicoll as far back as the torcular and was found to contain a large quantity of soft purulent thrombi emitting a fetid smell, and containing the bacillus coli communis. Death occurred, and it was found that not only was the opposite lateral sinus involved, but the superior longitudinal, in a great part of its extent, was occupied by purulent thrombi. We must, therefore, *not delay operation* because there are no rigors, in the event of other symptoms being present.

The Temperature. The behaviour of the temperature is of great diagnostic importance. It is subject to striking oscillations. Beginning with the rigor or the chill it may at once rise from the normal to from 102° to 105° F., falling again, it may be, in a few hours to

normal or a little above normal. These oscillations may take place more than once in twenty-four hours, and are very significant of the nature of the disease.

The Pulse is rapid during the periods of high temperature, slowing down with the fall of the temperature. It becomes small and weak as the general systemic infection increases. The rapidity of the pulse may be unaffected by the administration of chloroform.

The Respirations are rapid during the high temperature, or *when pulmonary symptoms develop*. Pulmonary complications are very common, in consequence of infarctions in the lungs giving rise to septic pneumonia and abscess formations, with in some cases gangrene. This serious complication is usually ushered in by hurried breathing, variable pain or "stitch" in the walls of the chest, cough, and expectoration, streaked with blood or having a prune juice character; moist râles are also heard on auscultation. At first auscultation may not reveal these septic infarctions if they are confined to the central parts of the lung. The expectoration may become purulent and copious, and it sometimes emits a gangrenous odour.

Giddiness may be complained of, although it is not usually a striking feature (see remarks on giddiness at p. 317).

Disturbance of Vision is observed when the cavernous sinus is involved (see next paragraph). In a considerable number of cases optic neuritis is found.

Paralytic Phenomena, both general and ocular, are not so often observed in connection with septic thrombosis limited to the lateral sinus as when the other venous sinuses are involved.

The pressure of the thrombus upon the nerve trunks passing through the jugular foramen, in company with the internal jugular vein, sometimes produces characteristic symptoms. Various observers have reported the existence of phenomena due to irritation or paralysis in the regions supplied by the vagus, glosso-pharyngeal, or spinal accessory nerves. When the vein which passes through the anterior condyloid foramen is thrombosed, the hypoglossal nerve may be involved.

The symptoms of thrombosis in the *cavernous sinus* may be very numerous and varied, being produced either by stasis of its venous blood or by pressure upon the nerves lying close to the sinus. Stasis of the blood explains the occasional existence, in connection with this form of thrombosis, of exophthalmos, temporary blindness from œdema of the retina, and swelling of the forehead, eyelids, and nose; while pressure of the thrombus upon the abducens nerve or on the oculomotor may cause, in the former case, turning in of the eye-ball from paralysis of the external rectus muscle, and, in the latter, the symptoms of internal and external ophthalmoplegia, namely, paralysis

of accommodation, dilatation of the pupil, ptosis, and downward and outward squint.

When the thrombosis extends to the *superior longitudinal sinus*, serious symptoms may arise, such as epileptiform or apoplectic phenomena, probably due to effusion into the cortex of the convexity of the brain from obstruction to the flow of blood through the sinus. In children there may be bleeding from the nose, owing to the fact that in childhood part of the venous blood from the nasal passages is discharged into the superior longitudinal sinus, and the stasis of the venous circulation in the nose caused by obstruction of this sinus leads to hæmorrhage. From the same cause the veins passing in childhood from the anterior fontanelle to the temples and auricles may be dilated and prominent.

General Convulsive Attacks have been rarely observed when the thrombus has extended to the superior longitudinal sinus.

Mental Symptoms. The intellect usually remains quite clear to the end, if the disease be uncomplicated with abscess in the brain or meningitis. In the abdominal or typhoid type there may, however, be muttering delirium.

Course. Septic thrombosis may have a rapid course, terminating fatally in a few days by the paralyzing influence of the septicæmia. The course of the disease, however, more frequently extends to two or three weeks, and death usually takes place from metastatic abscesses, which are most frequently in the lungs, but also occur in the liver, kidneys, or in the brain itself. In the advanced stage one or more small abscesses may occur in the cerebrum or cerebellum, or purulent lepto-meningitis may be set up extending to the medulla and cord. There are, on the other hand, cases of a comparatively mild character, where there is intermittent and not great elevation of temperature—probably cases in which the thrombus entirely plugs the sinus and stops the circulation within it.

The writer had a case of otitis media purulenta of three months' duration followed by abscess in the vertical portion of the mastoid cells, then by extradural or rather extra-sinus abscess, and lastly by thrombosis of the lateral sinus, the sigmoid part of which, along with a portion of the horizontal, was converted into a round hard mass covered with firm granulation tissue. The plug in the sinus was found by microscopic examination to be composed of fibrous tissue which had evidently replaced a thrombus. In this case only one well-marked rigor and three slight ones occurred throughout, while the temperature on only one occasion reached 102° and was nearly always under 100° F. The patient made an excellent recovery after the sinus had been thoroughly exposed and the internal jugular vein ligatured.

If, however, in such a case the thrombus had disintegrated and softened, the infective material, loosened and carried into the general

circulation, would probably have given rise to such grave symptoms as rigors, great elevation of temperature, rapid and weak pulse, and pulmonary symptoms, if the lungs had been involved. In the case just described the internal jugular vein was tied, in order to avert such possibilities. It is to be remembered that, as all these conditions may co-exist, namely, infective sinus thrombosis, meningitis, and brain abscess, the symptoms may not present the typical character of one or other of these conditions. The thrombosis, if present, generally gives the character to the disease; if it is absent, and the other two are present, the meningeal phenomena will probably mask the symptoms of the other.

Diagnosis. When no objective symptoms are present, the diagnosis may be somewhat difficult. For a time it may be confounded with enteric fever or pneumonia. The existence of the purulent ear disease and the examination of the blood should help in avoiding such a mistake. From meningitis or cerebral abscess it may be distinguished by the more pronounced rigors in phlebitis, as well as by less disturbance of consciousness and motor power. On the other hand the symptoms of septic thrombosis may mask those of abscess or lepto-meningitis. Blood counts, repeated, may prove an aid to diagnosis. High leucocytosis is a valuable diagnostic indication; so also a high percentage of polymorphonuclear cells would point to abscess formation. Libman has made blood cultures in 26 cases of sinus thrombosis, and a positive result was obtained in 9 cases, in all of which the streptococcus was the organism present. The following are some of his deductions:—(1) A positive streptococcus blood culture nearly always points to the presence of sinus thrombosis; (2) the continued presence of streptococci in the blood, after the sigmoid sinus has been explored, may be regarded as an indication for tying the internal jugular vein; (3) if, after ligation of the internal jugular vein, streptococci are no longer found in the blood, the general invasion has been stopped; (4) in some doubtful cases, where there is evidence only of a past suppuration in the ears, and no other focus found from which bacteria could gain access to the blood, the discovery of streptococci in the blood would indicate the desirability of exploring the mastoid and sigmoid sinus.

Prognosis. There is no doubt that a certain degree of phlebitis, in connection with purulent ear disease, leading to thickening of the coats of the vessels and to thrombi, especially in the sigmoid sinus, sometimes exists without a fatal issue. This may be owing, as has been already said, to the plug in the vessel obstructing the circulation, and so preventing systemic infection. Indeed, this is probably a much more frequent complication of ear disease than is usually supposed. Timely operation affords a good chance to the patient.

DIFFERENTIAL DIAGNOSIS IN UNCOMPLICATED OTITIC BRAIN ABSCESS, LEPTO-MENINGITIS, SEPTIC THROMBOSIS OF SIGMOID SINUS AND EXTRA-DURAL ABSCESS.

SYMPTOMS.	BRAIN ABSCESS.	LEPTO-MENINGITIS.	SEPTIC THROMBOSIS OF SIGMOID SINUS.	EXTRA-DURAL ABSCESS.
Otorrhoea.	Present or evidence of having been present.	Present or evidence of having been present.	Present or evidence of having been present.	Present or evidence of having been present.
Earache and Headache.	Pain in the ear is often the first symptom. Headache always present, usually intense, especially in the early stage, and often more marked over the affected side of the head. It may also be frontal or occipital (cerebellar abscess).	Pain in the ear may be the first symptom. Headache is always present and severe; more generally distributed over the head. The pain is often very marked over the back of the head and neck, and it may extend down the back, when the spinal meninges are affected; this is generally accompanied by retraction of the neck.	Pain in the ear may be the first symptom. Headache not generally so severe as in brain abscess or leptomeningitis. It is more likely to be localised to region between mastoid and occiput. There may be pain in the neck due to glandular enlargement or thrombosis of the internal jugular vein.	Pain in the ear may be the first symptom. Headache usually less marked and generally more localised to neighbourhood of ear. It may be deep seated, when abscess is at the apex of the pars petrosa.
Digestive Disturbance.	Vomiting nearly always present, more marked in the early stages, and cerebral in type. Tongue covered with sordes and breath offensive (odour may be similar to that of the aural discharge). Constipation is the rule.	Vomiting almost constantly present and of the cerebral type; generally more frequent at the commencement. Tongue thickly coated. Constipation not so constant as in brain abscess.	Vomiting may be absent, but generally occurs a few times at beginning. Tongue often brown, dry, and thickly coated. Constipation less common and diarrhoea may be marked so as to simulate enteric fever.	Vomiting, if present, is generally slight and at commencement. There are often no other evidences of digestive disturbances.
Rigors.	Seldom marked: may have one or two chills at commencement.	Very often slight rigors or chilly sensations.	Rigors in most cases frequent and pronounced; may occur three or four times daily, accompanied by chattering of teeth and violent shaking, lasting half an hour or even longer. In some cases no more than chilly sensations.	Often absent, if present slight and at commencement. When around the sigmoid sinus there may be rigors.
Temperature. Pulse. Respirations.	There may be slight pyrexia with increased pulse and respiration rates in the initial stage. Later on the typical condition is normal or sub-normal temperature, slow pulse and respiration, until the late stage, when leptomeningitis may supervene. In cerebellar abscess respiration may cease	Temperature generally persistently high with only slight remissions; pulse and respiration proportionately rapid.	Violent oscillations of temperature from normal or thereabouts to 105°F or higher, generally ushered in by a rigor or chill. Pulse and respiration follow the temperature unless pneumonia exists, when pulse keeps rapid and weak and respiration is accelerated.	Pyrexia generally slight if any. Temperature often normal throughout. If abscess is unusually large may simulate brain abscess.

Sweating.	Generally absent.	Generally absent.	Profuse sweating usually follows a rigor.	Usually absent.
Mental Condition.	"Slow cerebration," drowsiness, deepening into stupor and coma is the typical condition.	Excitability, irritability, restlessness, screaming fits, are commonly observed. In some cases delirious, almost maniacal, excitement.	Intellect clear as a rule all through the illness.	Generally no interference with the mental condition.
Paralytic Phenomena.	If abscess is in left temporo-sphenoidal lobe aphasia may be present from involvement of Broca's lobe or there may be interference with the naming centre in third left temporo-sphenoidal lobe. Paralysis of opposite limbs is occasionally observed when abscess is large.	There may be fleeting paralysis of some of the ocular muscles or twitchings of the face.	Seldom present. The glossopharyngeal, vagus, and spinal accessory may be involved in thrombosis of the jugular bulb. The hypo-glossal may be involved if the anterior condyloid vein be thrombosed.	Seldom present. If the abscess is in the region of the apex of the pars petrosa, the 6th cranial nerve is frequently implicated, resulting in diplopia.
Ocular Phenomena.	Paralysis of the 3rd cranial nerve with ptosis, external strabismus and diplopia is very common in temporo-sphenoidal abscess. Paralysis of 4th or 6th nerves much less frequent. Optic neuritis present in about 25%, more frequent in cerebellar abscess. Pupils frequently unequal, dilated generally on affected side. Nystagmus present in cerebellar abscess.	Optic neuritis in about 30%. Photophobia almost constant; inequality of pupils common. Nystagmus of an indefinite character present in some cases.	Optic neuritis present in about 25% of cases.	Optic neuritis less frequent, common however when 6th cranial nerve is involved.
Course and Termination.	If acute there is usually a rapidly fatal termination. If chronic and encapsuled may exist without or with few symptoms for months or even years. Death usually from meningitis owing to abscess bursting into sub-dural space; or may burst into a ventricle and cause a rapidly fatal termination. In cerebellar abscess death results not unfrequently from failure of respiration. Coma may precede death by hours or days. Operation gives good chance of recovery.	May be rapidly fatal within a few days, with great prostration. In other cases the patient may survive two or three weeks. Coma generally precedes death. Operation generally futile.	Course not generally so rapid as in meningitis. Death most frequently from lung infarctions; it may terminate in meningitis, septicæmia, pyæmia with abscess formation in visceral organs or joints. Early operation may give excellent results.	If operated upon recovery is the rule. Death may result from an extension to the brain, meninges or venous channels.

If metastatic abscesses have already formed in the lungs, brain, or liver, the issue of the case is generally regarded as almost certainly fatal. We should not, however, withhold from a patient suffering from these complications the chance given by operation.

The following case, attended by the writer, shows that even such complications as pulmonary abscess and gangrene are not necessarily fatal. The case was that of a man, 30 years of age, who, after suffering from purulent otitis media on the right side for 15 years, became affected with pain in the corresponding ear and side of the head; frequent and most severe rigors, with temperatures of from 100° to 105° F.; constant vomiting for days, and, after three weeks, pain in the chest, rusty expectoration, and rapid breathing. A large quantity of cholesteatomata was removed by the writer from a cavity in the mastoid, extending to and laying bare the sinus, *which, however, appeared normal*. The pulmonary symptoms continuing, with pyæmic temperatures, Dr. J. H. Nicoll, eleven days afterwards, tied the internal jugular and opened the lateral sinus, from the jugular foramen to the torcular, removing disintegrating purulent thrombi. Distinct improvement soon followed, as shown by lower temperatures and much less violent fluctuations, although there was now *purulent expectoration*. In two months his condition resembled that of phthisis pulmonalis, the expectoration being extremely copious, and having a gangrenous odour, while there was great emaciation. He returned to his home in the country, and his doctor after a time reported considerably diminished expectoration, disappearance of gangrenous odour, but the existence of a large cavity in the lower part of the right lung. Three months afterwards the late Dr. Finlayson, of Glasgow, found no definite signs of cavity in the right lung, but only dulness at certain places with some moist râles, and also a want of due expansion on the right side in front. The patient reported that there was now scarcely any cough or expectoration. The most striking change was the notable increase of flesh. Instead of having the emaciated phthisical look, he was quite full in the face and plump in the body. He thought he had gained about two stones since the early part of his illness. A deep groove in the scalp (see Fig. 185), extending from the mastoid to the external occipital protuberance, remains, and the long gap in the bone seems to be converted into fairly dense fibrous tissue. A dry cavity in the mastoid represents excavated mastoid, tympanum, and meatus. The purulent process in the ear is entirely at an end. There is still some shortness of breath, although, on a flat surface, he is able to walk five miles without discomfort.

Tuberculosis. We have already referred to the probability of the tubercle bacillus in the middle ear or temporal bone being conveyed by the lymphatics to the pia mater and producing tubercular meningitis. It is possible that even general tuberculosis may have its infective source in the middle ear.

The late von Trötsch of Würzburg related in Virchow's *Archiv*, so far back as 1859, three cases of acute miliary tuberculosis occurring in persons who suffered from chronic purulent disease of the middle ear. At that time he suggested, before we were aware of the existence of the tubercle bacillus, that some cases of tubercular disease might be due to the absorption of inflammatory products formed in the ear. He asked the question, "Whether many cases of suddenly-beginning and rapidly-developing tuberculosis might not generally be due to an infection of the blood from a purulent collection in some part of the body?" It was also remarked by him, in tracing the history of patients who had had

otorrhœa, that many of them died young. In such he found that tubercular meningitis, or tuberculosis of the lungs or of the bowels, was generally the cause of death.

No doubt there have been many cases observed, in which tubercular meningitis or acute miliary tuberculosis occurred in persons who were suffering from, or

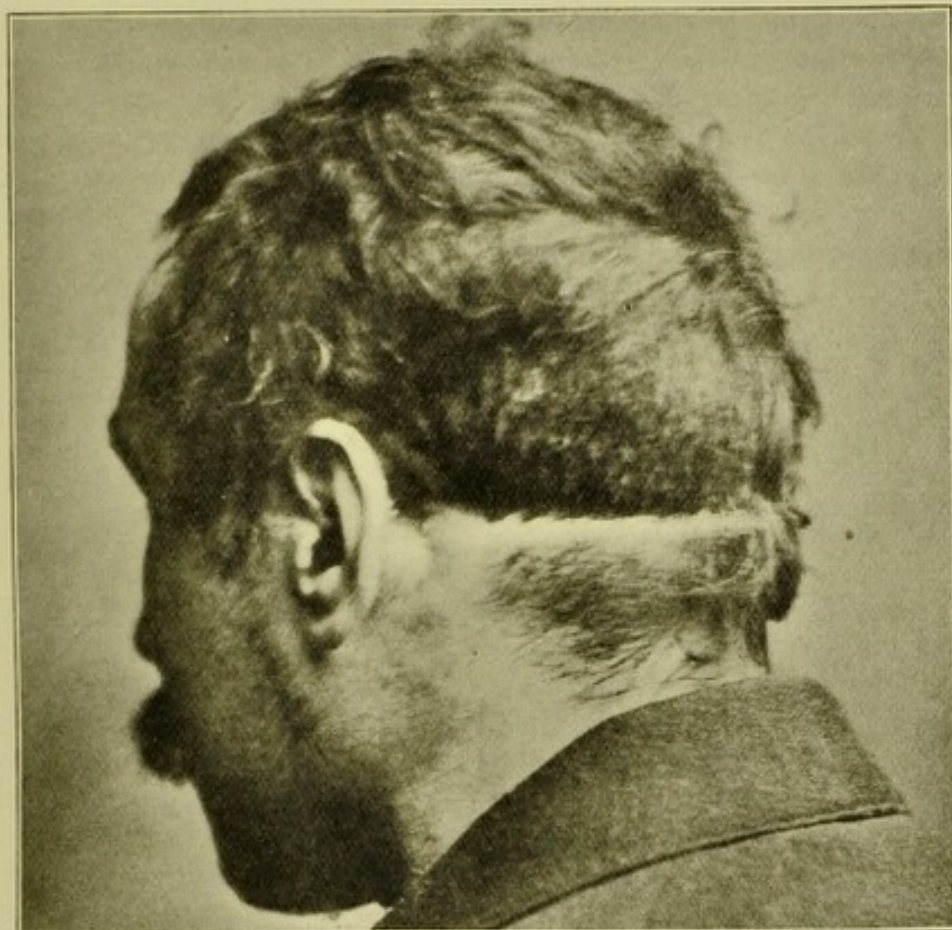


FIG. 185.—Photograph of patient's head, taken 4½ months after operation, showing depressed cutaneous scar over fibrous tissue occupying gap in skull left by removal of bone over lateral sinus. Behind the auricle there is a dry cavity remaining after the mastoid operation.

had been suffering from, purulent disease of the middle ear. In all such cases, however, it may be fairly urged that the existence of the disease in the ear is a mere coincidence, having no etiological relation to the tubercular disease. Or it may be reasonably maintained that the disease in the ear is a manifestation of the same constitutional tendency which produced the tubercular disease—that, in fact, instead of being the cause of the tubercular disease, the ear disease is the result of the tubercular tendency in the system.

Nevertheless, the presence or absence of caseous or tubercular collections in the middle ear should be made a point for investigation in the case of persons who have died from tuberculosis, and especially from tubercular meningitis.

Hæmorrhage from the Ear. Thirteen cases of fatal bleeding from the ear in connection with chronic purulent disease have been recorded (Hessler). These were all associated with carious disease, either of the osseous partition separating the mucous membrane of the middle ear from the internal carotid artery, or of that separating it from the sigmoid sinus. The carotid artery is the most frequent source of hæmorrhage, and the perforating ulcer in its walls is generally at the angle formed by the perpendicular and the horizontal parts in the carotid

canal. Ulceration of the sigmoid sinus or jugular bulb is much less frequently the cause of the bleeding. The blood escapes chiefly by the external meatus ; but it may also pass down the Eustachian tube and escape by the nostrils and mouth. It may also, when coming from the sinus, escape by a carious opening behind the auricle. The blood, in some of the cases, spouted out in a pulsating jet, causing death in a few minutes, and in others it oozed out for hours before the fatal termination. In some again there were repeated bleedings at intervals of from a few minutes to several hours, ending in fatal exhaustion. The introduction of astringents, or plugging the external canal, has little or no effect upon the bleeding. Continuous compression of the common carotid, when the hæmorrhage has its source in the internal carotid, should be tried ; and, if everything else fails, the propriety of ligaturing the common carotid should be seriously considered. Hitherto that operation has failed to save life.

CHAPTER XV.

TREATMENT OF INTRA-CRANIAL AND VASCULAR COMPLICATIONS OF PURULENT DISEASE OF THE MIDDLE EAR.

HISTORY OF THE OPERATIVE TREATMENT.

Operations for Temporo-Sphenoidal Abscess. To Arthur E. J. Barker of London belongs the credit of first removing a collection of pus from the temporo-sphenoidal lobe connected with purulent disease of the middle ear, *with the effect of saving the patient's life*, when no carious aperture or superficial swelling on the surface of the head guided him as to the seat of the abscess in the brain. This case was reported in the *British Medical Journal*, 11th December, 1886. The abscess was in the right temporo-sphenoidal lobe. Healthy brain tissue was penetrated to the depth of half an inch, when fetid gas and pus were evacuated. The trephine opening was made an inch and a quarter above and behind the external orifice of the ear.

Soon after this important success, which may be termed an epoch-making case, a series of successful cases was put on record, mainly in Great Britain. These appeared much in the following order: Caird of Edinburgh, reported by Greenfield in the *British Medical Journal*, 12th February, 1887, operated for abscess of the left temporo-sphenoidal lobe in a man twenty-six years of age. Sir William Macewen followed shortly afterwards, in the *Lancet* of 26th March, 1887, with a case of the writer. It was that of a boy ten and a half years of age, in whom there was an abscess in the right temporo-sphenoidal lobe. His condition as observed by the writer, thirteen years after operation, was the following:—He has all the signs of health, and can do a heavy day's work as a brassfounder. He says he never has a headache. Up till a year ago he was a devotee of football, frequently receiving the ball on his head. He has a good memory, and is mentally vigorous. There is still a slight pulsation at the seat of the trephine opening above and behind the auricle, but it is much less than it was a few years ago. On 10th March, 1888, David Ferrier of London published another case in the *British Medical Journal*, in which Sir Victor Horsley operated on abscess in the left temporo-sphenoidal lobe, in a man aged forty-seven. The next case fell to the lot of Macewen on 15th of May, 1888, and was briefly described by the writer at the Otological Congress in Brussels in 1888 (see *Quatrième Congrès International d'otologie*, p. 171). It was that of a man, aged twenty-one, from whose right temporo-sphenoidal lobe Macewen removed three ounces of fetid pus. Another case followed in the *British Medical Journal*, 20th April, 1889, operated upon at Liverpool by Jordan Lloyd, in which four ounces of fetid pus

were removed from the left temporo-sphenoidal lobe. E. von Bergmann, Berlin, reported in the *Deutsche Medicinische Wochenschrift*, 1888, No. 50, an otitic brain abscess successfully operated upon. Other two successes were recorded by Urban Pritchard in the *Archives of Otology*, No. 2, 1890. The first was that of a young man, aged twenty-three, in whom four trephine openings were made on the left side by Mr. William Rose, and a cerebral abscess drained. The second occurred in a young man, aged twenty-six, from whose left temporo-sphenoidal lobe Mr. Cheyne removed about half an ounce of fetid pus, followed by recovery. Since that time, there has been a brilliant ever-increasing record of life-saving work in this department.

Operations for Cerebellar Abscess. These pioneer operations opened out a great and fertile field for surgical work, and had the effect of stimulating further efforts in other directions. Within two years from Barker's operation it was demonstrated by Sir William Macewen that abscess in the cerebellum could also be localized and operated upon with success. This was reported by the writer in the *Archives of Otology*, No. 3, 1889. It occurred in a young man 17 years of age. Four ounces of pus were liberated from the left lobe of the cerebellum. Up to 1896, when Dr. Acland and Mr. Ballance published in the *St. Thomas's Hospital Reports* a paper on cerebellar abscess, containing a most full and exhaustive account of the literature of the subject, there had been published 10 cases of recovery after operation, and 16 cases of death after operation. Since that, however, there have been many cases reported, and while at first it was with some trepidation that surgeons operated upon cerebellar abscess, that fear has now disappeared with experience and with more accurate knowledge of the situations of these abscesses.

Operations on the Lateral Sinus. A further advance in the operative treatment of otitic intra-cranial suppurations took place, when the lateral sinus came within the sphere of surgery, with far-reaching results. Probably Mr. W. Arbuthnot Lane was the first to expose and open the lateral sinus, remove septic thrombi, and, at the same time, ligature the internal jugular vein, with success, on 18th August, 1888. The case was shown to the Clinical Society of London. A boy, subject to periodic attacks of suppuration in the ear, was seized with rigors and high temperatures. The sinus was found externally covered with pus, and, when slit open, septic thrombi were found and removed. The internal jugular vein was at the same time ligatured, and perfect recovery ensued. Soon after, namely, at the beginning of 1890, Mr. Charles A. Ballance operated upon four cases of pyæmic thrombi of the lateral sinus, in all of which he tied the jugular, resulting in two recoveries. These were published in the *Lancet*, 17th and 24th May, 1890. Since that time operations upon the sinus, with or without ligature of the internal jugular vein, have become very frequent, and have been the means of saving many lives.

The Scope of Operative Treatment. At the present stage in the history of the operative treatment of intra-cranial lesions due to ear disease, it may be said that we are able to reach and deal successfully in many instances with the following conditions:—(1) Purulent formations at the base of the skull, either (*a*) between the bone and the dura mater (external pachy-meningitis or extra-dural abscess), or (*b*) between the dura mater and the surface of the brain (internal pachy-meningitis or sub-dural abscess); (2) infective thrombosis of the lateral

sinus or internal jugular vein; (3) abscess in the cerebrum, especially in the temporo-sphenoidal lobe; (4) abscess in the cerebellum.

Preliminary Opening of the Middle Ear. In most of these conditions we are able to reach the disease conveniently from the cavities of the middle ear, in some we can deal with the abscess more satisfactorily through a trephine opening in the lateral wall of the skull, while in others we utilize both routes.

In *all* of the foregoing conditions it is very important, as a preliminary operation, to explore the cavities of the middle ear by means of the radical mastoid operation (see p. 115). With the cavities of the middle ear thus opened we ought to scrutinize with good light, aided by a reflecting mirror, the bony partition which separates the tympanum and antrum at their roof from the dura mater, as well as (and this is still more important) the bony partition at the sigmoid groove. The existence of a purulent track, exposed dura mater or sigmoid sinus, or of granulation tissue sprouting from these, will regulate the further procedure. The bony partitions of the roof and sigmoid groove, separating the middle ear from the temporo-sphenoidal lobe above and the sigmoid sinus behind, are the two great pathways by which the infective matter effects its fatal entrance to the interior of the cranium. Fortunately they are both readily accessible from the middle ear spaces; and, by the preliminary and essential operation of opening these spaces, we are able to remove the pus, cholesteatomatous matter, granulation tissue, cario-necrotic debris, and the pathogenic organisms from the attic, antrum and mastoid cells, and at least stop further septic infection.

The writer would emphasize the importance, where there is suspicion of intra-cranial mischief from ear disease, of careful examination of the tympanic wall of the labyrinth with the eye, assisted by the probe, so as to discover, if possible, whether the bone there is softened; likewise, when working in the antrum we should examine closely the posterior part of the labyrinth, especially the external semicircular canal, as well as the inner wall of the antrum, where the latter lies in front of the sigmoid groove. If in either, or all, of these directions carious erosions or septic products are found, the probability is that we have to deal with a lesion under the tentorium, involving the dura mater, or the anterior part of the lateral lobe of the cerebellum corresponding with the posterior surface of the *pars petrosa*. Cerebellar lesions are sometimes overlooked through inattention to this pathway of infection.

When *both* ears are affected there may be some difficulty in deciding upon which side of the head the intra-cranial disease is situated; usually the condition of the middle ear and the situation of the pain will guide us to a correct decision.

OPERATIONS FOR MENINGITIS.

PACHY-MENINGITIS EXTERNA, PACHY-MENINGITIS INTERNA, LEPTO-MENINGITIS,
SEROUS-MENINGITIS.

Pachy-meningitis Externa (Extra-dural Abscess). The sigmoid groove is the most common situation for extra-dural suppuration, and we should therefore first open the cranial cavity at this part by working backwards from the antrum with the chisel, gouge, or bur. This may sometimes take a considerable time owing to sclerosis of the bone, and, before reaching the groove, we may notice small portions of granulation tissue, springing from the dura mater and protruding through orifices in the bone, or pus, sometimes with bubbles of gas, may be seen to ooze out as we open the groove. The opening should be carefully and sufficiently enlarged with gouge and bone forceps (the dura mater or sinus wall being carefully separated from the bone by a narrow blunt spatula), the pus evacuated, and the granulation tissue carefully removed with a sharp spoon, when the dura mater and sinus are to be minutely examined. It is to be remembered that we may find, on exposing a large mastoid cavity and clearing out its contents, that the sinus and neighbouring dura mater are already exposed, forming the back wall of the mastoid cavity (see p. 326). In such a case recovery usually takes place by the effective treatment of the mastoid cavity without interference with the sinus; an incision made too deeply might, if the outer cortex of the mastoid were extensively destroyed by the disease, wound the sinus or dura mater. Above the roof of the middle ear, extra-dural suppuration is much less common than at the sinus. The bony partition has to be carefully removed here as at the sigmoid groove, and the dura mater should be pretty widely exposed so as to ensure the complete removal of all the pus and granulation tissue. This also permits thorough examination to ascertain if the dura bulges, is dark grey or pulsating, or if there be indications of intra-dural suppuration. In both situations the parts should be powdered with iodoform and boracic acid (1 in 3), and lightly packed with iodoform gauze. In either situation, although pus is found, we must keep in view that this may be only a part of the disease. Thus, at the sigmoid groove we may have, in addition to extra-dural suppuration, septic thrombosis of the sinus, or sub-dural or cerebellar abscess; while, above the roof of the middle ear, we may have sub-dural abscess, lepto-meningitis, or temporo-sphenoidal abscess. It is also to be noted that extra-dural suppuration may take place at the posterior surface of the petrous bone even as far as the tip (see p. 327); in this case the pus may be reached either through the labyrinthine cavities, in which such a collection has usually its origin, or by working inwards and

forwards from the sigmoid groove. In the tuberculous forms of the disease in infants and in osteo-myelitis the bone in contact with the dura mater may be extensively necrosed, and several operations may be required before the whole of the necrosed bone can be removed. Operations for the removal of extra-dural suppuration are extremely successful, if it be not complicated with a sinus or other intra-cranial affection.

Pachy-meningitis Interna (Sub-dural Suppuration). Where, at the tegmen of the middle ear, or close to the sinus, or at the posterior surface of the *pars petrosa*, we find, after exposing the dura mater, that the latter is dark and bulging or presents granulation tissue, careful inspection should be made, when a necrotic condition may be found with, perhaps, a sinus leading into the arachnoid cavity. Such a condition would call for the careful opening of the dura. In the event of a purulent collection with, perhaps, ulceration or erosion of the cortical surface of the brain, being found, cleansing and anti-septic treatment of the parts, with free drainage, would give the patient a chance.

Lepto-meningitis. In the presence of symptoms of diffused purulent lepto-meningitis the patient's prospects are grave in the extreme, under any form of treatment. Some successful results have been reported from opening the dura mater behind and above the external meatus, draining the sub-arachnoid space, irrigating with a solution of boracic acid and introducing a gauze strip to soak up secretion; in some instances the lateral ventricle has been tapped and drained. No doubt the purulent exudation in such cases is generally too diffused to be susceptible of anything like thorough removal. Yet it has been shown that localized purulent collections in lepto-meningitis may be removed, with the result of saving the patient's life. Körner is of opinion that only in cases of staphylococcic infection has there been recovery in such conditions. Lumbar puncture has been of no more than diagnostic value in lepto-meningitis.

Serous meningitis. The treatment of this form of meningitis is much more hopeful. As the result of incising the dura mater (after the radical mastoid operation) and allowing the escape of serous fluid (which exuded in such quantity as very soon to drench the dressings and the pillow), the writer has seen marked benefit, followed by ultimate recovery. Lumbar puncture is also of great value and may prove sufficient without opening the dura; 25 to 30 cubic centimètres of the clear fluid may be removed at a time and this may be repeated. While the fluid is escaping from the puncture needle a careful watch should be kept on the patient's pulse and appearance. If a large quantity of fluid is removed *too quickly* serious collapse or even fatal syncope may occur.

Symptoms suggestive of a mild form of meningitis, probably of the serous variety, not infrequently disappear after the radical mastoid operation, without opening the dura.

OPERATIONS FOR SEPTIC THROMBOSIS OF THE LATERAL SINUS OR INTERNAL JUGULAR VEIN, AND THEIR TRIBUTARIES.

If symptoms exist (see p. 330) pointing indubitably to septic sinus thrombosis, no time should be lost before freely exposing the sigmoid sinus, and dealing surgically with its contents. The present trend of surgical opinion is in favour of ligaturing the internal jugular vein in the neck before opening the sigmoid sinus or even before performing the radical mastoid operation, if this has not already been done. The question of ligaturing the internal jugular, and at what stage, will be presently considered.

Exposure and opening of the Sigmoid Sinus. The sigmoid sinus is to be exposed after the radical mastoid operation by working back from the posterior wall of the mastoid cavity, as in the search for an extra-dural abscess in that situation, until the anterior part of the knee of the sinus is exposed; if a perisinus abscess exists the pus will escape as soon as the sigmoid groove is opened. When the sinus is reached its further exposure is aided by the use of Jansen's forceps, after the sinus wall has been (as far as possible) separated from the bone by a blunt spatula. The exposed sinus should now be carefully examined. It may be grey and firm and apparently occupied by a septic thrombus, or dark and necrotic with pus oozing from the interior of the sinus; on the other hand it may be soft and elastic, having the dark blue normal colour and appearance; even in the latter case there may be serious disease within the sinus. In any case, in the presence of the typical symptoms of sinus thrombosis, complicating a purulent ear disease, the sinus should be opened with a sharp-pointed curved bistoury, first to the extent of 2 mm., and afterwards, if a thrombus is found, when little or no bleeding will take place, to the extent of an inch. If the current of blood still flows through the sinus, the stream of blood from the opening made by incising the wall may wash out a soft mural thrombus. To control the bleeding, the upper and lower ends of the exposed sinus are pressed upon by narrow firm gauze pads; by modifying the pressure it will be seen whether the bleeding is from above or below or both. A good plan also, in order to prevent bleeding when the sinus is opened, is to insert a thin piece of gauze between the bone, and the sinus at either end of the part to be excised; the prevention of bleeding greatly facilitates the examination of the interior of the sinus. If no thrombus is found, the lips of the cut sinus are pressed down with gauze upon the inner wall of the

sinus, so as to obliterate the blood channel; in such a case the thrombus is probably in the jugular bulb. No doubt the infection may sometimes be due to septic thrombosis of the smaller veins—tributaries of the lateral sinus or internal jugular vein.

Clearing out the Sinus. If the sigmoid sinus is occupied by an obstructive thrombus, occluding the channel entirely, especially if there are indications of purulent disintegration, it is considered safer practice, before attempting to clear it out with a curette (especially downwards towards the jugular bulb), to ligate the internal jugular vein, if that has not already been done. By doing so we, to a large extent, isolate

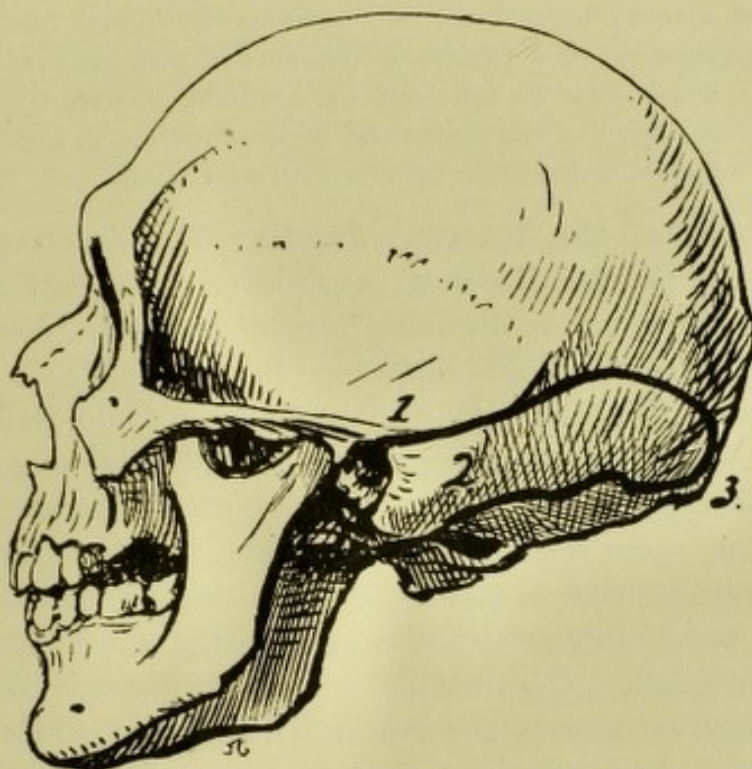


FIG. 186.—Shows area of bone removed in order to expose lateral sinus: (1) above auditory meatus; (2) over posterior border of mastoid; (3) opposite situation of torcular.

the infected region from the general circulation; otherwise there is great risk, while curetting, of dislodging the infective particles so that they are carried into the circulation. The vein having been ligatured, attempts should be made to curette (very carefully so as to avoid injuring the walls of the sinus), clearing away the thrombi as far down towards the jugular bulb as possible, and back towards the torcular till the blood stream appears, when we must pack the bleeding sinus carefully with gauze. It may be necessary, when there is very extensive thrombus formation, to remove the bone over the sinus as far back as the torcular or as far down as the jugular bulb (see Fig. 186, also case narrated at p. 338).

Some recommend that, before opening the sinus, the bone behind towards the torcular and below towards the bulb should be removed sufficiently to expose the sinus on either side, as far as to be clear of

the thrombus; the sinus would in this way be opened where it is likely to be healthy, and, after plugging with gauze, the operator would proceed to remove the diseased contents. It may not always be possible to carry this out on the bulbar side of the sinus, but it can almost always be done in the torcular direction. By this method it is claimed that we avoid infecting the healthy part of the sinus with gauze or instruments fouled by contact with the infected part of the sinus.

When there is an extra-dural abscess over the sinus, it may be considered justifiable to wait for 24 or 48 hours before ligaturing the internal jugular vein (if that has not already been done) and opening the sinus. As we have seen (see p. 327), the removal of a perisinus collection of pus, even when there have been repeated rigors, may be followed by complete recovery without further interference. The return of the rigors and high temperature, however, would be the signal for immediate operation on the vein and sinus.

The Ligation of the Internal Jugular Vein in the neck, as first proposed by Sir Victor Horsley, in addition to operating upon the sinus, so as to prevent or diminish further systemic infection, is now admitted to be of paramount importance in many of these cases.

In the hands of Sir Victor Horsley, Arbuthnot Lane, Ballance, Nicoll, and others, the operation of ligaturing the jugular vein, laying open the sinus, and clearing out the purulent thrombi, has often saved the patient even in some cases where secondary foci had formed in the lungs and elsewhere (see p. 338). Even when the thrombus seems to be solid and completely obstructive, presenting no clear evidence of purulent disintegration, the tendency among surgeons is to ligature the vein as a precaution against the possibility of systemic infection arising from subsequent disintegration; it is to be noted that an apparently sterile solid clot has in some instances been proved by subsequent bacteriological examination to be septic. Two ligatures are usually applied near to each other about the level of the cricoid cartilage, after which the vein may or may not be divided; in the event of there being a solid thrombus or evident disease in the vein, the ligature should be applied *below* the thrombus or diseased part, and the diseased vein may be resected as far as the upper angle of the skin incision, or, as some advocate, right up to the bulb. It is well, however, when possible to ligature above the facial vein, and if there are indications that the thrombosis is in the jugular bulb (now believed to be a very common situation), or in the upper part of the internal jugular, it is good practice to divide the vein between two ligatures and bring the upper end out and suture it to the edge of the skin wound. In this way the vein itself acts as a drainage tube for draining the jugular bulb and upper part of the vein (Ballance). Grunert recommends, in cases of bulbar thrombosis, the removal of the bone and

exposure of the sinus down to the jugular bulb, and, if necessary, the exposure and opening of the internal jugular vein in the neck. In short, he would in certain cases expose and freely open the diseased venous channel in its entire length even from the torcular to the clavicle.

Objections to Ligature. Some authorities are by no means in favour of ligaturing the vein in all cases. It has been pointed out by Sir William Macewen and others that, although the blood current is stopped at the place of ligature, infective matter may pass from the upper regions through the smaller veins, thereby reaching the lungs; besides the tying of the vein may, by the reverse flow which it provokes, even encourage the passing of infective matter downwards by other and more circuitous paths. Another objection advanced is, that if in the person operated upon the one vein is smaller than the other (and it is known that such a peculiarity sometimes exists), and if the larger vein be the ligated one, serious consequences to the brain may follow. Nevertheless Macewen believes that there are cases where the internal jugular is seriously involved, in which ligature is desirable, but that "in the majority of instances the obliteration of the upper two-thirds of the sigmoid sinus is all that is necessary for the prevention of systemic infection." The opinion now generally held is that the dangers of ligaturing are slight compared with the risks attending delay in isolating the infective disease higher up.

Ligaturing as the First Stage in the Operation. The practice hitherto generally adopted has been first to remove the focus of infection in the temporal bone by performing the radical mastoid operation, at the same time exposing the sinus at the sigmoid groove and dealing with it as already described, reserving the ligation of the internal jugular vein for further developments. More recently the practice, especially in America, has been, as just described, namely, to do the radical mastoid and expose the sinus, but, before freely opening the sinus and removing thrombi, to ligature the internal jugular vein in the neck. There is now, however, a growing feeling in favour of ligaturing the internal jugular as the *very first step* in the operation. Amongst other reasons for doing so is the belief that the concussions caused by working with the chisel and hammer upon the bone, in doing the radical mastoid and exposing the sinus, may tend to dislodge infective particles from the thrombus and send them into the circulation; the previous ligature of the vein would check their entrance into the general circulation. Alexander of Vienna has recently reported that in 32 cases operated on in this way 78 per cent. recovered; this compares very favourably with the results of operations in which the vein is not ligatured or ligatured later on.

The following are the stages of the operation for sinus thrombosis as practised by Alexander and the modern school:—(1) The ligature of the vein in the neck; (2) the performance of the radical mastoid operation if the ear disease be chronic, or antrectomy if the disease

be acute; (3) the full exposure of the sigmoid sinus; (4) the opening of the sinus and thoroughly clearing out all thrombi whether parietal or entirely obstructive, in doing so going down if necessary to the bulb or back to the torcular; (5) suturing the upper cut end of the vein to the edge of the skin wound in the neck, and introducing into the vein moistened strips of gauze, thus forming a natural drainage tube. This may be done when the vein is first tied or after the lapse of hours or days. In the event of the vein being involved low down in the neck resection of part of it may be necessary.

What is of vital importance is that there should be no delay in operating after we are satisfied that the symptoms, such as rigors and violent oscillations of temperature, point to systemic infection from sigmoid sinus or bulbar thrombosis. Every hour of delay increases the terrible danger of septic infarctions in the lungs or metastasis to the brain or other viscera. As Ballance observes, "the fate of most of these cases lies in the hands of the general practitioner."

OPERATIONS FOR TEMPORO-SPHENOIDAL ABSCESS.

In the presence of symptoms pointing to temporo-sphenoidal abscess (see p. 315), no time should be lost before we open into the abscess cavity; even the delay of a night may prove fatal.

Opening through the Roof of the Middle Ear. The majority of otologists and surgeons now advocate the opening of brain abscesses from the cavities made by the radical mastoid operation thus, in the words of Ballance, "following the stalk of the abscess." In this way we endeavour to open into the abscess where it is nearest and at the most dependent point, following also the pathway of infection, besides opening the meninges where adhesions may have already taken place—a great advantage as protecting the sub-dural space. The tegmen tympani and tegmen antri, with part of the squamous portion of the temporal bone are removed, after the radical mastoid operation, and as large an area of the dura exposed as is required. The latter may be normal in appearance, or it may be dark grey and bulging without pulsation; occasionally pus may be found over the dura (extra-dural abscess), if so it must be carefully removed. A fistulous orifice may be discovered leading to the sub-arachnoid space or brain. After careful cleansing of the dura mater and mastoid cavities with a 5 per cent. solution of carbolic acid, a small opening is carefully made with a knife and forceps in the centre of the exposed dura, and with the aid of a director this is lengthened in the line of the pia-matral vessels, which, if possible, must not be injured; the cerebral convolutions are now exposed to view, and we

may find the cortex dark in colour or showing evidence of sub-cortical pressure. If the abscess be large, a bulging of the brain into the trephine opening will probably be observed; occasionally pus is found under the dura mater (sub-dural suppuration). The exploratory cannula of Macewen, which has lateral apertures at the inner end, or Horsley's explorer may now be pushed into the brain with slight lateral movement, upwards and inwards. When the abscess cavity is tapped, to effect which one or two reintroductions of the cannula in various directions may be required, pus appears at the outer orifice of the cannula. Ballance and others, however, have given up the use of the cannula owing to its being so apt to become blocked by brain tissue, leading perhaps to the serious blunder of missing an abscess or pushing the instrument through one into healthy brain tissue beyond, or even into the lateral ventricle. They incise with a long, sharp-pointed, narrow-bladed bistoury, and introduce dressing forceps which, when opened, provide a space for the escape of the pus. A chronic and encapsuled abscess may readily be missed with the cannula, and sometimes even the bistoury fails to penetrate the capsule. Cases have been reported in which a thickly encapsuled abscess has been removed *en masse* without rupturing the limiting membrane. This is no doubt the ideal method of dealing with such an abscess, and when possible it should be tried. The possibility of there being two abscesses must not be forgotten—perhaps an acute abscess more superficial and an encapsuled one deeper.

The introduction of the little finger into the abscess cavity to explore its walls may be safely tried. An encephaloscope (similar to an aural speculum, but furnished with a plug) is sometimes used for assisting, with the aid of the reflecting mirror, in the inspection of the walls of the abscess, and likewise for facilitating the introduction of narrow strips of iodoform gauze, especially into an encapsuled abscess cavity. Frequently, in an acute abscess, shreds of sloughed brain tissue have to be drawn out with the help of dressing forceps, introduced close alongside the cannula, or after the incision with the bistoury, then opened so as to allow of the escape of the shreds between the blades, sometimes along with inspissated and cheesy material. The removal of these sloughs of necrotic brain tissue is of great importance, and in some cases, in order to ensure thorough removal as well as to secure good drainage, another opening, made with a trephine higher up, may be required.

Trephine opening above Meatus. If it be considered inadvisable to open the cranium from the roof of the middle ear, or if, after such an opening is made, an additional one is required for more thorough drainage, a trephine opening of half or three-quarters of

an inch in diameter is usually made above the external meatus in the lateral part of the skull (see Fig. 187). The incision in the soft parts, probably already made over the mastoid in performing the radical mastoid operation, is extended upwards two inches beyond the linea temporalis; the periosteum and soft parts are sufficiently

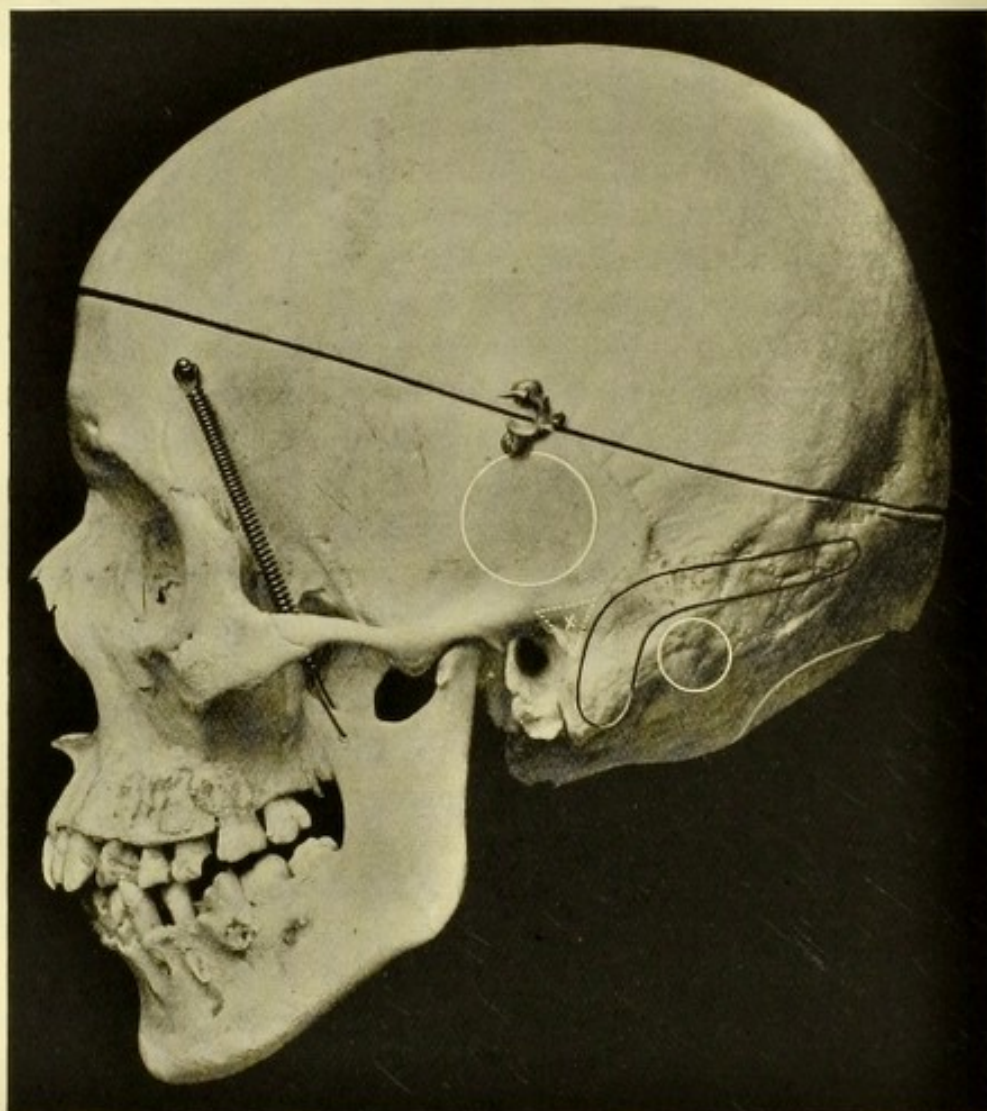


FIG. 187.—Situations of the trephine openings for temporo-sphenoidal and cerebellar abscesses; also the supra-meatal triangle and position of the horizontal and vertical parts of the lateral sinus (Barnhill and Wales).

raised from the bone and retracted. Some operators make a large semicircular flap reflected downwards. At a point three-quarters of an inch upwards, in the vertical line, from the junction of the roof and the posterior wall of the bony meatus, the central pin of the trephine is placed. This is a very thin part of the skull, and, as the inner surface is somewhat irregular, a searcher is required to see that the bone is penetrated equally all round and not so deeply as to endanger at any point the dura mater; a periosteal elevator is used to prize out the button of the bone, which should be preserved in warm boracic solution in case of its being wanted

for replacement. The opening may be enlarged in any direction, if necessary, by means of suitable bone forceps. The dura mater is to be opened as at the tegmen, but in order to guard the sub-arachnoid space from infection when the abscess is opened, it is recommended, after opening the dura mater, to wait 24 hours for adhesions to form, before tapping the abscess. Generally, however, the case is too urgent to admit of waiting.

Evacuation and Drainage of the Abscess. It is exceedingly important to evacuate the abscess thoroughly as, from the elasticity of the brain, the walls of the abscess (in the acute form) tend to collapse immediately, and in that way may shut off spaces occupied by pus. A wide india-rubber drainage tube may be required for a time till the pus formation ceases; or a decalcified chicken bone drainage tube (Macewen) may be inserted and stitched to the external soft parts, the outer end being flush with the skin. If there be an opening above the meatus as well as at the roof, a perforated indiarubber drainage tube should extend from the one opening to the other. No doubt drainage tubes are attended by a certain degree of risk, and some surgeons on that account employ iodoform gauze introduced through the channel leading to the abscess cavity; in the encapsuled form the cavity may be filled with a long strip of gauze introduced through an encephaloscope. Packing with gauze, however, is not to be recommended in an acute abscess, for it is apt to prevent the proper coalescence of the abscess walls. In acute cases, however, a narrow single strip of iodoform gauze, gradually shortened at each dressing, may be preferred to a drainage tube. The tube draining downwards should extend to a point outside the mastoid dressings, and there should be no perforations in the part of the tube outside the dura mater in order to avoid any communication between the brain cavity and the mastoid spaces. It may be advisable to syringe the cavity, very gently, with a sterilized normal saline solution, or a 1 per cent. solution of carbolic acid, the fluid being allowed to escape through a second drainage tube of *considerably larger lumen* than the first, or through the counter-opening. Syringing is much safer in the encapsuled abscess than in the acute form, in which it must be done with the greatest caution. The more thoroughly the shreds of slough and brain tissue with the purulent contents of the abscess are removed, and the cavity made aseptic at the time of the operation, the more rapid will be the course of recovery, and the wound, in that case, need not be disturbed for a week afterwards. The large quantity of gauze, however, placed externally for absorption of the discharge should be frequently changed, as it soon becomes saturated, and the external parts should be bathed with an antiseptic solution. If the clearing out of the

contents of the abscess has been insufficiently effected, and pus continues to form, frequent, it may be daily, dressings with careful cleansing are required. At each dressing the drainage tube or the gauze strips should be shortened. In regard to dressings, a powder, composed of 1 part of iodoform to 3 of boracic acid, is sprinkled over the opening. This is covered with a large quantity of gauze, over which sufficient gamgee is placed, a gauze bandage being then applied over all.

The immediate effect of the operation is usually striking. The improvement is at once manifest in the pulse, temperature and return of consciousness. The patient should be kept in bed for at least a month under the care and skilled observation of nurses, day and night, while attention to the nutrition of the patient is important. There is no doubt that in these cases the ultimate success depends greatly upon the carefulness and intelligence employed in the after-treatment. Every precaution should be taken against hernia cerebri by the exercise of care in the technique of the operation and by strict antisepsis afterwards. If a second abscess forms, as is shown by the return of the symptoms, a fresh opening must be made.

OPERATIONS FOR CEREBELLAR ABSCESS.

When we come to operate for cerebellar abscess, the sigmoid groove has usually been already opened for the examination and treatment of the sigmoid sinus and dura mater. It may be found that an aperture or fistulous opening already exists in the dura mater near the sigmoid sinus, communicating with and forming a guide to an abscess in the cerebellum. In this case, or if there is reason to believe that the abscess is deeply seated behind the posterior surface of the *pars petrosa*, the bone internal and anterior to the sigmoid groove should be removed, and the sinus may be reflected backwards to afford more room. In the event of the sigmoid sinus having been opened, in dealing with a concomitant sinus thrombosis, the cerebellum may be opened through the sinus wall. If the posterior route be decided upon, a horizontal incision down to the bone is made backwards from about the middle of the vertical one already made over the mastoid. The soft parts (consisting chiefly of a considerable mass of muscle) and periosteum are retracted, exposing the inferior occipital fossa, behind the vertical and below the horizontal parts of the lateral sinus, where the bone is comparatively thin (see Fig. 187). A trephine opening is made as in the case of a temporo-sphenoidal abscess; the centre pin of the trephine being placed about $1\frac{1}{2}$ inches behind the centre of the meatus and $\frac{1}{2}$ an inch below Reid's line; or the bone may be removed with forceps, chisel or bur by an extension backwards from the already existing bony

cavity in and behind the mastoid. The trephine opening may be enlarged with forceps, taking care to avoid the sinus. Many authorities claim that the anterior route is the best for tapping and draining a cerebellar abscess, and that only in a few instances is a trephine opening behind and below the sinus required in order to improve the drainage. In certain very urgent cases where the respiration is arrested or the patient very feeble or collapsed, it may be considered necessary to trephine at the inferior occipital fossa at once and leave the mastoid operation to a future time. In cerebellar abscess delay in operating is especially dangerous owing to the sudden failure of respiration which is so apt to take place. If, during the

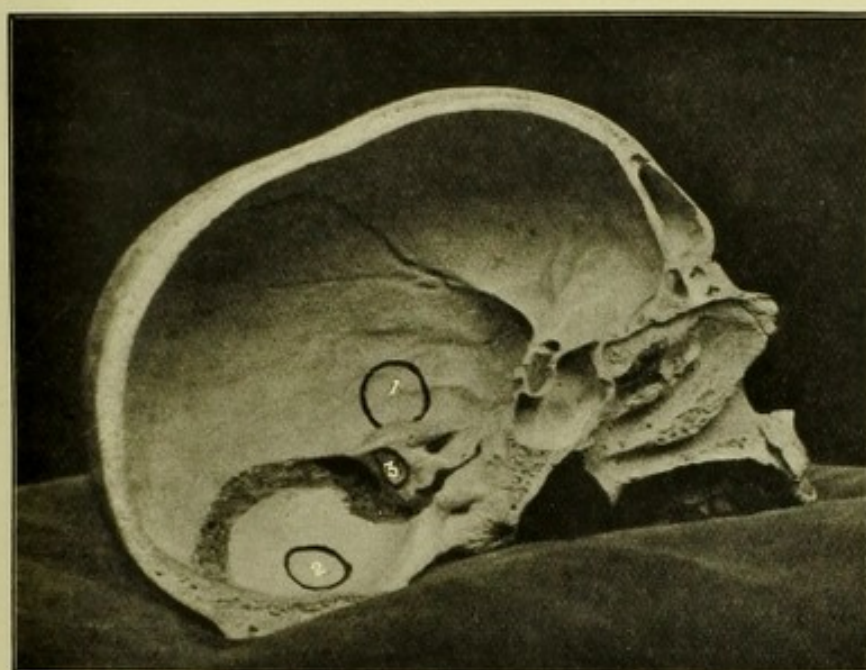


FIG. 188.—Section showing interior of skull to illustrate case of cerebellar abscess: (1) trephine opening made to explore temporo-sphenoidal lobe; (2) trephine opening through which the cerebellar abscess was first tapped; (3) second opening made through posterior wall of petrous bone to drain abscess more thoroughly.

operation, respiratory difficulty should present itself, the operation should not be interrupted but rather hastened. The simple opening of the dura mater may relieve the arrested breathing by diminishing the intra-cranial pressure. The *modus operandi* of opening the dura mater and tapping the abscess is similar to that in temporo-sphenoidal abscess; only in tapping a cerebellar abscess the trocar and cannula are to be preferred to the bistoury. Ballance uses a cannula furnished with a ring at its outer end to admit of its being stitched to the skin, and the trocar is allowed to remain and act as a drainage tube. The after-treatment is the same as in temporo-sphenoidal abscess.

The following case of the writer shows the necessity which may arise for making a second opening in front of the sigmoid groove when the trephine opening behind proves insufficient for drainage:—The temporo-sphenoidal lobe was first explored with the cannula through a trephine opening (Fig. 188, 1),

but no abscess was found in that situation. Dr. J. H. Nicoll, the operator, then opened the cerebellar fossa at the spot indicated (Fig. 188, 2) behind the vertical and below the horizontal part of the lateral sinus. The dura at once bulged, evidently under considerable pressure, and, on incising this, the cerebellar cortex also presented the marked bulging and pallor characteristic of pressure. The exploring cannula, on being inserted into the cerebellum, tapped an abscess cavity at a depth of about half an inch from the cortex, and from the abscess there drained a quantity of excessively fetid pus. A rubber-drainage tube was placed in the abscess cavity, extending two inches from the scalp, to which it was secured by suture. At the end of six weeks there still escaped at each dressing, from the drainage tube, a certain quantity of slightly fetid pus, and Dr. Nicoll again operated, making an aperture into the cerebellar fossa in front of the sigmoid sinus through the posterior surface of the petrous bone—this surface is bounded

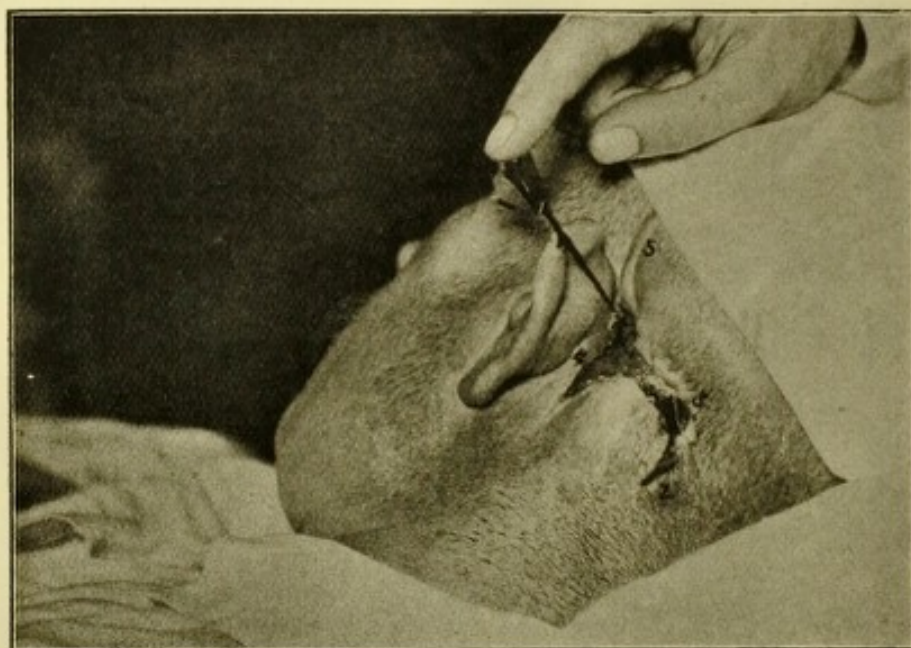


FIG. 189.—Shows case of cerebellar abscess after the second drainage opening was made: (1) rod introduced through anterior channel; (2) head of probe introduced into posterior drainage channel; (3) outer end of drainage tube; (4) anterior lip of mastoid opening; (5) scar of wound made in trephining over temporo-sphenoidal lobe.

by the sinus behind, the internal auditory meatus in front, and the tentorium cerebelli above (Fig. 188, 3). This was reached from a cavity previously made by the writer in the mastoid. The dura was incised and a cannula introduced through the cerebellar cortex into the abscess cavity. Through this channel the abscess was douched and drained as well as by the pre-existing drainage route (Fig. 189) established at the former operation, and at the end of five weeks the discharge had entirely ceased. The writer saw the patient two years after the operation. The scar over the trephine opening, just above the ear, was then soft and pulsated; the depressed cicatrix over the cerebellar opening was firm and free from pulsation. The interior of the ear was absolutely dry. The hearing was entirely gone, but bone-conduction existed. Originally a wood-cutter, he had adopted the avocation of packman, traversing large tracts of country in all weathers, walking sometimes 15 miles a day carrying a heavy burden.

Treatment of Mixed Intra-Cranial Conditions. It is to be remembered, however, that many cases are of a mixed character. We

often have abscess formation in the brain, along with lepto- or pachy-meningitis, or with septic thrombosis of the lateral sinus, or the whole of these conditions may exist at the one time in the same patient. If lepto-meningitis exist along with abscess in the brain tissue, the symptoms of the latter are masked by those of the former, and we are apt to conclude that we have to deal with a pure meningitis, and decide against operation. The experience of the writer, however, would incline him to the view that, although the symptoms may be those of lepto-meningitis, our duty is to expose the middle and

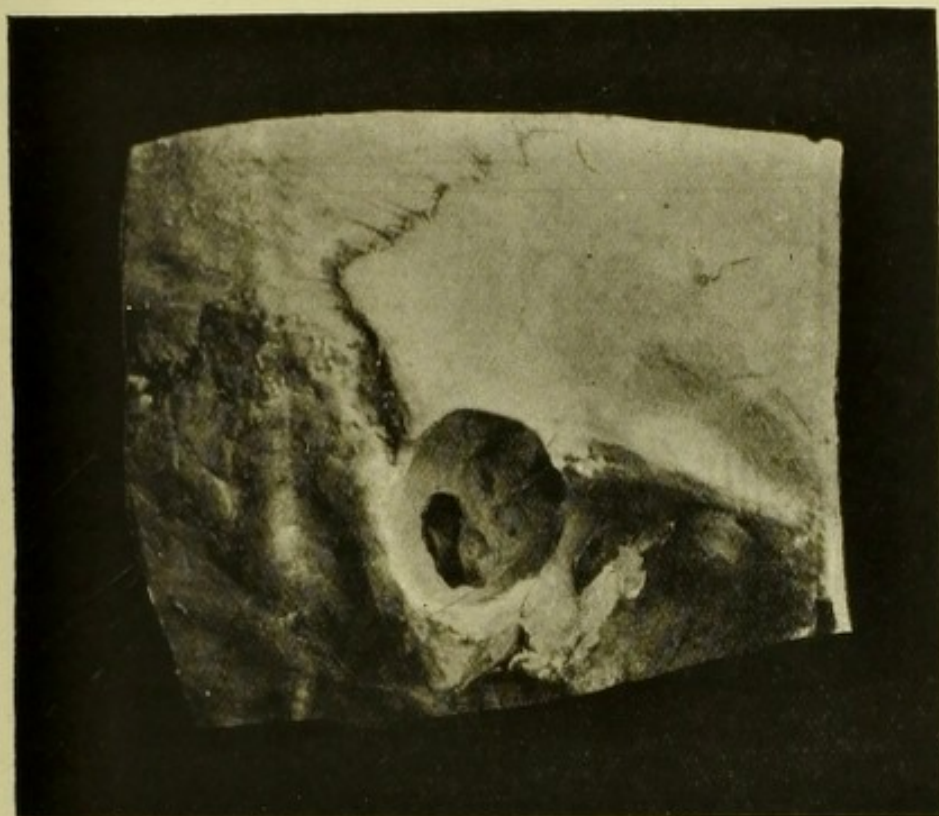


FIG. 190.—Temporal bone, showing large opening made with bur and dental engine, leading into antrum and attic, with two branch openings; the one behind exposed the sigmoid sinus, and the other, further in, exposed the dura mater over the roof of the antrum. Patient died from cerebral abscess and purulent meningitis.

posterior fossæ of the skull, and, in the words of Dr. J. H. Nicoll, "search for evidence of sub-cortical pressure (bulging of cortex, resistance on palpation, absence or diminution of cerebral pulse, etc.), or of cortical erosion or ulceration, or of old firm 'anchoring' of cortex to the internal aperture of a cario-necrotic or purulent osseous tract, or other such evidence as might reasonably lead to the suspicion of the presence of a sub-cortical collection of pus in addition to that present on the meningitic cerebral surface. Whether, in the event of the surgeon finding no such significant indications after exposing the cortex, exploration of the interior of the brain be advisable in presence of the surface meningitic purulent exudation, is a question which must be answered in any given case in the light of the patient's

condition, of the distribution of the surface exudation, and the other circumstances of the case and operation."

The writer attended a woman, twenty-eight years of age, who had suffered from a purulent disease of the right middle ear from early childhood. She was seized with symptoms of intra-cranial mischief. There were vomiting, intense pain all over the head, rigors on three occasions, persistently elevated temperature, quick pulse, delirium, unceasing movement, and entire absence of sleep. In fourteen days from the apparent commencement of the intra-cranial mischief

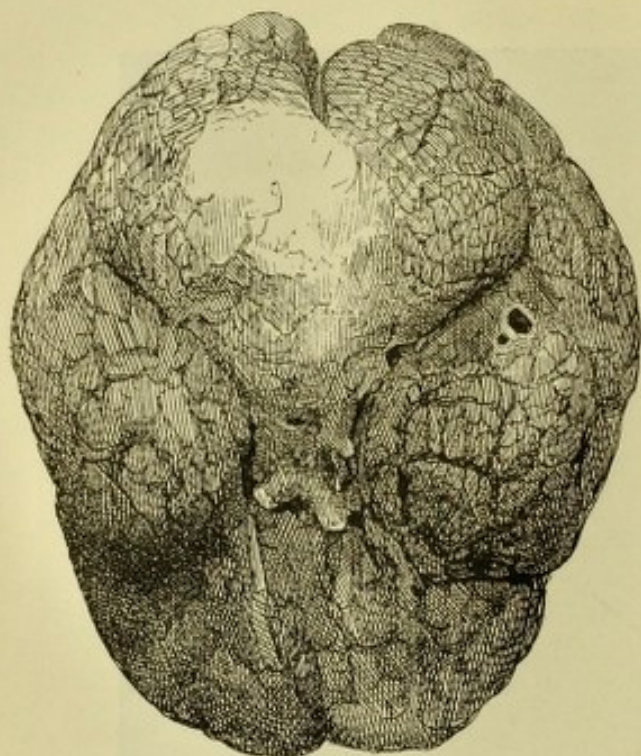


FIG. 191.—Base of brain from patient whose temporal bone is depicted in Fig. 190. Two perforations are seen in base of right temporo-sphenoidal lobe, through which pus escaped on to the base of the skull from an abscess in the interior of the lobe, which is also seen to be larger and broader than on the other side. A purulent deposit is also depicted on the cerebellar surface, due to the lepto-meningitis.

these symptoms terminated in death. Immediately after seeing her for the first time, the writer opened the cavities of the middle ear, and removed fetid purulent matter and inflammatory debris. He exposed the dura mater at the roof of the antrum and also the wall of the sigmoid sinus—these openings are seen in Fig. 190. There was no thrombosis of the sinus, and no pus between the dura mater and bone in either situation. As the symptoms did not seem to point to abscess in the brain, but rather to meningitis, he proceeded no further. On examining the interior of the skull after death, while extensive lepto-meningitis on both sides, with lymph and purulent deposit, was found, there was likewise an abscess in the temporo-sphenoidal lobe, the pus from which had partially made its way through two perforations in the base of the lobe into the middle and

posterior fossæ, and also into the spinal canal (Fig. 191). From the thickness of the pyogenic membrane lining the abscess, there was reason to believe that the abscess had existed for a considerable time before the onset of the symptoms of intra-cranial mischief, and the lepto-meningitis was evidently set up by the escape of pus into the sub-dural space. While the trephining of the skull would not have saved this patient at the time she came under observation, it would perhaps, from the surgical point of view, have been more satisfactory had the collection of the pus been exposed and drained as far as possible. It is even conceivable that, at a very early stage of the symptoms, the meningitis might have been checked and the patient's life saved by the thorough removal and drainage of the contents of the abscess.

The present trend of surgical opinion is that we shall rarely go wrong, in the presence of grave intra-cranial symptoms evidently

connected with a chronic septic process in the middle ear, if we explore the various pathways by which the disease invades the interior of the skull. If no extra-dural collection be found, or, when found, if its removal be not followed by marked improvement, we should open the dura mater and examine the sub-dural space; even then, if the results be negative, we need not hesitate to explore the temporo-sphenoidal lobe or cerebellum or both.

CHAPTER XVI.

MALIGNANT DISEASE OF THE MIDDLE EAR.

MALIGNANT disease of the ear is comparatively rare. Bürkner's statistics show that carcinoma of the ear occurs only in the proportion of 1 in 3000 of ear diseases, and Dr. J. G. Connal found among

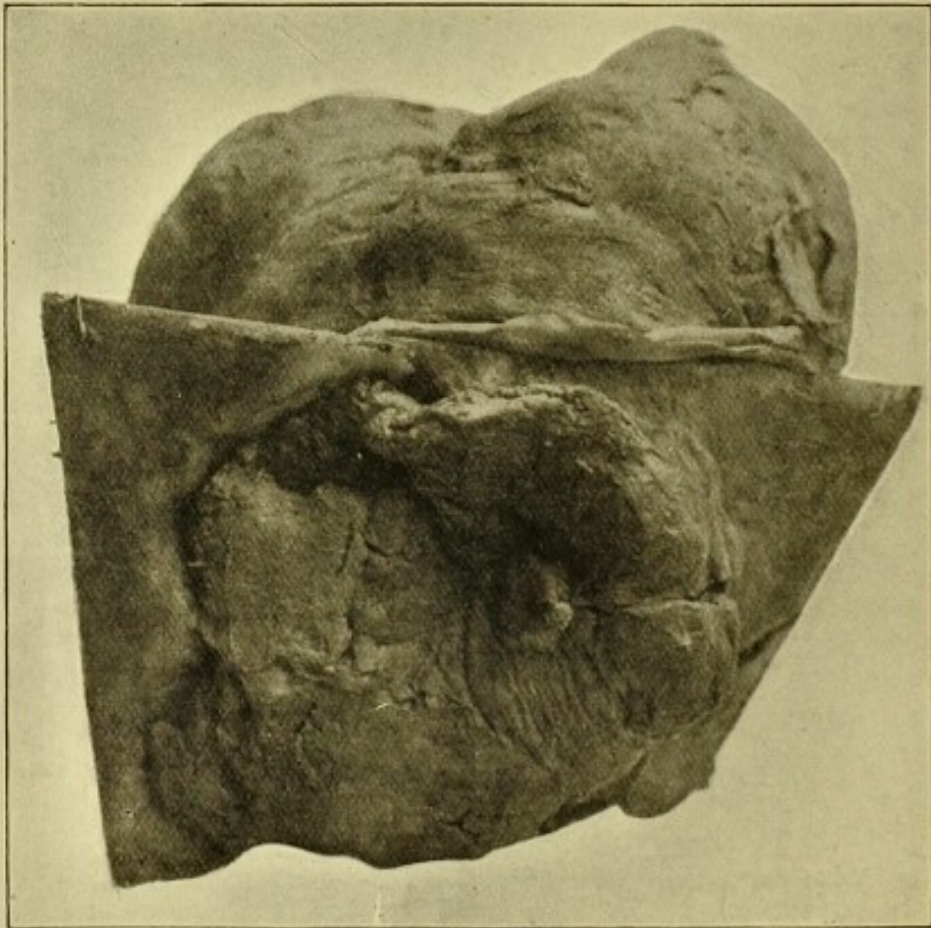


FIG. 192.—Outer aspect of tumour, showing the fungating extensions through the operation openings in the side of the skull.

15,000 patients attending the Glasgow Ear Hospital, the proportion to be 1 in 2500. No doubt a considerable number of cases of malignant disease of the ear begin as epithelioma of the external meatus (see page 212). It is certain, however, that cases, especially

in the form of sarcoma, sometimes originate in the middle ear and may at first be confounded with purulent disease, upon which it is probable they are sometimes based. Indeed it is possible that a simple inflammatory neoplasm in the middle ear may, in certain cases, develop subsequently into a sarcoma. In each of the cases of sarcoma which have come under the writer's notice, as well as in other recorded cases, there was purulent discharge with a polypus-looking excrescence,

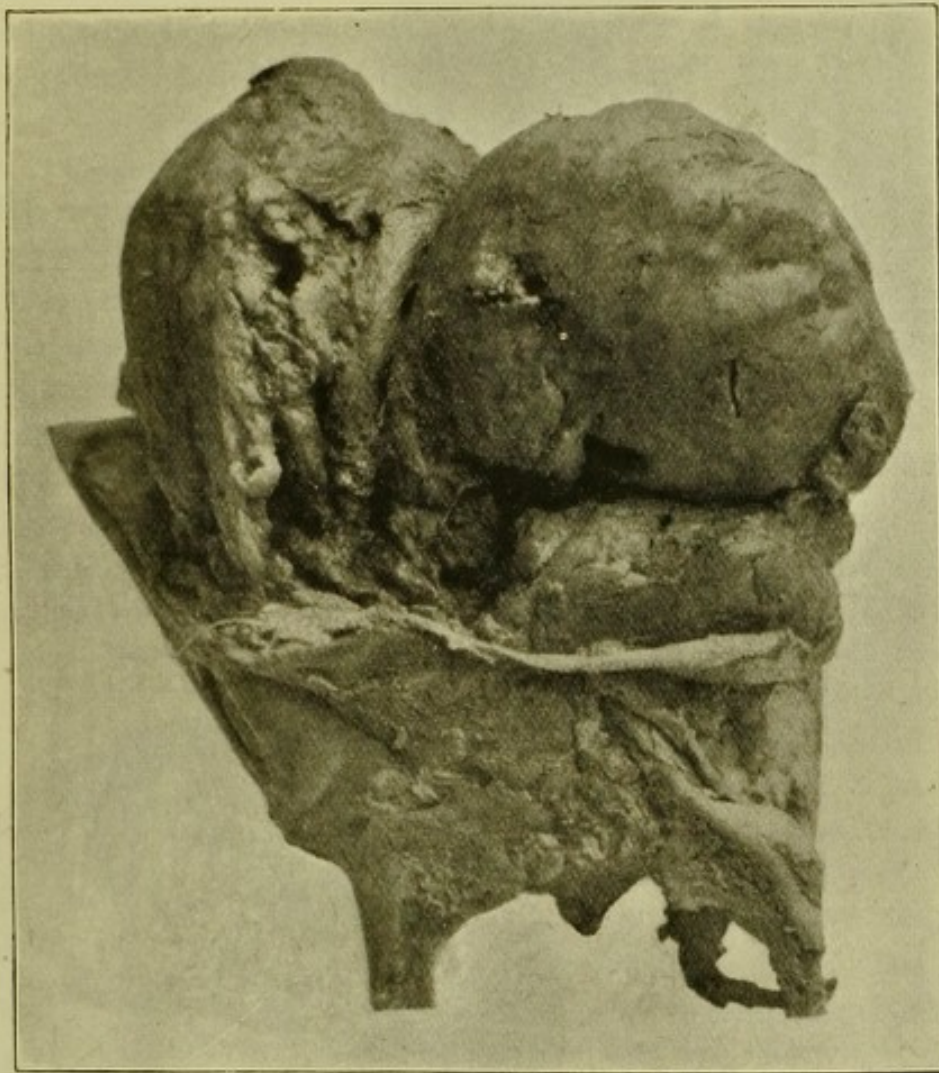


FIG. 193.--Inner aspect of tumour.

tough in texture, occupying the external meatus, having a tendency to bleed on contact and very prone to recur after removal. An important symptom in every case was intense and persistent pain. The growth leads to a fatal issue by extending into the cranial fossæ. The fact that sarcomatous disease occurs probably more frequently in youth, when also purulent middle ear disease is commonest, renders the two likely to be confounded in the early stage of sarcoma. In an interesting case which came under the care of the writer—the case of a boy 11 years of age—the symptoms were those of a purulent middle ear disease with a fibrous polypus occupying the meatus, which

bled readily and freely on manipulation. It was removed on several occasions, each removal being followed by rapid recurrence. The

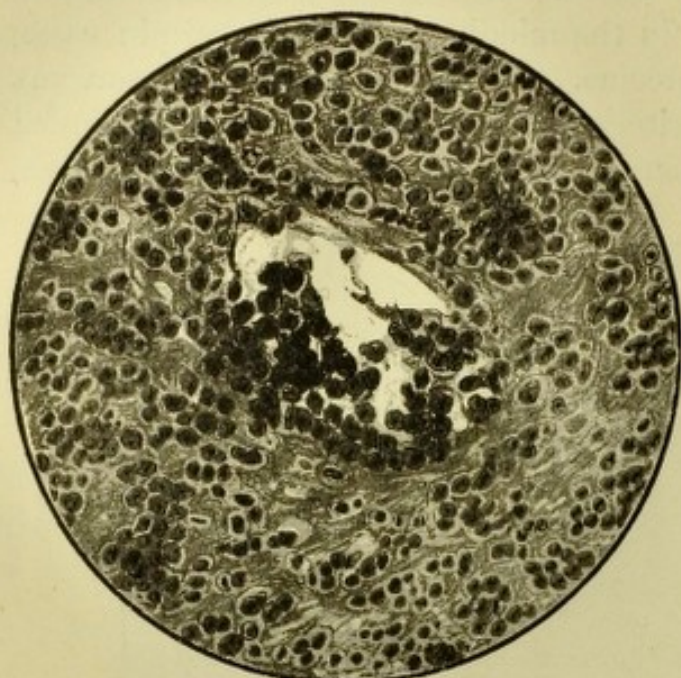


FIG. 194.—Microphotograph of section of tumour. $\times 150$.
(Dr. Leslie Buchanan.)

boy suffered great and continuous pain in the ear. There was, however, no glandular enlargement, no external swelling nor induration, and no ulceration. Symptoms ultimately showed themselves which bore a striking resemblance to temporo-sphenoidal abscess; all the classical symptoms of abscess being present. The skull was trephined by Dr. J. H. Nicoll with the expectation of meeting an abscess, but instead of pus there was found, under the cortex of the temporo-sphenoidal lobe, a large firm greyish mass of tissue readily distinguished by the sense of touch from the soft brain around. A large portion of the intra-cranial growth was removed, and it was found to spring from the petrous bone. The patient died about 3 months afterwards in a comatose condition. Fig. 192 depicts the outer aspect of the tumour, showing the fungating extensions through the operation openings in the side of the skull. In this direction the growth became very exuberant after the operation, so that portions had to be sliced off more than once. Fig. 193 shows the inner aspect of the tumour, which is here somewhat bifurcated. No

actual destruction of bone had taken place. From the middle ear, where it originated, it had extended in the form of the polypus-looking excrescences through the meatus, and, probably somewhat later, it

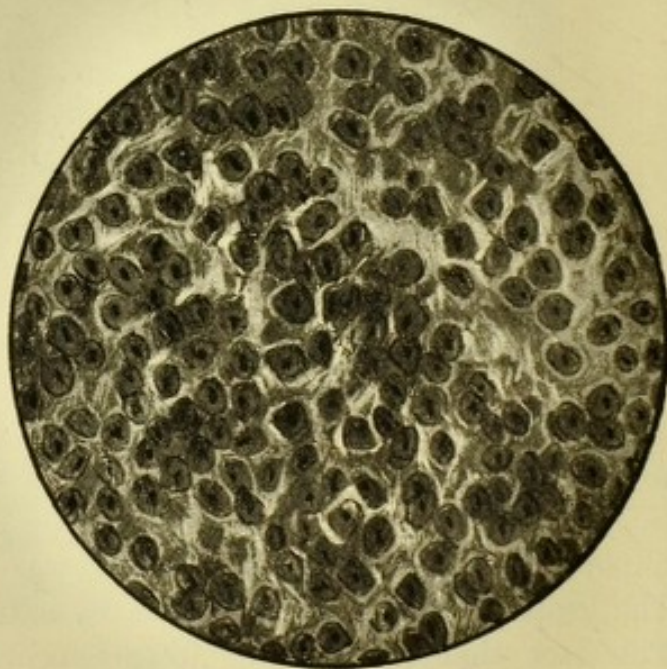


FIG. 195.—Microphotograph of section of tumour. $\times 300$.
(Dr. Leslie Buchanan.)

extended upwards through the roof of the middle ear to the middle cranial fossa, forming the large mass found at the operation. Figs. 194 and 195 show microphotographs of sections of the tumour. This case, which was interesting in other points (especially in the circumstance that failure of the respiration occurred during the operation, requiring artificial breathing for an hour—spontaneous breathing being only established on opening the skull and removing part of the growth), will be found fully recorded in the *British Medical Journal*, 16th October, 1897. It contrasts with another interesting one communicated by Dr. J. G. Connal to the International Otological Congress, held in London, August 1899. In this case, occurring in a girl 6 years of age, the sarcoma seems to have originated in the meatus, where a greyish-looking mass was found at the first examination. The tympanic membrane was also found to be destroyed and the bone forming the inner wall of the tympanum was denuded of periosteum. As contrasted with the other case there were marked external manifestations. The tissues in front of the ear (Fig. 196) and in the mastoid region became greatly swollen, firm, and matted; the glands at the angle of the jaw became much enlarged, with subsequent ulceration; and facial paralysis supervened. The severity of the pain and the recurrence of the growth when removed were also notable features here. The patient died 7 months after her first visit to the hospital and no post-mortem examination was permitted, but a section of the tumour taken during life presented the microscopic appearance of sarcoma.



FIG. 196.—Child suffering from sarcoma of right ear.

Symptoms of Sarcoma of Middle Ear. The presence of greyish-looking fibrous polypoid excrescences in the ear showing a tendency to bleed and to recur, with *severe and long-continued pain*, unrelieved by ordinary remedies, should excite suspicion and calls for immediate microscopic examination, even when there is no external swelling, thickening, glandular enlargement, nor facial paralysis.

The treatment should consist in the thorough removal of the growth from the cavities of the middle ear as early as possible by a radical mastoid operation, extending the operation into the cranial cavities if required.

For further information on malignant growths in the middle ear references may be made to the following :—A case of sarcoma of the middle ear, by G. L. Cheatle, *Brit. Med. Journal*, 22nd Octr. 1898. Two cases of angio-sarcoma and myxo-sarcoma of the middle ear, by Wm. Milligan, in the *Archives of Otology*, Vol. xxv., No. 3, 1896. A case of round-celled sarcoma, by Orne Green, in the *Archives of Otology*, Vol. xiv. Case of round-celled sarcoma, by Hartmann (in which the growth extended from the middle ear to the cranial cavity), in *Archives of Otology*, Vol. viii. A tumour described as fungus hæmatodes of the ear, described by Toynbee in his *Diseases of the Ear*, page 386. Gruber reports three cases of round-celled sarcoma in children in his *Diseases of the Ear*, English translation, 1893, p. 540. Haug, in *Archiv für Ohrenheilkunde*, Vol. xxx., reported a case of myxo-sarcoma of the tympanic cavity and mastoid process in a girl aged 18. Pomeroy reports in the *American Journal of Otology*, Vol. iii., p. 98, a case of intra-cranial myxo-sarcoma coming from the middle and posterior fossæ of the cranium through the tympanic cavity and external meatus. Politzer's treatise, English translation, 1894, should be consulted at pp. 543-545. See also clinical contribution to the "Study of Malignant Tumours of the Middle Ear," by A. F. Rasmussen and G. Schmiegelow, in *Archives of Otology*, Vol. xv.

CHAPTER XVII.

EXUDATIVE INFLAMMATIONS OF THE MIDDLE EAR WITHOUT PERFORATION.

THESE include (1) the painful exudations, with pronounced inflammatory changes in the tympanic membrane (*acute non-purulent inflammation of the middle ear*), and (2) the simple, painless exudations with but slight inflammatory changes in the tympanic membrane (*exudative catarrh of the middle ear*).

We shall first take up the painful and more pronounced inflammatory form.

ACUTE NON-PURULENT OR NON-PERFORATIVE INFLAMMATION OF THE MIDDLE EAR.

SYN.—ACUTE INFLAMMATION OF THE MIDDLE EAR—OTITIS MEDIA ACUTA (Politzer); ACUTE SIMPLE CATARRH (von Tröltsch); ACUTE CATARRHAL INFLAMMATION OF THE MIDDLE EAR (Roosa).

To describe this affection in detail would involve the recapitulation of much of the description of the *first stage* of purulent inflammation of the middle ear (the stage before perforation). The causation is very much the same as in purulent inflammation (see p. 246); so also the pathology, the subjective symptoms, and the objective symptoms are very much the same as in the first stage of purulent inflammation (see pp. 245, 248, 251).

Distinction from Purulent Inflammation. The chief distinction is that this form of inflammation does not go on as in the purulent variety to perforation and discharge; the virulence of the infective organisms is usually not such as to cause necrosis of the tissue of the middle ear. If rupture of the membrane takes place, with discharge of purulent or muco-purulent secretion, the case should then be regarded as one of purulent inflammation. While, if the painful symptoms and the inflammatory appearances of the membrane pass away without perforation or discharge, the case is regarded as one of

non-purulent inflammation. This distinction carries with it important consequences, and leads to a different prognosis.

The non-purulent form of inflammation, instead of terminating in perforation or discharge, usually subsides in from four days to a week. But a greater or less degree of deafness and a dull, heavy, feeling in the ear may continue, even in favourable cases, for three or four weeks. During this time crackling sounds are sometimes heard in the ear, especially while blowing the nose or swallowing, which are due to the separation of the walls of the Eustachian tube; these sounds are frequently attended by more or less improvement in the hearing. The deafness occasionally passes off completely with a loud crack, described by some patients as being like the report of a pistol; as a rule, however, the improvement of the hearing after such a sound is only temporary.

The Tympanic Membrane presents very much the appearance described as that in the first stage of purulent inflammation (see p. 251). After the acute inflammatory stage passes away, it assumes a yellowish-grey or sometimes a leaden colour, with, at certain points on its surface, a moist appearance. In the greater number of cases, however, the membrane recovers, in the course of three or four weeks, its normal aspect and polish. As long as any secretion remains in the tympanic cavity, we may find a number of small separate vessels radiating from the centre to the periphery of the membrane (Coloured Plate II., Fig. 3). A somewhat hyperæmic state of the membrane along the manubrium and in the vicinity of the short process is probably the last objective symptom to disappear.

Consequences. Acute non-perforative inflammation of the middle ear may lead to permanent swelling and thickening of the mucous membrane, with the inspissation of secretion. As the result of repeated attacks of the disease, or even of a single attack, there may be laid the basis of permanent changes in the tympanum and Eustachian tube, changes which will be considered under the heading of *non-exudative inflammation* (see p. 377). In this way deafness, increasing gradually over years, and attended by distressing tinnitus aurium, may have its origin in one or several attacks of this disease.

Prognosis of Acute Non-perforative Inflammation. While this form of otitis media does not so frequently lead to dangerous intra-cranial or vascular complications as the purulent variety with perforation, it is to be noted that such complications may and sometimes do occur and should therefore be kept in view. There is more risk of the disease leaving behind a damaged tympanum. Owing to its viscid character the secretion may not be readily absorbed without treatment, while, from the greater intensity of the inflammatory process, permanent changes in the mucous membrane are more to be feared than in the

simple exudative catarrh. We often find patients tracing their permanent deafness in after years to *earache in childhood*, no doubt in many cases the expression of non-perforative inflammation which had initiated permanent interstitial changes. The pathological meaning of these earaches is rarely understood by the physician, and, as a consequence, unseen and unsuspected processes are allowed to pursue their course undisturbed by treatment.

It may be truly affirmed that the cases are few in which improvement cannot be effected by appropriate treatment, while entire recovery is the rule. Only when treatment is imperfect or quite neglected, or where the affection occurs in certain unfavourable states of health, should serious and permanent consequences ensue. The inflammatory process may, in such circumstances, lead (1) to irremediable condensations, contractions, or adhesions in the middle ear; (2) to softening and perforation of the tympanic membrane, with all the possible consequences; or (3) to the development of grave labyrinthine changes.

The Treatment of Acute Non-perforative Inflammation is, in its *early* stage, the same as that of the first stage of purulent inflammation;—local abstraction of blood, antiseptics, warm applications, sedatives, etc. (see p. 269).

When the acute or painful symptoms have passed off, inflation of the middle ear is of great importance in improving the hearing and relieving the subjective sounds as well as the sensations of fulness and numbness in the ear. In the early stage of the inflammation, when the pain is very acute, inflation may aggravate the disease. When, however, the pain has become less severe, but the deafness more marked, owing to the exudation in the cavity of the tympanum, the use of Politzer's method of inflating the middle ear is generally very beneficial both in improving the hearing and in mitigating the unpleasant sensations. At first the pressure upon the air-bag should be moderate; but, as the acute inflammatory symptoms pass off, and if no pain is excited by the inflation, a greater amount of pressure may be employed. If the improvement in hearing continue for only a few hours after inflation, Politzer's method should be repeated every day for a few days, and then, when the improvement continues for a longer period, the interval should be extended to two days, and afterwards to three or four days, until complete recovery of the hearing is established. This in most cases will be achieved within four weeks, supposing no disease has previously existed in the ear.

Incision of the Tympanic Membrane is not, as a rule, to be recommended for this form of inflammation except in the late stages, when some exudation may persist in the tympanic cavity after all the acute symptoms have disappeared. In the earlier stage, incision should only be practised if a distinct bulging (see p. 251) presents itself

(Coloured Plate II., Fig. 4) along with extremely painful symptoms which do not abate under the treatment already described.

Here as in all middle ear affections the nasal and naso-pharyngeal spaces should be carefully examined and any abnormality treated. Repeated attacks of earache in childhood, due to this disease, often disappear after the operative removal of post-nasal adenoids.

For the treatment of the *secondary changes in the tympanic cavity* (see consequences, p. 366), the student is referred to the treatment of non-exudative inflammation at p. 389.

EXUDATIVE CATARRH OF THE MIDDLE EAR.

SYN.—SEROUS OR MUCO-SEROUS CATARRH OF THE MIDDLE EAR; CATARRH OF THE MIDDLE EAR (Politzer); OTITIS MEDIA CATARRHALIS; ACUTE TUBO-TYMPANIC CATARRH.

PATHOLOGY.

In this form of inflammation the hyperæmia and swelling of the mucous membrane are less severe and more superficial than in the previous form, while the secretion consists of mucus or serum, or both combined. The catarrhal condition is sometimes limited to the Eustachian tube, either simply at the pharyngeal opening or over the whole of the cartilaginous part, and there may be then, at least for a time, no exudate in the tympanic cavity. The tubal obstruction caused by the catarrhal swelling or secretion is apt to be followed by serous transudation into the cavity of the tympanum, owing to the suction upon the vessels of the mucous membrane caused by the rarefaction of the tympanic air (*hydrops ex vacuo*); even blood may exude from this cause. More frequently, however, the morbid process extends to the lining membrane of the tympanic cavity, with serous, mucous or muco-serous exudation. There is rarely spontaneous perforation of the tympanic membrane; and, if there is, the opening, after giving exit to some mucus or serum, soon heals up, seldom leaving a trace behind.

CAUSES OF EXUDATIVE CATARRH.

This affection is most frequently found in children, *when it is in most cases associated with adenoid vegetations in the naso-pharynx* (see p. 150). In adults it often originates in acute or chronic rhinitis. In some persons a slight form, perhaps confined to the pharyngeal opening of the Eustachian tube, occurs during almost every cold in the head. The exanthematous diseases, especially measles, are not unfrequent causes. It occasionally arises from syphilitic disease of the throat. It may be superadded to the non-exudative form of catarrh. (See chapter on the Causes of Ear Disease, p. 65.)

SUBJECTIVE SYMPTOMS.

In the slighter forms, when the catarrhal process is limited to the pharyngeal end of the Eustachian tube, the symptoms complained of by

the patient may be no more than a sense of fulness and pressure in the ear with impairment of hearing and tinnitus. There may be also a sense of crackling when blowing the nose. Autophonia is also common.

In more pronounced forms, when the process extends to the tympanic cavity, although the *defect of hearing* is much greater, the sense of *pressure* or *fulness* in the ear may be less marked. If both ears are affected, the deafness may be so considerable, that very loud speaking close to the ear is necessary. The hearing varies, however, in different cases as well as in the same person at different times. These fluctuations, which are often very sudden, may be due to changing conditions in the Eustachian tube, or to changes in the position of the exudation. The deafness is most marked when the exudation or swelling involves the ossicula and fenestral structures. The patient has sometimes a sensation of water dropping in the ear, and the hearing may vary with the position of the head. When the head is erect the hearing may be better, but when the head is bent forward or to the side it is much worse, probably owing to the exudation then covering the fenestral regions. The sudden opening of the tube from subsidence of the swelling of its mucous membrane or from the expulsion of a plug of mucus, is often attended by a crack in the ear, after which the hearing may be much improved for a time. The dulness, however, usually returns soon, accompanied by a sensation, which the patient sometimes compares to the shutting of a valve. A *sensation of numbness* over the side of the head and affected ear is often complained of.

The Perception by Bone-conduction is, in uncomplicated cases, markedly increased. If the catarrhal process be limited to one side, the vibrating tuning-fork applied to the median line of the head is heard with much greater intensity in the affected ear than in the normal one, indeed the patient often feels as if the sound were heard only on the deaf side. If the tuning-fork be heard better on the *normal* side, and if a distinctly catarrhal process exist in the other ear, there is probably a concomitant affection of the labyrinth. The patient sometimes complains very much of the sense of increased resonance of his own voice (autophonia), which has been compared to the sensation felt while speaking with the head in an empty cask (Politzer).

Subjective Sounds may be heard, but they are not usually constant or severe. Crackling sounds are most common, particularly on swallowing or blowing the nose, probably arising from the passage into the tympanum of air through the Eustachian tube, when its partially agglutinated walls become separated from one another.

Occasionally patients complain of *heaviness*, *confusion*, and *diminished power of mental work*, while *giddiness* may be experienced, especially if the onset has been sudden and severe. The writer has in certain cases seen all the phenomena of Ménière's disease associated with it. Children, on the other hand, who have exudative catarrh of the middle

ear, are not unfrequently observed to be dull, incapable of mental exertion (aproxexia), disinclined for play, capricious, and ill-humoured.

OBJECTIVE SYMPTOMS OF EXUDATIVE CATARRH.

The appearance of the tympanic membrane varies greatly.

The Indrawn Tympanic Membrane. In cases where the Eustachian tube has been for a time obstructed the position of the membrane is characteristically changed (Fig. 197, also Coloured Plate II., Fig. 1). By the rarefaction of the air in the tympanic

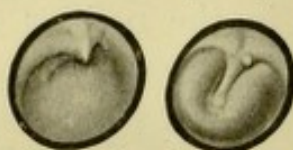


FIG. 197.

FIG. 198.

FIG. 197.—Indrawn tympanic membrane caused by obstruction of the Eustachian tube, showing short process of malleus with the indrawn manubrium below; the pointed short process of the malleus, the prominent and tense posterior fold and the foreshortened manubrium are seen.

FIG. 198.—The same tympanic membrane after inflation by Politzer's method.

cavity the pressure of the atmosphere on the outer surface of the membrane is no longer counterbalanced by an equal pressure on the inner surface, the result being that the membrane is forced *inwards*, and its outer concavity, especially at the centre, is markedly increased. This change is shown most clearly by the altered position of the manubrium, which is tilted inwards, upwards, and slightly backwards, and appears perspectively as if shortened. While the handle of the malleus is thus tilted inwards and upwards, the short process projects strongly towards the external meatus, frequently resembling a white pointed peg, and the folds passing from this are rendered more tense and prominent, especially the posterior fold, which may appear like a projecting ledge or ridge. If the inward bulging of the membrane be extreme, the lower half may present a convex appearance due to the membrane at that part lying in contact with the promontory, while the anterior rounded edge of the entrance to the fenestra rotunda may be seen behind and below. The cone of light is usually absent, but we often find a dark line, like a fine fold, extending parallel with, and a short distance from, the antero-inferior periphery of the membrane. The membrane frequently presents a violet or reddish tint, derived from the reflection of the hyperæmic lining of the tympanum. The long process of the incus or its junction with the stapes may be seen through the membrane, especially when the latter is thin and transparent at the postero-superior quadrant.

After Effective Inflation the indrawn membrane, if not bound down by adhesions, etc., undergoes a striking change (Fig. 198). The manubrium and the short process with the folds passing from it return partially or completely to their normal position, and the membrane may even bulge outwards on each side more than in the natural state, so that the manubrium lies in a furrow. The vessels of the manubrium become for the moment more injected, and the colour of the

membrane again becomes distinctly grey, while fine vessels are sometimes perceived radiating from the centre to the circumference, and the parts within the tympanic cavity, which may have been previously visible, now disappear from view. By auscultation during inflation a faint moist râle may be heard, at other times a pretty loud "thudding sound" is heard.

Fluid Exudation in the Cavity of the Tympanum. Along with this indrawn position of the membrane, or even without it, there may be signs of *fluid exudation* in the cavity of the tympanum. If the membrane be fairly transparent, and the exudation *serous* in character and only partially occupying the cavity of the tympanum, the exudate may sometimes be seen through the membrane.

A line, generally dark grey or even black, corresponding in position with the upper surface of the exudation (Fig. 199), is seen in favourable circumstances. This line may cross the membrane from side to side, and may be convex, concave, or wavy, or it may extend only over a portion of the membrane, such as from one side of the manubrium to the periphery. Below this line the membrane has usually a darker and sometimes a more yellowish colour than above, from the exudation behind it. This line may change its direction, when the patient's head is moved backwards or forwards, from the change in position of the thin exudation; while, after inflation, a number of small circles, with dark well-defined outlines, may be seen through the membrane (Fig. 200). These are air bubbles produced by the mixing of the air with the exudation, and they may be seen to move briskly during the inflation.

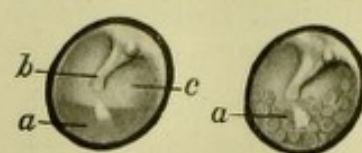


FIG. 199.

FIG. 200.

FIG. 199.—Exudation in cavity of tympanum, seen through transparent tympanic membrane. *a*, Exudation; *b*, lower end of manubrium; *c*, membrane in front of manubrium.

FIG. 200.—Air bubbles seen through tympanic membrane immediately after inflation in case of fluid exudation in cavity of tympanum. *a*, Air bubbles.

A well-marked Bulging in the upper and back part of the membrane sometimes indicates the presence of exudation. This bulging is most frequently yellowish-grey or greenish-yellow in colour, more rarely whitish. Probably in these cases the membrane at the bulging part has undergone a thinning process (atrophy or a cicatrix) so that it yields to the pressure of the secretion. The bulging is sometimes found to appear only after inflation, when yellowish secretion may be seen behind the atrophied and now bulging part of the membrane (Coloured Plate III., Fig. 15).

When there is no Bulging of the Membrane, but rather the contrary, which is generally the case, the signs of exudation are less distinct. If the membrane be not opaque and the exudation be straw coloured or yellowish, a more or less greenish-yellow glitter is seen, and the membrane may have a more *moist shining appearance* than in the normal state (Coloured Plate II., Fig. 1). After inflation the colour may become more yellow, and a bulging may be perceived at some particular part of the membrane, especially behind the umbo, giving at once the impression of a fluid collection.

Fluid Exudation with Unchanged Membrane. If, as is frequently the case, the membrane be not sufficiently transparent to admit of the contents of the tympanum being seen through it, the signs of fluid exudation in that cavity are much less reliable. When the membrane is not completely obscured, illumination with the sun's rays reflected from a mirror may help us to make out the presence or absence of exudation in the tympanum. If the membrane be completely opaque, simple inspection will not help us much. When, however, moist crackling is heard by auscultation during inflation, and when there is decided improvement of the hearing immediately after, there is great probability of the existence of exudation. The crucial test, however, if we are in doubt, is to incise the membrane (see page 109).

COURSE AND CONSEQUENCES OF EXUDATIVE CATARRH.

Duration. When the catarrh is due to an acute nasal catarrh, and limited to the pharyngeal mouth of the tube, the swelling and hypersecretion usually pass off under suitable treatment in from a few days to a few weeks, with complete restoration of the hearing. When, on the other hand, the disease is due to post-nasal adenoids, as is usually the case in children, or to chronic rhinitis or post-nasal catarrh in adults, it is apt to run a very much more protracted course, and improvement is liable to be interrupted by relapses. The affection may in these cases *go on for years*, especially in childhood, if the post-nasal growths are not attended to, becoming more aggravated during winter and spring, and improving again in warm dry weather. The character of the exudation has also an important influence on the course of the disease. When it is *thin and serous*, its absorption by nature, or its complete removal by operation, is more certain and rapid than when it consists of *viscid stringy mucus*.

Consequences. As the result of more virulent microbial infection from the naso-pharynx or irritating causes acting *via* the external meatus, the catarrhal process may assume a *purulent* character. It may, however, exist for years without producing more than swelling of the mucous membrane and fluid exudation, an ultimate cure resulting without any injurious after-effects. In other cases changes take place either during the stage of secretion, or more generally, after this stage has passed off. The long-continued indrawn condition of the membrane, due to the Eustachian obstruction, may lead to important and permanent consequences.

Atrophy of the Tympanic Membrane. The abnormally increased tension may lead in time to thinning or *atrophy*, involving a part or even the whole of the membrane. The atrophied part, from being abnormally thin and flaccid, is depressed below the healthy membrane; the upper and back part is most frequently found to have undergone atrophy. The interior of the tympanum, opposite the atrophied part, is sometimes seen as distinctly as if nothing intervened

(Fig. 201). During inflation or when we employ suction with Siegle's speculum, the atrophied part bulges out, sometimes like a small bladder (Fig. 202, Coloured Plate III., Fig. 15), but the bulging soon disappears. Even after the Eustachian tube has again become freely permeable the atrophy remains, and while inflation of the middle ear, by Politzer's method or Valsalva's experiment, causes it to bulge out, and temporarily improves the hearing, it is found that in a short time the atrophied part returns to its collapsed position, and the improvement in the hearing at the same time passes away. When there is a very permeable Eustachian tube we may find the atrophied portion *moving with inspiration and expiration*. A limited atrophy, however, is quite compatible with good hearing.

Adhesions, Thickenings and Condensations. The long-continued indrawn position of the membrane may also lead to its permanent adhesion to the promontory or to the articulation of the incus and stapes, or to permanent retraction of the tendon of the tensor tympani muscle. In some persons the persistent hyperæmia and swelling lead in time to gradual thickening and condensation of the mucous membrane of the tympanum and Eustachian tube, while the exudation may become gradually inspissated and organized, and adhesions, false bands, etc., form between various parts of the tympanum and between the walls of the Eustachian tube—changes which will be described under the heading of interstitial inflammation. Why in some persons the interstitial exudation in the mucous membrane becomes absorbed, while in others it goes on to the new-formation of connective tissue, is not easily understood.

DIAGNOSIS AND PROGNOSIS.

We recognize this affection chiefly by the appearance of the tympanic membrane and *by the effects of inflation*. If we are in doubt, incision of the membrane with subsequent inflation will demonstrate the presence or absence of fluid exudation in the tympanic cavity. The prospects of complete recovery of the hearing are in most cases very favourable, if the hearing has been normal before the attack. The prognosis is less favourable; (1) when, in the case of a child, the removal of adenoids, followed by inflation, produces no marked or permanent improvement in the hearing; (2) when, in the case of an

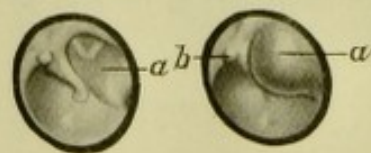


FIG. 201.

FIG. 202.

FIG. 201.—Left tympanic membrane in which there is atrophy, including the postero-superior part; through the transparent atrophied portion is seen, above, the articulation of the incus and stapes; below, the rounded border of the entrance to the fenestra rotunda. The atrophied part lies in contact with these. *a*, Centre of atrophied part of membrane.

FIG. 202.—The same membrane immediately after inflation by Politzer's method, showing the bladder-like bulging of the atrophied portion. *a*, Centre of atrophied part; *b*, short process of malleus.

adult, inflation of the middle ear, or incision of the membrane with evacuation of the secretion, effects little or no improvement in the hearing; (3) when, in the case of an adult, there is a marked tendency to nasal catarrh, especially if his surroundings and habits be unfavourable, or if he be tubercular or syphilitic.

For other prognostic considerations, see Prognosis of Non-exudative Inflammation of the Middle Ear at p. 387.

TREATMENT OF EXUDATIVE CATARRH OF THE MIDDLE EAR.

Our main objects should be, first, to treat the naso-pharynx, especially by the operative removal of post-nasal adenoids in children (see p. 168), and by appropriate treatment of acute or chronic rhinitis, nasal polypi, septal deformities, and accessory sinus disease in adults (see p. 153). While, without further treatment, the removal of post-nasal adenoids is followed by restoration of normal hearing in a goodly number of cases, it is often necessary for the patient to undergo a short course of inflation by Politzer's method (see p. 17, and p. 76).

Inflation especially by Politzer's method is of great importance. If the patient cannot come sufficiently often to the surgeon, the treatment by inflation may be entrusted to the patient or to the parent at home, with very careful and sufficient instructions. In adults, in order to overcome the resistance offered by plugs of mucus in the Eustachian tube or by the swelling of its walls, two or three compressions of the air-bag may be necessary, before we are able effectually to inflate the tympanum. We must, however, be very cautious if there is an atrophic membrane. A crack is sometimes heard by the patient, when the inflation is successful. Immediately after inflation, the patient usually feels marked relief—not only is there decided improvement in the hearing, but there is a sense of clearness in the head and relief to the fulness in the ear. The improvement in hearing is *sometimes very striking*, so that the patient, who previously could hear loud conversation only when spoken close to the ear, now hears the whispered voice several yards off, or the hearing distance of a watch may be increased from two inches to twenty or thirty inches.

The Duration of the Improvement in Hearing is a guide to the frequency with which we should employ inflation. If the improvement lasts for only a few hours, it should be performed daily for several days. As the duration of the improvement extends, the intervals may be increased to two, three, four days, etc., until, as shown by the normal hearing, the swelling has subsided, and the secretion become absorbed.

The use of the Catheter (see p. 76) is not called for in the great majority of cases, which is fortunate, as the affection so frequently occurs in children, while in

adults there is frequently a condition of acute rhinitis which would probably be aggravated by the passage of the catheter. As a matter of experience, it is found that in this affection Politzer's method generally produces even a greater amount of improvement in the hearing than inflation by the catheter. In some rare cases the catheter may be necessary, but even in these cases one or two applications will suffice to prepare the tubes for effective inflation by Politzer's method.

When the exudation in the middle ear is very thin and serous, a quantity of it may flow into the pharynx immediately after Politzer's air-douche has been applied, especially if during the inflation the patient's head is inclined forwards, downwards, and towards the opposite side.

Incision of the Tympanic Membrane. In a large number of cases inflation of the middle ear, *in conjunction with proper treatment of the naso-pharynx and nasal passages* (see p. 153), will suffice to bring about complete recovery of the organ. In a certain proportion of cases, however, in consequence of the secretion being too abundant or too viscid, it is necessary to make an *opening in the tympanic membrane* in order to ensure the complete removal of the exudation.

For a description of the details of the operation of paracentesis of the tympanic membrane the reader is referred to page 109. We cannot better describe the indications for the operation in this affection than in the words of Politzer. He says, "I perform paracentesis of the tympanic membrane in those cases where, after the use of the other described methods of treatment for several days, no diminution of the exudation is observed, and where, even when exudation is not proved, the immediate improvement of hearing, which constantly follows the inflation of the tympanum, disappears in great part on the following day or on the second day thereafter. I also frequently perform the operation when, on the first examination, the collected mucus is found to be copious, for, although here a cure may be obtained through inflation alone, the treatment is protracted through several weeks, while by paracentesis a complete recovery is often effected in a few days."

In a large number of cases a single operation will suffice. In all cases Politzer's method of inflating the middle ear must be employed at proper intervals after the operation. It may be necessary to continue the inflation for 2 or 3 weeks. After the mechanical irritation caused by the presence of the exudation has been removed, the secreting process usually stops. It is, on the other hand, occasionally necessary, if, after the wound heals, the exudative process still goes on, to make a fresh opening in a week or so; and this may even in rare cases require to be repeated two or three times.

If the preceding treatment does not bring about restoration or marked improvement of the hearing, we have to deal with one or other of the following conditions: (1) a persistently swollen state of the mucous membrane of the Eustachian tube and tympanum; (2) a permanent state of atrophy or flaccidity

of the membrane from the long-continued increase of tension ; (3) thickening, condensation, and rigidity of the mucous membrane, especially of that covering the articulations of the ossicula and the fenestral structures, or (4) implication of the labyrinth. For the treatment of the first three the student is referred to the treatment of non-exudative catarrh at p. 389, and for the fourth to the treatment of labyrinthine affections at p. 422.

Nasal and Pharyngeal Treatment is of great importance, and has been already emphasized. In most cases there will be found some pathological condition of the nasal or naso-pharyngeal space, such as adenoid vegetations, acute or chronic rhinitis, septal deformities, or accessory sinus disease. It may be said that, with the discovery of post-nasal adenoid growths and their operative treatment, the prospect of effecting a complete cure in this class of affections has attained a degree of certainty seldom reached in any other region of the body.

General remedies should be employed if the patient be tubercular, anæmic, or syphilitic (see Formulæ for General Remedies). There is no doubt that attention to the general health is a most important adjunct. For the hygienic treatment the student is referred to p. 97.

CHAPTER XVIII.

NON-EXUDATIVE INFLAMMATION OF THE MIDDLE EAR AND OTOSCLEROSIS.

THESE include (1) conditions in which the pathological appearances and symptoms point to a chronic inflammatory process (*non-exudative or interstitial inflammation of the middle ear*) and (2) where there is an osseous change involving mainly the foot-piece of the stapes, the annular ligament and the bony capsule of the labyrinth (*otosclerosis*).

I. NON-EXUDATIVE OR INTERSTITIAL INFLAMMATION OF THE MIDDLE EAR.

SYN.—CHRONIC DRY CATARRH; ADHESIVE PROCESSES IN THE MIDDLE EAR (Politzer); PROLIFEROUS INFLAMMATION OF THE MIDDLE EAR (Roosa); CHRONIC CATARRHAL OTITIS MEDIA.

The pathological conditions included under this designation constitute a large proportion of cases of deafness. In frequency this disease probably comes next to purulent inflammation of the middle ear. Out of 1088 cases of ear disease recorded by the writer, 291, or about 27 per cent., were classified under this heading. Generally both ears are affected, although one is usually worse than the other.

PATHOLOGY.

The pathological changes found in the middle ear frequently arise out of non-perforative inflammation, or exudative catarrh. After simple hyperæmic swelling the mucous membrane becomes thickened, owing to new-formation of connective tissue in its interstices, and in many cases becomes the seat of chalky or fatty deposition. The thickened and condensed mucous membrane usually in course of time undergoes a shrinking process. The secretion may also become inspissated and organized, agglutinating the ossicula, and hindering their movement. Adhesions, connecting bands, and pseudo-membranes form, so that parts which are usually separate come to be in contact, and after a time unite. In this way the tympanic membrane may form adhesions with the inner wall of the tympanum

or with the incus or stapes; or the crura of the stapes may become firmly adherent to the walls of its recess. The ligaments connecting the ossicles with the walls of the tympanum may, on account of the change in the mucous membrane covering them, become contracted and rigid, and in this way these small bones may be bound down and fixed. The tendons of the tensor tympani and stapedius muscles may also be contracted from the same causes. Further, there are frequently found bands or filaments of connective tissue, connecting and binding various parts of the tympanic walls and contents—thus the tympanic membrane may be connected with the inner wall of the tympanum, and the ossicles with the walls of the tympanum or with one another. The cartilages and capsules of the joints between the ossicles become in many cases stiffened, rigid, and adherent. The malleo-incudal joint and the connection between the edge of the foot-piece of the stirrup-bone and the annular ligament are apt to share in this stiffening process.

Effects of these Processes upon the Tympanum. We may have in these various ways:—(1) The free space of the tympanum much diminished or even obliterated; (2) the tympanic cavity divided into compartments separated from each other by adhesions or connecting bands; (3) the whole chain of bones or individual bones fixed or bound to the walls of the tympanum, or firmly ankylosed to one another, or stiffened by the thickened mucous membrane covering them; (4) the stapes adhering or bound to the walls of its recess, or united immovably to the edge of the fenestra ovalis; (5) the membrane closing the fenestra rotunda, and the annular band of the fenestra ovalis thickened, stiffened, or perhaps calcified; (6) the tympanic membrane thickened. *As the result of these pathological changes the conduction of sound through the tympanum to the labyrinth is more or less seriously impeded.* The whole extent of the mucous membrane lining the walls and contents of the tympanum may be involved, or the morbid process may be limited to one part. The function of the tympanum is most seriously injured, when the ossicular chain, the annular ligament of the fenestra ovalis or the membrane of the fenestra rotunda is the seat of the pathological changes.

The Ventilating Function of the Eustachian Tube is in many cases impaired by thickenings of its mucous membrane, or by adhesions or connecting bands which prevent due separation of the walls of the tube during the act of swallowing, etc. Or the defective opening of the tube may be caused by imperfect action of the two tube muscles—the abductor tubæ and the levator palati—which may have undergone fatty degeneration, or become atrophied or paralyzed. In either case the defective ventilation of the tympanum leads to the indrawn tympanic membrane with its consequences.

Disease of the Labyrinth may become associated with any of these pathological conditions. Originating as it may do in the labyrinthine fenestræ, the labyrinth may be partially involved from the beginning.

The condition of the **mastoid cells** is not very well understood; but these spaces are said to be frequently encroached upon by thickening of their lining membrane or of their osseous walls.

CAUSES OF NON-EXUDATIVE INFLAMMATION.

While we found that exudative catarrh is met with most frequently in youth or childhood, this condition is *most common in adult age*. It is found in persons or families otherwise perfectly healthy. In child-

hood, however, the existence of the scrofulous diathesis seems to favour the development of exudative catarrh into interstitial inflammation. *Hereditary influence* undoubtedly plays an important part in the causation of this disease.

As already stated, the pathological conditions embraced under this disease may originate in acute non-perforative inflammation or in exudative catarrh, particularly after *repeated attacks* of these affections. No doubt neglect of treatment is sometimes responsible for this. Just as we found in the other inflammatory diseases of the middle ear, the *fons et origo* of the mischief is often in *the nasal and pharyngeal mucous membrane*. In a large number of cases it will be found that the person is liable to "cold in the head," and that he attributes the beginning of the disease to this cause. He also frequently suffers from some form of chronic rhinitis. In persons predisposed to the disease injudicious cold water bathing is apt to induce it. A rheumatic origin has been attributed to those cases associated with ankylosis of the ossicles.

Syphilis may give rise to this affection or become grafted upon it, and then its course is usually very rapid; marked and hopeless deafness, with labyrinthine complication, frequently resulting.

Paresis, atrophy, or fatty degeneration of the muscles of the Eustachian tube and soft palate may excite or at least aggravate the disease. Diphtheria, anæmia, tuberculosis, or indeed any debilitated state of the constitution may impair the functional activity of these muscles. The student is referred to the chapter on the Causes of Ear Disease for further details (see p. 65).

SUBJECTIVE SYMPTOMS OF NON-EXUDATIVE INFLAMMATION OF THE MIDDLE EAR.

The symptoms complained of most frequently are *defective hearing and subjective sounds in the ear*.

The Degree of the Deafness varies very much in different cases and at different stages of the same case. This is chiefly due to variation in the seat of the pathological changes; for instance, the deafness is very marked in fixation of the stapes along with thickening and rigidity of the membrane of the fenestra rotunda; if the labyrinth also become involved, the deafness may be almost complete. The defect of hearing is frequently very insidious in its origin, as well as slow and gradual in its progress. If the morbid changes be confined to one ear, the patient may, for a considerable time, be *quite unconscious* of any impairment of hearing, and the disease may exist for a long time, even in both ears, without materially disturbing him either in his social or business relationships; besides, the patient is unwilling

to admit the existence of defective hearing at all, even after it has become very apparent to his friends. Hence in our inquiries it is often very difficult, or impossible, to ascertain *when* the dulness of hearing began.

Deafness liable to Fluctuation. The degree of deafness is liable to fluctuation, although not in so marked a way as in exudative catarrh. It is usually aggravated for the time by cold, moist, and dull states of the atmosphere, which influence injuriously the mucous membrane of the Eustachian tube; but extreme heat may also act unfavourably. It is to be remembered that, when the mucous membrane of the Eustachian tube is in a state of permanent swelling or thickening, a very slight additional swelling, say from a "cold in the head," will have a more important effect on the hearing than in the case of a previously normal Eustachian tube. In these conditions, crackling sounds, occasionally followed by transient improvement in the hearing, are sometimes heard by the patient. The deafness is also often aggravated by bodily and mental fatigue, by indisposition, by strong emotion, by much speaking, *during the mastication of food*, by alcoholic stimulants, by excessive smoking, by the use of quinine or salicin, and by hot close apartments. In these cases the aggravation is probably due either to a change in the condition of the Eustachian tube, or to a change in the perceptive power of the auditory nerve.

Anomalies of Hearing. The phenomenon of *paracusis Willisii*, or hearing better in a noise, is not unfrequently observed (see p. 49).

A want of proportion between the power of hearing simple tones, such as the tick of a watch, and speech is also found occasionally to exist (see p. 48). Politzer believes that, when a tone, such as the tick of a watch, is heard better in proportion than speech, there is rigidity of the ossicular chain, while the membrane of the fenestra rotunda is normal, the sound waves in such a case reaching the labyrinth through the latter channel.

Deafness for *speech* is most marked, and musical tones are usually heard quite distinctly, except when the deafness is extreme. Painful impressions are sometimes produced by loud sounds, the so-called *hyperæsthesia acoustica* (see p. 50). On account of this peculiarity some patients cannot tolerate loud speaking or the use of a hearing trumpet.

Osseous Conduction (see p. 39). The perception of sound by osseous conduction is usually *increased*. In cases, however, which have been obstinate and long continued, and especially when attended by great noises in the ear, osseous perception may be much *diminished*. This is more apt to be the case when the disease is complicated with syphilis, or when the patient works amid noisy

surroundings. In elderly persons, also, hearing by bone conduction is usually diminished.

Tinnitus Aurium (see p. 51). Next to defective hearing this is the most important and common symptom complained of. A very large number of persons, who have this disease, suffer from these sounds, although many say they get "used to them." Children seldom speak of them, although they may be present. The subjective sounds are sometimes complained of *before the patient is conscious of any deafness*; at other times the deafness and the noises in the ear come on simultaneously, while in many cases the "tinnitus" comes on some time *after* the impairment of hearing has been noticed. The descriptions given by patients of the character of these sounds are very varied. They may be likened to the humming of a shell, the buzzing of bees, steam escaping from a pipe, the sound of a waterfall, the singing of a kettle, water falling into the fire, etc. (see p. 51).

In many cases these sounds are much more annoying than the deafness, the patient asserting in earnest tones that he could get on in spite of the deafness, but that the noises in the ear are most distracting and a terrible affliction. They often become more aggravated as the deafness increases, until the patient may come to the sad position of being to a great extent shut out from external sounds, while he is tormented with intolerable noises within the head. At other times when the insensibility to external sounds has become almost complete, the subjective noises in the ear fortunately disappear. They are generally worse in the evening, and in the house, as compared with the free open air; while in a quiet room they are heard much more loudly than amid the noise and engrossment of business, when for the time they may not be perceived at all. The causes, which have been mentioned as increasing the deafness (see p. 380), usually also aggravate the tinnitus aurium.

Painful Sensations in the Ear or Head. While *pain* is seldom complained of, a sense of fulness, pressure, or "stopping up" in the ear is not unfrequently spoken of by patients. Some patients get into the habit of frequently *sniffing*, which seems to relieve them for the moment. It may be difficult to convince a patient that there is not an actual obstruction in the canal of the ear which should be easily removed. Patients are also in some cases much disturbed by a sensation of crackling or friction in the ear during swallowing. When actual pain is experienced, it is generally due to dental irritation or to neuralgia of the tympanic plexus.

Some patients suffer from a sense of pressure in the head, and others from dull pain over the frontal sinus. Localized pain in the head, which is usually regarded as neuralgia, is also occasionally complained of. This is probably of a reflex character, due to the irritation of the mucous lining of the middle ear transmitted, chiefly

through the branches of the trigeminus, to the nerves of the head, just as we find in pain due to dental irritation.

Giddiness, either temporary or permanent, sometimes along with sickness and vomiting—symptoms often attributed to disease of the brain or nervous system, at other times to gastric disturbance—is not unfrequently met with. In these cases the deafness and noises in the head have usually been very marked. This group of symptoms, namely, deafness, noises in the head, giddiness or unsteadiness of gait, and sickness or vomiting, is generally termed Ménière's disease. While these symptoms, when arising suddenly, are more often due to a pathological change in the semicircular canals, they may also undoubtedly be excited by pressure upon the labyrinthine fluid from the direction of the tympanum, such as may be produced by the pathological conditions found in this affection (see Ear Giddiness, p. 56).

Mental and Nervous Disturbance, such as diminished power for mental work with depression of spirits, seems not unfrequently to be connected with these chronic processes in the ear. Patients assert that an amount of mental work, which they could at one time perform with ease, has now become impossible. These symptoms, indicative of disturbance of the central parts of the nervous system, probably occur in persons whose nerve force or resisting power either is naturally weak, or has been impaired by causes acting on the system independently of the ear disease. Probably also the *distracting influences of the noises in the ear* may have something to do with the restlessness and inability to engage in mental work. It is to be noted that these phenomena are met with not only in nervous females but also in men of strong will.

OBJECTIVE SYMPTOMS OF NON-EXUDATIVE INFLAMMATION.

Before describing the changes found in the tympanic membrane, it must be observed that we cannot, in any given case, determine the extent of the deafness from the appearance of the membrane. While in some cases of extreme deafness, due to this affection, *the membrane is almost normal* in appearance, there are others in which the hearing is only slightly impaired, although the membrane presents *marked abnormality*, such as retraction, atrophy, opacity, or calcareous deposit. In the former case probably the fenestral structures are the seat of the pathological changes, while in the latter the morbid changes are limited to the tympanic membrane. The condition of the membrane is nevertheless to be carefully studied, as its appearance not unfrequently throws light upon the diagnosis and prognosis.

The Indrawn and Adherent Tympanic Membrane. A change in the position of the membrane similar to the "indrawn" or "sunken" condition, described at p. 370, is very frequently observed (Fig. 203,

also Coloured Plate I., Fig. 3). While in exudative catarrh inflation is usually sufficient to force out the membrane, and restore it to its natural position, we find that in this form of inflammation it becomes in many cases so fixed and immovable, owing to stiffening or to organised adhesions between it and the inner wall of the tympanum or incus and stapes, that neither inflation nor suction with Siegle's apparatus is capable of restoring the proper curvature. Localized or limited indrawings of the membrane, due to adhesions or bands, are also met with. In front of the upper part of the manubrium, for example, the membrane is in many cases distinctly sunken, imparting an unusual sharpness and depth to this part of the manubrium. Behind the upper part of the manubrium depressions are frequently seen, the



FIG. 203.

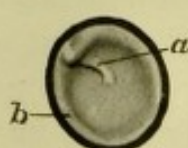


FIG. 204.

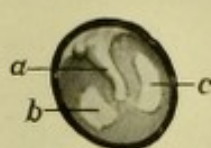


FIG. 205.



FIG. 206.

FIG. 203.—Indrawn tympanic membrane caused by obstruction of the Eustachian tube, showing the short process of the malleus with the indrawn manubrium below; the pointed short process of the malleus, the prominent and tense posterior fold and the foreshortened manubrium are seen.

FIG. 204.—Left tympanic membrane, very much "sunken," and showing the white ring at the periphery. *a*, Middle of manubrium, which is very much drawn in; *b*, white ring.

FIG. 205.—Left tympanic membrane, having patches of calcareous deposition. *a*, Middle of manubrium; *b*, calcareous deposit in front of manubrium; *c*, deposit behind manubrium.

FIG. 206.—Left tympanic membrane, showing calcareous patch having a horse-shoe shape. *a*, Manubrium; *b*, calcareous patch.

depressed portion of the membrane probably adhering to the long process of the incus or the head and posterior crus of the stapes. Pittings of the membrana flaccida are also not unfrequent. A depression, sometimes of considerable size, behind and below the umbo, is occasionally present, and is due to adhesion of a portion of the membrane to the promontory. It is to be remembered that an indrawn membrane and even anomalies of tension are in some cases *compatible with normal hearing*.

The Normal Lustre of the outer surface of the tympanic membrane is frequently retained, owing to the epidermic layer being in many cases unaffected, and hence the manubrium is generally seen distinctly through the transparent dermoid layer. If, however, the dermoid layer be thickened and dull, the general polish as well as the cone of light may be altogether absent, while the manubrium may be very indistinctly seen. The *cone of light* is affected by change in the curvature of the membrane, especially in the indrawn membrane. It may in that case become divided into several parts, or extremely narrow or irregular at its edges, or it may be reduced to a point.

Opacity of the Tympanic Membrane. This is frequently found either in the whole extent or at circumscribed parts of the membrane. Instead of a general pearly grey colour it is often a whitish grey (Coloured Plate II., Fig. 15) or even quite white like opal glass. More rarely it has a general leaden grey or yellowish grey tint. *Local* changes of colour are still more frequently observed. A whitish ring, of variable breadth, is fairly often seen round the periphery of the membrane (Fig. 204). This is looked upon by some as analogous to the *arcus senilis* in the eye, but it is also met with in young persons. Behind the upper part of the manubrium a whitish stripe, extending backwards, is sometimes seen, which is probably due to adhesion of the leaf of the posterior pouch of the membrane to the membrane itself. White thickened bands may also be found extending from the umbo to the lower part of the periphery of the membrane. But the most frequent form of greyish white opacity is found in the posterior half of the membrane; or it may be crescentic, extending in front of, below and behind the manubrium (Coloured Plate I., Fig. 7). When the mucous membrane lining the inner wall of the tympanum is hyperæmic and the membrane lies close to it, the latter presents, especially in its lower half, a *reddish tinge*.

Calcareous Deposit. In the posterior half of the membrane there is not unfrequently a very well-marked white or yellowish white appearance, frequently of a semilunar shape with the concavity forwards and *sharply demarcated* from the neighbouring parts of the membrane. It is due to a calcareous deposition in the layers of the membrane (Fig. 205, also Coloured Plate I., Fig. 11). A similar deposition, but more oval in shape, is less frequently seen in front of the manubrium. This sometimes unites below with a deposition behind, when a calcareous patch is formed having a horse-shoe shape (Fig. 206). Calcareous deposition in the tympanic membrane is most frequently met with in connection with chronic purulent disease of the middle ear (see p. 257), although it is not rare in the affection we are now considering.

Thickening of the Membrane is often present in addition to whiteness or opacity. This is generally in the inner or mucous layer, which may become three or four times thicker than normal.

Atrophy. But instead of being thickened, the membrane is not unfrequently *thinned or atrophied* owing in many cases to the prolonged tension from long-existing impermeability of the Eustachian tube (see p. 372). Sometimes a part of the membrane is atrophied, while the rest is thickened.

Condition of Eustachian Tube. Auscultation or inspection during inflation frequently gives evidence of *obstruction of the Eustachian*

tube (see p. 21). But it is to be noted that the auscultation sound may be full, clear, and blowing, *indicating a wide tube*, although great deafness may exist from the chronic processes in the tympanum. In such cases either the earlier thickening of the mucous membrane of the tube has given place to atrophy with abnormal width of the canal, especially at the isthmus, or the catarrhal process has been from the beginning almost confined to the tympanum, the Eustachian tube having been but little affected. Patients are not unfrequently met with in whom there is in the one ear extreme and long-standing deafness with great permeability of the tube, while in the other there is more recent deafness with the signs of obstruction of the Eustachian tube. It will usually be found that the ear with the obstructed Eustachian tube is more amenable to treatment than the other.

In the External Meatus we may find a tendency in some cases to excess of cerumen with impaction—such a tendency is occasionally a precursor of the middle ear disease. We may find, on the other hand, an entire absence of ceruminous secretion, with a wide dry meatus.

COURSE AND CONSEQUENCES.

Slow Course. In the great majority of cases the pathological changes in the middle ear advance, often *slowly and gradually*, with increase in the deafness and tinnitus. The adhesions become stronger, the thickening and contraction of the mucous membrane increase, while ultimately, in many cases, the labyrinth shares in the morbid process. The defect of hearing sometimes remains stationary for many years, and then becomes gradually or rapidly worse. If the labyrinth remain intact the deafness can never be *total*. Subjective sounds in the ear may be complained of for a long time before the hearing becomes impaired, especially in fenestral deafness. After the hearing of one ear has become very seriously impaired, *the other ear usually begins to be affected*, and it is not unfrequently found that the second ear, before long, becomes more seriously involved than the first, the patient remarking that the ear which was first affected, and the hearing of which he supposed to have been totally gone, is now the only one with which he hears anything at all.

Rapid Course. Much less frequently the disease pursues a rapid course, the hearing becoming rapidly and seriously damaged in a few months, probably without much alteration in the condition of the tympanic membrane and Eustachian tube. Here the process probably begins in the fenestral structures, and then extends inwards to the interior of the labyrinth. In a *syphilitic patient* the course of the disease is usually very unfavourable, the deafness and noises in the head

becoming rapidly worse. Sudden and loud noises, such as the report of a gun unexpectedly in the neighbourhood, as well as injuries to the head, are not unfrequently followed by marked aggravation in the symptoms.

Temporary Aggravations. The condition is often more or less aggravated by an attack of exudative catarrh, acute non-perforative inflammation, or acute purulent inflammation of the middle ear. After these complications have passed away the hearing power may return to its previous condition, but it is sometimes left rather worse than before. Some rare cases are reported of actual improvement in the hearing resulting from an acute purulent process. Spontaneous and permanent improvement is very rare.

Patients suffering from this affection in one ear have frequently some other affection in the opposite ear. This may be purulent inflammation, exudative catarrh, or impacted cerumen.

DIAGNOSIS OF NON-EXUDATIVE INFLAMMATION OF THE MIDDLE EAR.

The diagnosis is generally easy, and is based upon the history, the examination of the tympanic membrane and the Eustachian tube, the character of the subjective symptoms and the effects of treatment, especially of inflation. An important point in the diagnosis is to distinguish disease in the labyrinth or auditory nerve from disease in the conducting structures, especially when the tympanic membrane and the Eustachian tube are found to be normal. This is considered fully in the section on Bone-Conduction (see p. 39).

Adhesions, Atrophy, or Anomalies of Tension of the tympanic membrane and ossicular chain are usually made out by means of Siegle's speculum, or by inflation of the middle ear during inspection. The immobility of an adherent portion of membrane and the great mobility of an atrophied portion (see p. 372), during the alternate condensation and rarefaction of the air in the external meatus, usually point out pretty clearly the presence of these conditions. If there be excessive mobility of the membrane, there is defective tension; on the other hand, if the mobility be very slight, there is probably undue tension.

Stiffening, Rigidity, or Anchylosis of the ossicles cannot always be ascertained with certainty. Complete absence of movement of the manubrium during the use of Siegle's speculum or during inflation is presumptive evidence either of rigidity of the whole chain or of the malleo-incudal joint. If speech be not heard through a hearing-tube inserted into the external meatus, while it is heard when very loud if spoken close to the head without a hearing-tube, we may assume anchylosis of the ossicula. When words, spoken into a hearing-tube, connected to the outer end of a catheter introduced into the Eustachian tube, are heard

the presumption is that the stapes is movable, while the malleus and incus are rigid. Further, when the labyrinth is proved to be intact, and yet *no improvement follows repeated inflation*, there is probably a stiff immovable condition of the whole or some part of the ossicular chain.

*PROGNOSIS OF NON-EXUDATIVE INFLAMMATION OF THE
MIDDLE EAR.*

The question as to what will be the probable course of this disease in any particular case is fraught with intense interest and importance to the patient.

Complete Recovery as a rule Impossible. When it is considered that this small region, enclosed in great part by unyielding bones, is occupied by structures, the delicacy of whose vibrating power is of paramount importance for the due performance of the function of hearing, and that the processes in this affection lead to stiffening, rigidity, and immobility of these parts, we cannot escape the conviction that after a time complete structural and functional restoration is impossible. This lapse of time has, unfortunately, usually taken place before treatment is asked for or resorted to. The painless course of the disease and the at first almost imperceptible and extremely gradual loss of hearing explain why the patient rarely comes for advice until the pathological processes have gone on for one year, five years, or even ten years. It is then frequently found that the hearing of one ear is extremely defective, while that of the other is gradually failing.

The surgeon is therefore unfortunately always compelled to explain to the patient that complete restoration of the hearing is not possible. We are thus limited to the consideration of the question, will the hearing become gradually worse, or will it remain as it is, or may it improve? It must be admitted that it is not always possible to decide, from the history and symptoms of a given case, which of these three courses will be taken by the disease.

Importance of Objective Symptoms. It may be said broadly, that in any given case, the more marked the objective changes found in the ear the more favourable are the prospects of improvement. If we find manifest signs of catarrhal or inflammatory changes in the middle ear—an indrawn membrane, a prominent posterior fold, an obstructed Eustachian tube, an atrophied membrane; *if nasal stenosis, post-nasal catarrh, or adenoid vegetations be present*; and especially if, by a single efficient inflation with the catheter or Politzer's method, a measure of improvement in the hearing, or a diminution in the intensity of the subjective sounds be produced, we may reasonably hope to check or hinder the further development of the stiffening and adhesive processes. If, on the other hand, in a case presenting marked defect of hearing and violent subjective sounds, originating imperceptibly and progressing rapidly, we find no abnormal change in the tympanic membrane; if the naso-pharynx and nasal passages exhibit neither catarrhal nor hypertrophic change; if the Eustachian tube be freely permeable, and especially

if no improvement in hearing be produced by a single successful inflation, the likelihood is that very little good will be effected by treatment. The fenestral structures and the ossicular joints are probably permanently stiffened.

Information from Results of Inflation. The fact has been emphasized that the absence of improvement, or the temporary aggravation in the deafness after a single act of inflation, must be looked upon as, in most cases, an unfavourable omen. This is especially so if the air passes through the Eustachian tube into the cavity of the tympanum with a full clear sound, or the tympanic membrane is seen to move freely outwards, showing an open, if not abnormally open, Eustachian tube, and yet no improvement in the hearing follows. In cases, on the other hand, where the air enters the tympanum with difficulty, yielding a thin, shrill, intermittent sound, with a slight improvement in hearing, we may feel more hopeful of doing good than in the previous case. By a course of inflation, we may reasonably hope to overcome, in some measure, the adhesive and stiffening processes, if these are not so complete as to resist entirely the mechanical effect of repeated acts of inflation. It is, however, unsafe hastily to assume, in all cases where a negative result from inflation is found, that no good will be achieved by a course of treatment. Especially when the mucous membrane of the nasal passages or naso-pharynx is the seat of a catarrhal or hypertrophic process, real and permanent improvement has sometimes followed treatment.

The Test of Treatment. It is rarely, indeed, whatever the pathological conditions found or supposed to exist, that we are justified in definitely excluding the possibility of doing good until we have applied the test of treatment. We must be careful, however, not to push this experimental treatment too far; we must watch closely that no increase in the deafness, or in the subjective sounds is produced by it; and that on the first indication of such an untoward result the experimental efforts are immediately discontinued.

Exudative Element superadded to the Interstitial. In the mixed class of cases where the exudative form of inflammation is superadded to an already existing interstitial form, the prognosis is undoubtedly much more favourable. A patient who has been dull of hearing for many years becomes suddenly worse. This will sometimes be found to be due to a more recent process of an exudative nature being added to a previous interstitial affection. Immediate improvement generally follows inflation in such cases, and we are able to relieve the anxieties of the patient, and promise at least a return to the previous condition.

When Associated with Labyrinthine Disturbance. In the class of cases supposed to be associated with labyrinthine disturbance, the facts yielded by tests applied to determine the state of the bone-conduction of sound in relation to the air-conduction are of considerable importance. While there is no doubt that excess of bone-conduction, as tested both by Weber's and Rinne's tests, should be regarded as a favourable point in the prognosis, it is by no means a reliable indication that treatment will prove useful. That incurable stiffening of the ossicles may be attended by relative excess of bone-conduction is a familiar clinical fact. In like manner, where the bone-conduction is found to be relatively weak, we must not hastily give an absolutely unfavourable prognosis. This refers not only to persons over sixty years of age in whom, as we know, weak conduction by the bone is usual, but to patients in early and middle life, where, notwithstanding the existence of relatively weak bone-conduction, improvement sometimes follows a course of treatment. There are no doubt many cases of middle ear inflammation associated at the same time with a nerve or labyrinthine affection, it may be temporary in

character, in which the latter neutralizes, or more than neutralizes the tendency to excess of bone-conduction excited by the former. In such cases the treatment of the inflammatory element in the middle ear, or of the labyrinthine disturbance, may lead to appreciable improvement. Still it must be admitted that weak bone-conduction has usually a sinister meaning, and nearly always implies, even in the exudative form, that no more than partial improvement need be expected from treatment. Weak bone-conduction bears the worst meaning in cases of non-exudative otitis media in children where repeated inflation produces no impression upon the hearing. In regard, therefore, to the significance of excessive or defective bone-conduction, caution should be exercised in giving a categorical opinion simply upon such a basis. The other features of the case, both subjective and objective, which have been already adverted to, must at the same time be carefully considered.

The Significance of Hearing better in a Noise. This anomaly of hearing is present in a considerable number of the non-exudative cases of otitis media, and it is now generally admitted that its presence indicates a degree of stiffening of the conducting structures. In so far as this is the case, it is generally regarded as unfavourable from a prognostic point of view. It must not be regarded, however, as necessarily excluding all chance of improvement. As a matter of fact, improvement does occasionally follow the judicious treatment of cases associated with this phenomenon.

The Bearing of Defective States of Health upon Prognosis. The tendency to the development of permanent changes is greater in unsound constitutions, especially in the tuberculous, or in anæmic conditions, or when there is a marked hereditary tendency to middle ear disease or nasal catarrh. When the patient's mode of life is such as to be unfavourable to health, or such as to expose him to the usual causes of middle ear inflammation, there is a greater tendency to persistence or recurrence of the disease. The exanthematous diseases, especially measles and scarlet fever, often impress upon the inflammation a tendency to the development of permanent changes in the tympanum. Syphilis seems to engraft upon these cases a serious character; in cases of non-exudative otitis media which have been quiescent for a considerable time one often sees a rapid change for the worse, due to involvement of the labyrinth, after the reception into the system of this virus. So when the disease occurs in a constitution already infected with syphilis, the prognosis must be regarded as much less favourable, owing to the greater tendency to labyrinthine complication, with defective bone-conduction.

TREATMENT OF NON-EXUDATIVE INFLAMMATION OF THE MIDDLE EAR.

The treatment may be divided into three parts: (1) the local treatment of the ear; (2) the treatment of the nasal and pharyngeal spaces; and (3) the constitutional treatment.

(1) **Local Treatment.** This aims at (*a*) restoring the proper tension of the tympanic membrane and ossicular chain; and (*b*) counteracting the adhesive, thickening, and contracting processes, which are going on in the middle ear.

Inflation of the Middle Ear is an important means of attaining these objects; either by means of the catheter, or by Politzer's

method, or both combined. For the explanation of the therapeutic value of inflation of the middle ear and the comparative merits of the two methods, the reader is referred to the chapter on Methods of Treatment (p. 76). In many cases Politzer's method does best, while in others the best results are attained by the combined use of the catheter and of Politzer's method. When the Eustachian tube is considerably obstructed, and the tympanic membrane markedly indrawn and thickened, the use of the catheter, at intervals of three days, for a month may be indicated. If there be great resistance to the entrance of air into the cavity of the tympanum, as shown by the character of the auscultation sound and by the fixed position of the membrane, five or six strong compressions of the air-bag at each sitting are essential. On the other hand, if the tube be freely permeable, or the membrane atrophied, the compression of the bag should be very moderate. If such a course of catheterization proves beneficial by improving the hearing or relieving the tinnitus, Politzer's method repeated every second or third day for another fortnight may add to the improvement. As a rule the patient is quite able, after proper instruction, to carry out Politzer's method at home. Sometimes *Poltitzer's method alone* is more effective in improving the hearing and relieving the subjective noises than the use of the catheter. The surgeon must note the effects of each and regulate his conduct accordingly.

Effects of Inflation. By either method, the therapeutic effects are never so striking nor so lasting as in exudative catarrh. A temporary slight aggravation may even be caused, due to the excessive tension of the tympanic membrane, which, however, usually soon passes off, especially after swallowing. The best effects are obtained when the mucous membrane has still a certain degree of softness and flexibility, and when the tympanic membrane is not fixed immovably in an abnormal position, or the ossicula have not become completely rigid. The improvement in the hearing or in the tinnitus, which may follow inflation, is generally at first transient; in atrophy of the membrane or retraction of the tendon of the tensor tympani the duration of the improvement may not exceed a few minutes. The parts stretched out by the mechanical effects of the inflation soon shrink or fall back again. When improvement in hearing, lasting one or two days, follows each of the first few inflations, the ultimate result of treatment is likely to be much more favourable than in cases where no improvement follows the first few inflations. If treatment by inflation seems to increase the subjective sounds or the defective hearing (unless very temporarily) *it should at once be stopped*.

Valsalva's Method. Save in exceptional cases treatment by Valsalva's method is to be deprecated. The temporary improvement

which sometimes follows is dearly bought at the cost of injury to the hearing through its too frequent repetition (see p. 78).

Application of Solutions to the Interior of the Middle Ear (see p. 84 for mode of application). The therapeutic effects of inflation may be augmented or assisted by the use of medicated solutions. These are more likely to prove useful when there is simple swelling of the mucous membrane due rather to round-celled infiltration than to interstitial formation of connective tissue. A 1 per cent. solution of such substances as bicarbonate of sodium, chloride of ammonium, and iodide of potassium (the latter specially when the disease is connected with syphilis) may be employed. Delstanche reported great benefit from the forcible injection of sterilized oil of vaseline, which, he said, promoted in many cases the separation of adhesions and improvement in hearing. The injection of a few drops of a 2 per cent. solution of pilocarpine three times weekly is recommended by Politzer, and the writer has frequently employed it apparently with advantage. In the use of solutions it is well to employ them alternately with inflation by Politzer's method, or by catheterization, at intervals of two or three days for several weeks, carefully watching the results. The writer frequently employs fluid in a finely nebulized form, through the Eustachian tube, to the mucous membrane of the middle ear, by means of the globe nebulizer of Oppenheimer and a catheter bag. Formulæ are prepared by this firm suitable for use; the one which the writer most frequently employs for the middle ear contains iodine, menthol, carbolic acid, camphor, and neboline. This combines gentle inflation with the action of these medicaments, in some cases apparently with advantage. The writer also employs cocaine and adrenalin in the same way where there is catarrhal swelling of the pharyngeal end of the Eustachian tube.

The inflated air may be impregnated with the vapour of acetic ether, chloric ether, chloride of ammonium, menthol, eucalyptus, or iodide of ethyl as described at p. 85.

Rarefaction and Condensation of the Air in the External Meatus (pneumo-massage of the tympanum) is often employed in this affection as a form of massage of the tympanic membrane and ossicles. This method was probably suggested by the fact that patients often seem to find relief from rapidly repeated pressure on the tragus or external meatus with the finger. The conditions in which this method of treatment does most good are those associated with rigidity and retraction of the tympanic membrane and ossicles. The methods of employing it are described at p. 86. The writer believes that, used with discrimination in properly selected cases, it is capable of doing good, especially if associated

with treatment by inflation. While employing it the surgeon should have his eye on the tympanic membrane so as to note the effects, and he should make sure that the ear-piece fits air-tight, as shown in most cases by the quivering of the tympanic membrane. The stroke of the piston should be carefully regulated in length and frequency. From 1 to 4 mm. may be regarded as a safe length of stroke. With the long stroke high speed should be avoided, a few hundreds in the minute being sufficient. With the short stroke from 1,000 to 2,000 movements are allowable. The loud noise produced in the ear by the rapid movement of the piston, impelled by the electro-motor, is a disadvantage and may in some cases prove injurious. It may be repeated twice or even thrice weekly, allowing 3 minutes at a time, but should not be prolonged beyond a month. If it is clear that benefit is derived by this method the treatment may be repeated a few months afterwards; the patient may, as with inflation, employ it at home either with a suitable air ball or with a hand motor (see p. 86). The writer believes that harm is sometimes done from the lack of discrimination in the use of this method by persons unacquainted with the true nature of the ear affection for which it is recommended. The effects should be carefully watched, and if it causes pain or aggravation of the deafness or tinnitus it should be discontinued.

Special treatment of Constriction of the Eustachian Tubes. When there is great swelling of the lining membrane of the Eustachian tube or stricture by adhesions or thickenings, neither inflation nor the introduction of vapours or solutions may be possible. In these cases cautious attempts may be made (only by the experienced aural surgeon) to reduce the swelling of the mucous membrane with various substances, or to dilate the canal by mechanical means. When the mucous membrane is simply swollen it is recommended by Politzer to introduce through the catheter as far as the isthmus tubæ, for a few seconds, a violin string or catgut bougie, the end of which to the extent of two inches has been previously dipped in a saturated solution of nitrate of silver or sulphate of copper, and then allowed to dry. It is asserted by this high authority that if this be employed every third day for three or four times, the swelling of the mucous membrane of the Eustachian tube may be reduced to such an extent as to allow of effective inflation by Politzer's method. The writer, however, prefers the introduction of nebulized fluid as just described.

Eustachian Bougies. When such local treatment fails in opening the tube sufficiently to allow of a stream of air passing into the tympanic cavity, the *experienced* surgeon is justified in attempting gradual mechanical dilatation by means of thin gum elastic bougies (for method of application see p. 16).

On the whole, efforts to dilate the Eustachian tube by mechanical means are attended by but limited success, as frequently, owing to the character of the stricture, it is quite impossible to dilate it; while, even in cases where complete dilatation has been achieved, improvement does not always take place in the hearing or in the subjective sounds in the ears. This method may be employed

when there is evidence of a marked stricture or narrowing of the Eustachian tube, and where other methods have been tried without success. Urbantschitsch has found benefit from introducing a bougie into a Eustachian tube *where no stricture existed*, and employing slight frictional movement.

Electrolysis has been proposed in stricture of the Eustachian tube, but its value has not yet been established.

Mechanical Vibration. Dr. Dundas Grant says he has derived good results in sclerosis of the middle ear from "mechanical vibration applied to the spine" (see *Brit. Med. Journal*, 22nd Oct., 1898). Dr. Grant thinks that the effect is due to an indirect massage of the stapedio-vestibular joint (compare with tone treatment at p. 430).

Collodion. The late Dr. M'Keown advocated the application of collodion to the outer surface of the tympanic membrane when the membrane is flaccid, or where adhesions exist. He claimed for collodion applied in this way that, by firming and exercising traction upon the membrane, it tended to prevent or destroy adhesions, and replace the membrane in its normal position.

Sniffing. Some patients are found to be frequently *sniffing*, even when they are themselves unconscious of the fact. The writer has observed that such persons have usually an unduly flaccid membrane with an abnormally patent Eustachian tube, and that the act of sniffing gives relief to a sensation of fulness in the ear which they often experience. The sensation is caused by currents of condensed air passing up the tube and pressing out the membrane; this is relieved by the suction of air from the middle ear which takes place in sniffing.

The feathered sound of Lucaë is recommended by him for applying to the short process of the malleus and pressing it repeatedly inwards. It is a painful process, and while some improvement may follow, especially if associated with inflation and other forms of treatment, permanent improvement is rare.

Tympanic operations. *Incision of the Tympanic Membrane* (see p. 109) is sometimes employed in the treatment of certain forms of this affection. There are two conditions in which this may be useful. (1) When there is an extremely retracted membrane with great prominence of the posterior fold and short process, the hearing being very defective, and the tinnitus distressing, a perpendicular section through the middle of the posterior fold may be attended by benefit, especially as regards the tinnitus. The good effects of such an incision depend on the partial setting free of the manubrium and its assumption of a more normal position. While the relief is sometimes permanent it is, unfortunately, more frequently only temporary. Of course, no effect can be hoped for when, in addition, the fenestral structures are rigid or the ossicles ankylosed. (2) In the case of an atrophied or flaccid membrane, when three or four incisions are made in the atrophied part. They heal usually in twenty-four hours, and should be repeated every fourth day for two weeks. The beneficial effects, if any, are due to the contraction of the linear cicatrices and the consequent firming up of the flaccid tissue. The writer has not seen much benefit from this measure, but others have reported more favourably.

A permanent artificial opening in the tympanic membrane is very difficult to maintain. Attempts have taken the form of excision of a portion of the membrane or of burning a hole in it with the galvanic cautery (see p. 89). The point of the burner is applied to the postero- or antero-inferior quadrant with very slight pressure so as to avoid burning the inner wall of the tympanum. It is

found, however, that the opening made in either of these ways generally heals in course of time. If it were possible to maintain a permanent opening, a certain number of cases of deafness would probably be improved. When the tympanic membrane is so thickened or changed that the sound waves cannot be properly transmitted by it, or where the Eustachian tube is completely occluded, *while the fenestral structures are freely movable and the labyrinth intact*, an opening in the membrane is likely to improve the hearing and probably relieve the subjective sounds. And it is found by experience in these cases that so long as the opening remains the improvement continues; but, as soon as it is closed by a cicatrix, the improvement disappears. The writer has found in some cases of extremely distressing subjective sounds marked relief so long as a perforation made by the galvanic cautery remained open.

Excision of the whole Tympanic Membrane and the Malleus or Malleus and Incus has been already described, and its value indicated at p. 114, to which the student is referred.

Division of the Tendon of the Tensor Tympani Muscle. This operation is best performed with Hartmann's curved tenotome. An incision is made parallel with, and immediately behind, the handle of the malleus. The tenotome is then introduced between the manubrium and the long process of the incus and the tendon is cut *from below upwards*. If it were possible to ascertain with certainty in any case that the deafness and tinnitus depended solely or even mainly upon retraction of this muscle, division of its tendon would be a justifiable and even a reasonable proceeding. But it is well known that in nearly all cases of retraction of this tendon, adhesions, thickenings, and contractions of various kinds exist at the same time in the cavity of the tympanum. As might be expected, therefore, good results from this operation are either temporary or altogether absent, and unfortunately there is a possibility, as experience has shown, of damaging the hearing still further. If attempted at all, it should be done where the deafness is already of an extreme character, and where the tinnitus is such as to demand every effort to relieve it.

Kessel's Operation for the Mobilization or Extraction of the Stapes in ankylosis of the latter need not be described here, as it is still in the experimental stage, its usefulness or safety being far from established.

Synechotomy of the Crura of the Stapes has been recently suggested and performed by Politzer. This operation is for dividing or separating adhesions between the crura of the stapes and the walls of its niche. He admits that further experimental operations are necessary before deciding upon its usefulness.

Section of the Anterior Ligament of the Malleus has also been proposed by Politzer when there is marked drawing in of the tympanic membrane.

Duration of Local Treatment. An important question to decide is;—How long should treatment be continued? It may be said that if no improvement results either in the hearing or in the tinnitus after a month's treatment, carried out on the lines which have been laid down, the surgeon is justified in abandoning local treatment as likely to be useless. Indeed rarely does any improvement *begin* after two or three weeks' treatment. If, on the other hand, appreciable improvement takes place at an early stage, so long as this improvement gradually progresses the treatment should be continued. When no further improvement is

observed, the surgeon must be careful *not to prolong the treatment* over too great a space of time, otherwise the advantage gained may be completely lost. The maximum of good is usually attained in less than six weeks. After this a pause should be made of several months, and then inflation should be again practised either with the catheter or by Politzer's method, according as either of these answers best. If Politzer's method serves the purpose, the patient may go on with it at home every second or third day for six weeks. After this the surgeon must be guided as to the propriety of further local treatment by the state of the patient. In many cases it is found that in order to maintain the improvement or to prevent relapse, the local treatment requires to be repeated at least twice a year, for six weeks at a time.

It has to be confessed, however, that there are cases which, in spite of all treatment, advance until a condition of very serious deafness has been reached. In a few instances local treatment *seems to have rather an injurious influence*, when of course it should be abandoned. Where the deafness is but slight, and where objective examination of the ear shows no apparent morbid change, local treatment, even by simple inflation, should not be attempted.

If by treatment the surgeon is able to check the morbid processes, although no actual improvement in the hearing has been gained, he not merely saves the hearing power which remains, but also diminishes the tendency of the good ear to become affected. We have to add that, while no improvement in the hearing or relief to the sounds in the ear may result from treatment, the patient in some cases finds relief from the nervous symptoms which are frequently complained of in connection with this affection.

(2) Treatment of the Nasal and Pharyngeal Mucous Membrane—the *second* part of the treatment of non-exudative inflammation of the middle ear—must never be omitted by the surgeon. This region should be carefully examined in every case, and any morbid condition which may exist properly treated. *The treatment of the nasal and naso-pharyngeal spaces is sometimes of even greater value than the purely aural treatment.* If therefore such conditions exist as acute rhinitis, hypertrophic or atrophic rhinitis, marked stenosis from septal deflections or ridges, post-nasal catarrh or post-nasal adenoids, these must be treated as described in Chapter VII. on the Treatment of the Nose and Throat.

The propriety of operative nasal treatment in these forms of middle ear disease has given rise to pronounced divergence of opinion. Most authorities probably approve of operating upon, or otherwise removing, marked obstructions in the nasal channels. There can be no doubt that such obstructions exercise an injurious influence upon the tympano-Eustachian apparatus—first, by the effect of suction during the act of swallowing (see “negative Valsalva's method,” p. 20); and,

secondly, by inducing persistent or recurrent swellings of the Eustachian tube. Hence otologists are probably pretty well agreed as to the propriety of operative or other treatment for the removal of marked hypertrophies in the nasal passages, such as enlargement of the inferior turbinal, or very pronounced septal ridges or deflections causing considerable stenosis. Also, when post-nasal adenoids exist, most authorities would approve of operating, without, however, expecting such brilliant results as in the case of the exudative catarrhs. Fortunately, the dry forms of middle-ear deafness are comparatively uncommon in childhood. On the other hand, the existence of a spur or knob on the septum or a septal deflection interfering very little or not at all with nasal breathing, and producing no special tendency to catarrhal attacks, may wisely be ignored. It is to be remembered that intra-nasal operations occasionally seem to aggravate the deafness, perhaps through nervous shock, or from the entrance of blood into the Eustachian tube. There is probably unanimity as to the propriety of treating post-nasal catarrhs by the recognised methods, although it is not to be forgotten that these methods, such as the use of the nasal douche, may, in the absence of careful precautions, be productive of much harm.

(3) **Constitutional Treatment** is often of use when a cachectic condition exists, such as the tubercular, anæmic, or syphilitic diathesis (see *Formulæ for General Remedies*). Appropriate treatment for these conditions, if they exist, must never be neglected. If subjective sounds be the chief or only symptom complained of, there are certain special remedies which are discussed at p. 429. The condition of the digestive system should be inquired into, and any defect remedied; while the gouty or rheumatic conditions when present should be treated with suitable remedies, such as Carlsbad salts, alkaline medicines, etc., either at home or preferably at a spa.

Hygiene is also of importance in the prevention and treatment of this disease. This subject has been already considered in the chapter on *Methods of Treatment* at p. 97, to which the reader is referred.

As bearing upon the treatment of one of the chief symptoms (tinnitus aurium) of this disease the student is referred to the treatment of tinnitus aurium at p. 429.

II. OTOSCLEROSIS.

During the past few years the subject of Otosclerosis has received much attention from otologists and pathologists, and some of the obscurity, which previously surrounded it, has been cleared up. For this advance in our knowledge we are indebted especially to the investigations of Siebenmann, Bezold, Denker and Politzer.

Pathology. Primarily the disease affects the bony capsule of the labyrinth, but especially that part of the capsule bordering upon the fenestra ovalis (pelvis ovalis); more rarely it implicates the fenestra rotunda, the promontory, or some part of the cochlea. In these regions

the osseous tissue of the bony capsule becomes markedly vascular and exhibits numerous giant cells and osteoblasts. This increased activity leads to out-growths of spongy osseous tissue, and when this occurs, as it most frequently does, at the pelvis ovalis, the annular ligament and even the foot-piece of the stapes are invaded and ultimately firmly ankylosed by the new formed bone. In very advanced cases the pelvis ovalis may become filled up with a solid mass of spongy bony substance. The function of the stapes is necessarily interfered with or abolished, and deafness more or less profound is the consequence. The disease affects both ears in a very large number of the cases (over 80%); it is considerably more common amongst women, where it often commences shortly after puberty and is then frequently associated with anæmia. Otherwise it may be said to be a disease which has its commencement in early middle age. The influence of heredity is strongly marked; Körner and Hammerschlag found, in five families, forty-three members suffering from otosclerosis.

Causes. These are very obscure. Syphilis, gout, arterio-sclerosis, the uric acid diathesis, anæmia, pelvic disorders in the female, have all been suggested as possible causes. A fact which the writer believes to be of etiological importance, is the influence of pregnancy and the puerperium upon the disease. The commencement has often been traced to parturition, and it is a commonly observed fact that child-bearing aggravates the condition, each succeeding pregnancy leaving the patient with less and less hearing. The advisability of avoiding a second pregnancy when the first has gravely affected the hearing, or of even inducing early premature labour, when a second pregnancy does occur, has been discussed by Otological Societies, and the propriety of such prophylactic treatment, in certain cases, has been accepted by many.

Subjective Symptoms. The defect in the hearing comes on imperceptibly, and its tendency is to become gradually worse. After advancing for a period the deafness may become stationary for months or years, or its progress may be rapid for a time and then become much slower. Complete deafness is observed in only a comparatively small number of cases. Exhausting illnesses, worry, or nervous strain tend to aggravate the condition, and a moist, enervating climate is found by most patients not to be so suitable as dry, upland air. Hearing better in a noise (*paracusis Willisii*) is almost invariably observed. Distressing *tinnitus* is a marked feature, and accompanies the defective hearing in a large number of cases; it is often more bitterly complained of than the deafness itself. Tinnitus may be the first symptom noticed, and may precede the onset of the dulness of hearing by some months. *Giddiness* occurs less frequently and it seldom exists in an aggravated form.

Objective Symptoms. The tympanic membrane shows in most cases no manifest departure from the normal. A reddish blush sometimes seen behind the region of the umbo (Coloured Plate I., Fig. 12) is attributed to hyperæmia of the mucous membrane covering the promontory. In cases complicated by chronic adhesive catarrh of the middle ear the membrane may be indrawn, opaque, or thickened; or, if there has been previous purulent middle ear disease, a perforation, a cicatrix, or calcareous deposits may be observed. In typical and uncomplicated cases, however, the striking feature is, that *the membrane presents practically a normal appearance*. The external meatus is often wide and dry-looking. The Eustachian tube is in most cases patent, and air passes through it during inflation with a dry, full, blowing sound, but attended by no improvement in the hearing.

Valuable information is obtained from the use of tuning forks (see p. 36). By air conduction there is marked diminution in the perception of low tones, whilst notes of a high pitch, such as those produced by Galton's whistle, are generally well heard. In advanced cases, when the cochlea is involved, the power of hearing high notes is generally somewhat restricted although not to the same extent as for the lower registers. By bone conduction (see p. 39), as tested by a tuning fork (C = 128 vs.), Rinne's test gives in most cases a distinctly negative result, while by Weber's test the sounding fork is heard better in the worse or the affected ear. Schwabach's test almost invariably indicates increased power of bone conduction. Gelle's test for demonstrating the state of mobility of the stapes is only applicable in the case of educated people and cannot even then be always relied upon.

Diagnosis. In a typical case the diagnosis is not difficult; the normal appearance of the tympanic membrane enables us to exclude adhesive middle ear catarrh or the results of a past suppuration, while the use of the tuning fork prevents a mistaken diagnosis of a labyrinthine or auditory nerve affection. With an abnormal membrane the diagnosis is more difficult; marked loss of hearing out of all proportion to the objective signs—labyrinthine disease being excluded by the proper tests—would suggest that otosclerosis complicated the condition.

Prognosis. The tendency is to get gradually worse, but in only a comparatively small percentage of cases does absolute deafness result. In a large number of cases the disease is only slowly progressive, or it may even remain stationary for long periods. In cases which advance to profound deafness the tinnitus may disappear, and in most cases it tends to become less. This prospect is so far comforting to the patient suffering from otosclerosis. The symptoms which are regarded as seriously affecting the prognosis are the presence of the reddish blush round the umbo and the early involvement of the power of hearing

high-pitched notes. Marriage between two persons suffering from otosclerosis should be strongly discouraged.

Treatment. The treatment of this affection is highly unsatisfactory. Inflation of the middle ear is seldom attended by any good effect, unless, coincident with the otosclerosis, there be catarrh (muco-serous or adhesive) of the middle ear. Pneumo-massage, with an electrically driven air pump, relieves the tinnitus in a few instances, but, unless in the early stage of the disease, seldom beneficially affects the hearing. Potassium iodide has been recommended by Politzer, and the writer has observed some apparent benefit from the application with friction of iodine vasogen to the mastoid surface; this should be carried out twice daily for months. Phosphorus internally has been suggested by Siebenmann, who claims to have at least brought the disease to a standstill in some cases by the exhibition of this drug daily for long periods, even for years. Thiosinamin (fibrolysin or iodolysin) injected hypodermically has been favourably reported on by some, but the results obtained by the writer have not been encouraging. Many patients feel better in dry hilly districts such as the uplands of Switzerland. Pathological conditions of the nasal and post-nasal spaces, especially ozæna, which not unfrequently accompanies otosclerosis, should, if present, be suitably treated. Cauterisation of swollen nasal mucous membrane or the removal of hypertrophied tissue with the snare seems to be occasionally followed by cessation of the subjective sounds. The general health should be carefully attended to, and such conditions as anæmia, gout, rheumatism, etc., should receive appropriate treatment. A thoroughly hygienic life (see p. 98) should be insisted upon; probably in this direction and not in local treatment most benefit will be obtained. In women the pelvic organs should be examined and any defect rectified. For further information regarding the treatment of tinnitus aurium, so painful a symptom in this disease, the student is referred to p. 429.

CHAPTER XIX.

DISEASES OF THE INTERNAL EAR.

(LABYRINTH AND AUDITORY NERVE.)

ANATOMICAL AND PHYSIOLOGICAL DESCRIPTION.

THE OSSEOUS LABYRINTH.

THE membranous labyrinth is contained in an unyielding casing, the *osseous labyrinth* or *capsule*. This consists of spaces, corresponding in shape with the membranous labyrinth, in the petrous part of the temporal bone. These spaces

are filled with a watery fluid (perilymph), in which are suspended the membranous structures. Supposing a metallic cast were made of the cavities, as depicted in Fig. 207, there would be found three distinct divisions. There is a central space, named the *vestibule*, which communicates with the tympanic cavity by the fenestra ovalis (fenestra vestibuli), closed in the fresh state with membrane and by the foot-piece of the stapes, and situated in the inner wall of the tympanum. From the posterior side of this central cavity there spring three arched canals—the *semicircular canals*—the superior (eminencia arcuata), sometimes termed cerebral, from its relation to the cerebral surface of the pars petrosa, the posterior, sometimes termed cerebellar, from its

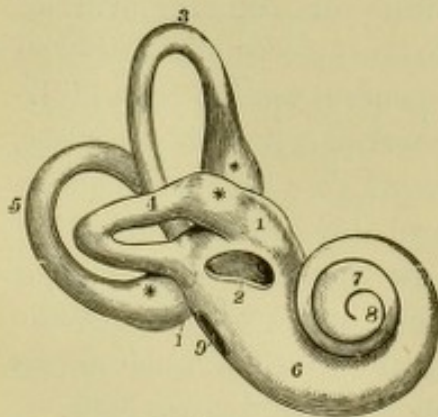


FIG. 207.—Right osseous labyrinth (after Sömmerring) $\times 2\frac{1}{2}$. 1-1, Vestibule; 2, fenestra ovalis; 3, superior semicircular canal; 4, horizontal or external canal; 5, posterior canal; 6, first turn of the cochlea; 7, second turn; 8, apex; 9, fenestra rotunda; *, ampullae.

relation to the cerebellar surface of the pars petrosa and the horizontal or external, which may be termed tympano-antral from its relation to the tympanum and antrum. Each of these has an enlargement at one end, the ampulla. Anteriorly there opens into the vestibule a peculiar spiral tube, which, from its resemblance to the shell of a snail, is called the *cochlea*. The cochlea (scala tympani) communicates with the tympanum by the fenestra rotunda (fenestra cochleæ) closed in the fresh state with a membrane (the secondary tympanic membrane). Thus, like the external and the middle ear, the internal ear is divided into *three* parts, the vestibule, the semicircular canals, and the cochlea. The inner wall of the vestibule and the base of the cochlea are pierced by a number of

apertures, through which the fibres of the cochlear and vestibular divisions of the auditory nerve pass from the internal auditory canal to the membranous structures (Fig. 208).

The Cochlea (Fig. 209) is the most anterior part of the labyrinth. It has a conical shape, its base being towards the fundus of the internal auditory canal, and its apex, the *cupola*, towards the osseous part of the Eustachian tube. From the base to near the apex extends a pyramidal osseous pillar, the *modiolus*, which is pierced in the direction of its long axis by canals conveying the fibres of the cochlear nerve destined for the cochlea, as well as small blood-vessels. The space between



FIG. 208.—Horizontal section through the tympanum and labyrinth (after Rüdinger)—*d*, the tympanic membrane; *e*, anterior wall of cavity of tympanum; *f*, stapes with its foot-piece attached to the fenestra ovalis; *g*, stapedius muscle; *h*, a portion of facial nerve; *i*, situation of tensor tympani muscle; *k*, vestibular division, and *l*, cochlear division of auditory nerve in the internal auditory canal; *m*, section of the cochlea; *n*, nerve going to the ampullæ; *o*, section of utricle; *p*, section of saccule; *r*, section of a semi-circular canal.

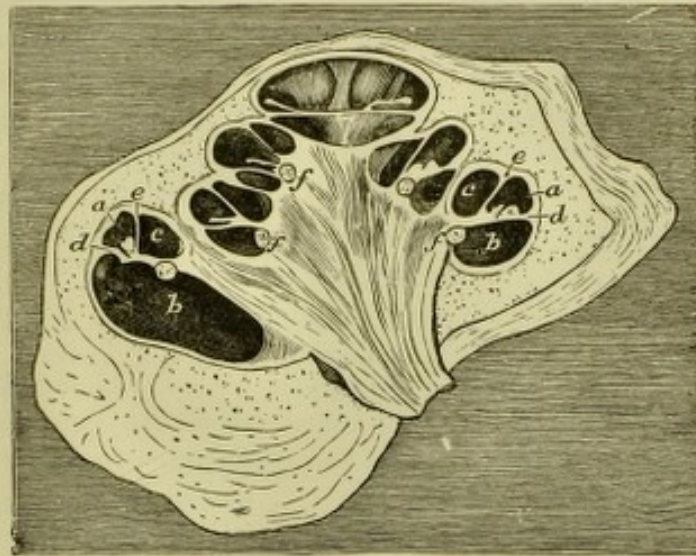


FIG. 209.—Section of cochlea of pig at birth. (Reichert.) *a*, Canalis cochleæ; *b*, scala tympani; *c*, scala vestibuli; *d*, basilar membrane and organ of Corti; *e*, membrane of Reissner; *f*, spiral ganglion. (From Cleland and Mackay's *Human Anatomy*.)

the outer wall of the cochlea and this central part is divided into two winding passages or "staircases," *scalæ*, lying over one another, by a partition which winds in a spiral direction from the base to the apex, the *spiral plate of the cochlea*, and extends between the central pillar and the outer wall. This partition is in part bone and in part membrane. The bony part, osseous spiral lamina, springing like a flange from the central pillar, reaches half across the interval, while the membranous part completes the other or outer half. At the junction of the osseous spiral lamina with the modiolus is the spiral canal for the spiral ganglion.

Scalæ of the Cochlea. The membranous part of the spiral lamina is in reality a triangular space—the *membranous canal of the cochlea* or *scala media*—containing structures of great complexity, bounded above and below by membrane. In using the terms *above* and *below* the cochlea must be imagined standing with its base downwards instead of backwards as in the body. The spiral lamina begins between the fenestra vestibuli and fenestra cochleæ, and, winding round the central pillar for two turns and a half, terminates near the apex. Of the two winding passages formed in this way the upper is called the staircase of the vestibule, *scala vestibuli*, because it opens directly into the vestibule; and the lower, the staircase of the tympanum, *scala tympani*, because in the

macerated bone it passes directly into the tympanum at the fenestra cochleæ, although in the recent state it is separated from the tympanum by the membrane closing that opening. These two *scalæ* open the one into the other at the apex by a small aperture, the *helicotrema*. There is a canal of communication, the *aqueductus cochleæ*, between the *scala tympani*, near the fenestra, and the sub-arachnoid space, near the lower margin of the posterior surface of the petrous bone. The third passage, the *scala media*, between the *scala vestibuli* and the *scala tympani*, belongs to the membranous labyrinth under which it is described. Many small passages, continuous with the canals in the central pillar, pierce the osseous spiral plate, and convey vessels and nerves to the membranous part of the spiral lamina.

The Perilymph. A membrane composed of connective tissue lines the osseous surfaces of the interior of the labyrinth. This periosteal membrane, lined by a layer of epithelium, secretes a thin fluid, the *perilymph*, which fills the *scala tympani* and *scala vestibuli*, and occupies the space between the walls of the osseous labyrinth and the membranous tubes and sacs contained in the vestibule and semicircular canals. Through the *aqueductus cochleæ* the perilymph and the cerebro-spinal fluid may communicate.

THE MEMBRANOUS LABYRINTH.

The membranous labyrinth consists of membranous canals and sacs, corresponding in shape with the osseous labyrinth to which they are attached at certain places. From behind forwards they are named the semicircular canals, the utricle, saccule, and membranous canals of the cochlea (Fig. 210). These are continuous with one another and contain a thin fluid, the *endolymph*, and are surrounded by the *perilymph*.

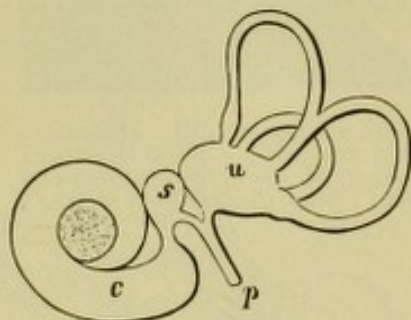


FIG. 210. — Membranous labyrinth (M'Kendrick)—*u*, utricle communicating with the semicircular canals; *s*, saccule communicating with the membranous canal (*c*); *p*, aqueductus vestibuli.

The three membranous semicircular canals are of much smaller calibre than the osseous canals—the latter being fully three times wider than the former, and they communicate by five openings with the utricle. The three canals have at one end a bulging *ampulla*, occupying a similar widening of the osseous semicircular canals. Each of the three ampullary enlarge-

ments presents on the inner surface a semi-lunar fold or thickening, the *crista acoustica*; these thickenings correspond with the terminal structures of the three branches of the vestibular nerve going to the ampullæ. No nerves have been found except at these ampullary widenings.

The utricle is a membranous bag flattened from before backwards, occupying the *recessus ellipticus* of the vestibule. It communicates with the semicircular canals by five openings and with the saccule through the forked upper endings of the aqueductus vestibuli. On the inner surface there is a small thickened patch, the *macula acoustica*, corresponding with the terminal structures of the utricular branch of the vestibular nerve. A delicate membranous tube, the *aqueductus vestibuli* (ductus endolymphaticus), passes from the utricle through an osseous canal terminating in a *cul-de-sac*, covered by *dura mater* (sacculus endolymphaticus) on the posterior surface of the petrous part of the temporal bone.

The saccule is a round bag, smaller than the utricle, occupying the *recessus sphericus* of the vestibule. It communicates with the utricle by means of a short membranous tube which joins the *aqueductus vestibuli*, while it is continuous with the membranous canal of the cochlea by means of a slender tube, the *canalis reuniens*. The saccule, like the utricle and each of the membranous semicircular canals, has an enlargement (*macula acoustica*) indicating the situation of the terminal structures of the branch of the vestibular nerve to the saccule.

To each of the *cristæ* in the ampullæ and to each of the *maculæ* in the utricle and saccule a separate bundle of nerve fibres proceeds from the vestibular division of the auditory nerve, and at each of these five spots the nerve filaments

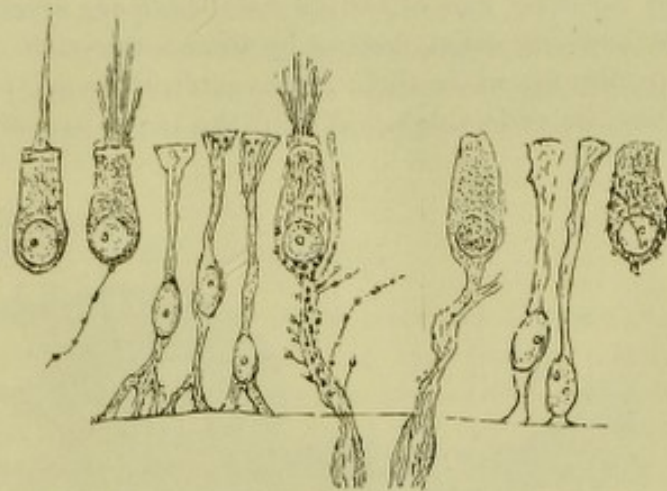


FIG. 211.—Auditory cells, elongated epithelial cells and nerve-endings from *macula acustica utriculi* of child at birth. After Retzius. (From Cleland and Mackay's *Human Anatomy*.)

terminate in specialized epithelial elements. These consist of cylindrical epithelium with auditory cells having hair-like processes projecting into the endolymph; these cells are supported by cylindrical cells without hair-like processes (Fig. 211). The ultimate nerve filament, after losing its medullary sheath, ends in a hair-cell. At each of these five spots are also found the *otoconia*—minute crystals of carbonate of lime embedded in a jelly-like substance.

The Membranous Canal of the Cochlea or Scala Media (Fig. 212, *c*) contains what is now regarded by physiologists as the most essential part of the

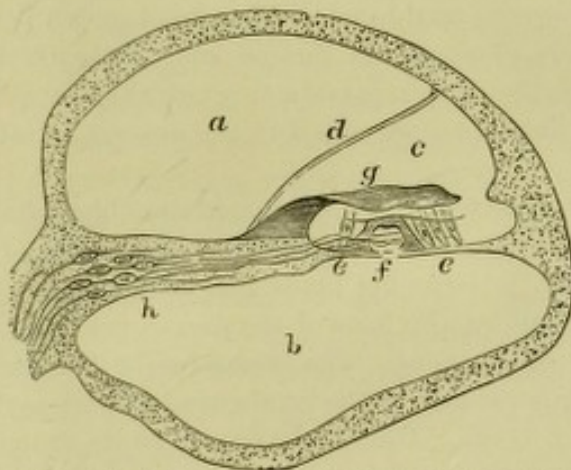


FIG. 212.—Cross-section of a turn of the cochlea (Landois)—*a*, scala vestibuli; *b*, scala tympani; *c*, membranous canal, cochlear duct, or scala media; *d*, Reissner's membrane; *e* *e'*, Corti's cells, and *f*, Corti's rods, both resting on the basilar membrane; *g*, Corti's membrane or membrana tectoria; *h*, osseous spiral lamina.

terminal apparatus of the auditory nerve, namely, the *organ of Corti* and *Corti's cells* supported on the basilar membrane. This canal is situated between the scala vestibuli above and the scala tympani below. The thin membranous partition, between it and the scala vestibuli, is termed *Reissner's membrane*, which passes obliquely from the upper surface of the osseous spiral lamina to the outer wall of the cochlea, while the partition between this membranous canal and the scala tympani is termed the membranous spiral lamina, or the *basilar membrane*, connecting the edge of the osseous spiral lamina with the outer wall of the cochlea.

The Organ of Corti (Fig. 213) lies on the upper surface of the basilar membrane, inside the membranous canal and immersed in the endolymph. This remarkable structure consists of a double series of rods or fibres, an outer and an inner, arranged on the upper surface of the basilar membrane along its whole length. These two rows are jointed together at their upper ends so as to form an arch.

There are more of the rods in the inner row than in the outer, so that three of the inner rods are sometimes attached to two of the outer. In the human cochlea there are supposed to be 3000 of the outer rods and still more of the inner rods. They gradually increase in length towards the *upper* part of the cochlea. External to the outer row of Corti's rods there are several rows of elongated cells (Corti's or auditory cells), resting by their lower ends on the upper surface of the basilar membrane, while their upper extremities are furnished with fine cilia projecting into the endolymph. Within the inner row of Corti's rods another row of these

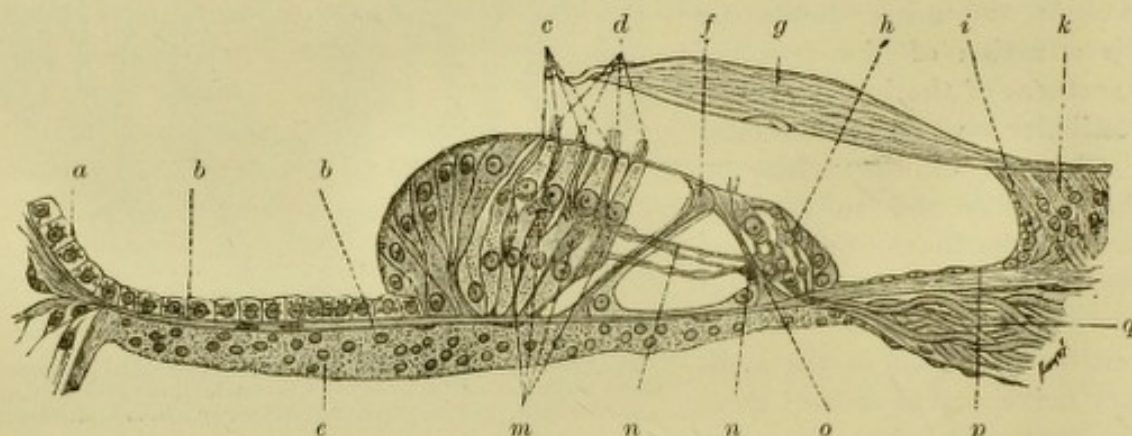


FIG. 213.—Organ of Corti in vertical section. (Böhm and v. Davidoff, after Retzius.)
a, Cells of Claudius over cochlear ligament (Bowman's muscle); *b*, basilar membrane; *c*, outer support-cells (cells of Deiters); *d*, outer auditory hairs; *e*, lining of scala tympani; *f*, outer rods; *g*, membrana tectoria (Corti's membrane); *h*, inner support-cells; *i*, sulcus spiralis; *k*, labium vestibulare; *m*, outer auditory cells; *n*, nerve-fibres passing to them; *o*, inner rod; *p*, simple epithelium of sulcus spiralis; *q*, medullated nerves. (From Cleland and Mackay's *Human Anatomy*.)

cells is found, also furnished with cilia. Corti's cells are supported by other cells having no cilia (Deiter's cells). These cells with Corti's rods are enveloped and kept together by a membrane (membrana reticularis), while arching over them is another membrane (Corti's membrane or membrana tectoria), which springs from the outer wall of the scala media near Reissner's membrane. It has been shown by Waldeyer and Gottstein that Corti's cells are *in connection with the ends of the fibres of the cochlear nerve*, which, branching from the nerves passing through the central pillar of the cochlea, reach Corti's cells by delicate cross canals in the osseous spiral lamina.

The Auditory Nerve has its origin at the back part of the medulla oblongata in the grey matter in the floor of the fourth ventricle. While the arrangement of the roots is still a subject of investigation, it is so far made out that they are connected with the grey matter of the cerebellum, the floor of the fourth ventricle, the restiform body, and the lower border of the pons. The researches of Ferrier seem to show that the cortex of the left temporal lobe of the cerebrum and possibly the right contains a centre of the auditory nerve. Opinion varies as to its exact location in the temporal lobe. Apparently each auditory nerve is associated with both temporal lobes. In the left there seems to take place "the elaboration of auditory sensations into speech perceptions," or the formation of "word pictures." Hence in disease of the left temporal lobe there may be "word deafness" while there is hearing for other sounds (sensory aphasia).

From the lower border of the pons to the fundus of the internal auditory canal the auditory nerve (portio mollis) is in contact with the facial nerve (portio dura), and in that canal they are connected by one or two filaments. A small artery destined for the labyrinth usually lies between them. In the internal auditory canal the nerve divides into two bundles of fibres. One bundle, the cochlear nerve,

pierces the front of the cribriform lamina below the opening of the aqueduct of Fallopius, and ascends in small canals through the centre of the modiolus, branching off through the osseous spiral lamina, where the fibres reach the spiral canal and enter the spiral ganglion (bi-polar cells interrupting nerve fibres), afterwards, losing their medullary sheaths, they pass to Corti's cells as varicose axis cylinders. The fibres forming the other bundle—the vestibular nerve—pierce the back part of the cribriform lamina, and divide into five smaller bundles, which pass to each ampulla (crista acoustica) and to the maculæ of the utricle and saccule.

FUNCTIONS OF THE LABYRINTH.

Sonorous Vibrations are conducted to the fluid in the labyrinth in two ways :

(1) By the special sound-conducting apparatus provided in man and in all air-breathing animals—this is sometimes called “air-conduction of sound”; and (2) by the bones of the head either from direct contact of the vibrating body, direct osseous conduction, or by the waves of sound reaching the surface of the head through the air, indirect osseous conduction.

The Vibrations of the Stapes place the fluid of the labyrinth in a state of oscillation. The minute wavelets, thus set in motion, stream through the spaces and passages of the labyrinth. Multitudes of little taps or blows impinge upon the terminal structures of the auditory nerve in the various parts of the membranous labyrinth; some kind of change is thus produced in the nerve, which is at once conveyed to the brain, and in a way unknown to us these purely physical movements of matter are transformed into that sensation which we designate sound.

An inward movement of the base of the stapes produces an outward movement of the membrane of the fenestra cochleæ; the wave of fluid displacement passes along the scala vestibuli of the cochlea through the helicotrema to the scala tympani, at the end of which it presses upon the membrane of the fenestra rotunda, which then bulges towards the tympanic cavity. On the other hand, in every movement of the stapes outwards this membrane sinks into the scala tympani. It is thus easy to see that thickening or rigidity of the membrane of the fenestra cochleæ must have a disturbing influence upon the vibratile movements of the labyrinthine fluid. Through the aqueductus cochleæ the perilymphatic space is connected with the subarachnoid space, and the perilymph, if exposed to great pressure, may be forced into the subarachnoid space, or, on the other hand, excessive pressure on the cerebro-spinal fluid may force it into the labyrinth. In the former case injury to the delicate nerve structures by excessive pressure may be averted, while in the latter way morbid conditions of the subarachnoid space may be communicated to the labyrinth.

Functions of the Auditory Nerve. Recent researches seem to show that the two constituents of the auditory nerve—the vestibular and the cochlear—are entirely distinct and have quite different functions. The vestibular nerve, which has its end apparatus in the ampullæ of the semicircular canals, the utricle and the saccule, is now generally regarded as having to do, not with hearing or auditory stimuli, but with the sense of position in space. It is endowed with the power by which the movements of the muscles of the body are so co-ordinated as to enable us to maintain the upright position. The specific stimuli are the impacts of the changing currents of the perilymph and endolymph produced by the movements of the head in space. These impacts act upon the cilia of the auditory cells,

especially in the ampullæ of the semicircular canals "which are cognisant of the three dimensions in space." The static theory of the function of the vestibular nerve originated in experiments of Flourens, who found, after severing the semicircular canals in the pigeon and rabbit, that peculiar rotatory movements were executed by the animals. Goltz, Mach, Crum-Brown, etc., confirmed by experiments the results obtained by Flourens, and the view seems to be fairly established that the semicircular canals are the "static organs" of the body, and have nothing to do with hearing. It is right to say that eminent experimenters such as Böttcher, Baginsky, and Moos, allege that these peculiar movements were due to injury inflicted on the cerebellum by the manipulations necessary in performing the vivisection. Further experiments, however, as well as clinical observations, seem to show that if the vestibular nerve endings are irritated disturbance of equilibrium takes place, while if the nerve be severed or destroyed the power of equilibrium is, at least for a time, lost. The view that the vestibular nerve is really a "static" or "equilibrate" nerve is strengthened by the study of the function of the otocysts in the low forms of life. These, upon which the organ of hearing seems to have been engrafted in the course of the evolutionary processes, were originally, before the dawn of hearing, purely static organs or organs of equilibrium. The apparatus of the vestibular nerve, with the semicircular canals and vestibule, now represents the primordial otocysts, and continues to carry on the function of equilibrium.

This view of the function of the vestibular nerve gains further confirmation from what has been stated by Professor D. J. Cunningham, of Edinburgh, regarding the vestibular centre in the brain of animals such as the chimpanzee and orang, whose climbing and other activities demand, we might suppose, a highly developed static centre. His observations showed that the vestibular centre in these creatures is more largely developed than in animals of more stationary habits. In the orang there is also a very large and conspicuous direct cerebellar tract.

Numerous and well-confirmed clinical observations, frequently referred to in the course of this work, of the effects upon the equilibrium (in causing vertigo, staggering, etc.) of disease in the semicircular canals and vestibule, also very strikingly support the "static" theory of the function of the vestibular nerve, and this is the theory which at present holds the field.

The Function of the Cochlear Nerve and Cochlea. The cochlear seems to be the true nerve for the sense of hearing—its specific stimulus being the sonorous vibrations in the fluid of the labyrinth produced by a sounding body. The cochlea may therefore be termed "the hearing labyrinth." According to the most generally accepted theory of hearing, the terminal apparatus of the cochlear nerve has to do with the recognition and analysis of musical tones. Hensen, supported by Helmholtz, holds that the fibres of the basilar membrane, which are in connection with the ends of the nerve through Corti's cells, may be regarded as a vast number of stretched strings of all lengths, and that only those of them are set into vibration which correspond with the particular tone which at the moment enters the ear. In this way long fibres vibrate in unison with low tones, and short fibres with high tones. If this theory be correct, injury or disease of the upper part of the cochlea, where the fibres of the basilar membrane are longest, would interfere with the perception of low tones, while the opposite would be the case were the lower part of the cochlea involved where the fibres are shortest.

DISEASES OF THE INTERNAL EAR.

Diseases *primarily* affecting this section of the organ are not so frequent as *secondary* disease of the labyrinth. When middle ear disease, such as non-exudative inflammation, has existed for a length of time, the structures of the labyrinth are apt to become involved; so also purulent middle ear disease (acute and chronic) often leads to infection of the labyrinthine structures. As we can rarely affirm, with anything like certainty, merely from the clinical facts of a case, what is the exact pathological condition of the internal ear, or even in what part of the internal ear the lesion is situated, we shall simply discuss the diseases in a general way under the following aspects:—(1) The most frequent pathological conditions found; (2) the varieties, based chiefly upon causation; (3) the symptoms manifested by them; (4) their diagnosis; (5) their treatment.

PATHOLOGICAL ANATOMY.

Toynbee, Voltolini, Kramer, and many other observers have done a great deal in laying before us the coarser pathological anatomy of the internal ear. The most frequent pathological changes, which many sections of the internal ear have shown to exist, are the following:—

Changes in the Labyrinth. Extravasation of blood or serum, hyperæmia, anæmia, syphilitic or atheromatous disease of the vessels, emboli, acute and chronic purulent inflammation, cholesteatomatous masses, caries or necrosis of the walls of the labyrinth, exostosis or hyperostosis of the osseous walls, thickenings of the membranes of the labyrinth, atrophy of the same, pigmentary collections, fibro-muscular tumours, defect or excess of otoliths, defective formation of semi-circular canals, vestibule or cochlea, absence of fenestral openings.

Changes in the Root, Stem, or Terminal Branches of the Auditory Nerve. Atrophy due either to the pressure of tumours, such as sarcomatous, cancerous, syphilitic, or tuberculous masses, or to defective nourishment of the nerve, or to disease in the cerebellum or medulla at the root of the nerve; inflammatory softening extending from the labyrinth or meninges, calcareous change, fibrous degeneration of the sheath, fatty metamorphosis, pigmentary deposition, formation of corpora amylacea.

Pathological Conditions of the Central Nervous System may involve the auditory centre or stem of the nerve, such as a tumour, an apoplectic clot, an embolism, softening of the brain substance, cerebral or cerebellar abscess, tubercular deposition, inflammation of the brain or meninges.

VARIETIES OF AFFECTIONS OF THE INTERNAL EAR.

(1) *PRIMARY OR ACUTE AFFECTIONS OF THE LABYRINTH.*

These are usually due to sudden pressure exerted upon the terminal structures of the auditory nerve by hæmorrhagic effusion, serous or plastic exudation, inflammation, simple congestion, concussion, or vaso-motor disturbance (angio-neurotic).

Abnormal States of the Constitution or Blood are the most frequent sources of these attacks, and the writer's experience would place syphilitic disease, either in the hereditary form or during the tertiary stage of the acquired form, among the most important. Effusion of blood into the cavities of the labyrinth from rupture of a vessel specifically diseased is probably the most common. Such effusions constitute irritative lesions which act upon the auditory nerve terminals. The degenerative changes in the blood-vessels, connected with Bright's disease, are no doubt in some instances the cause of the hæmorrhage. Atheroma of the vessels is, in elderly people, a source of the disease. When we consider that the internal auditory artery is a branch of the basilar, it is easy to understand that atheroma in the cerebral arteries is likely to be associated with a like degeneration of the labyrinthine vessels. In young children these labyrinthine attacks may be associated with mumps, acute labyrinthitis of Voltolini, cerebro-spinal meningitis, or leucocythæmia.

Traumatic Causes. Hæmorrhage into the labyrinth may, on the other hand, be due to a blow or a fall on the head; an injury of this kind, however, may simply cause great irritation of the terminal nerve filaments often eventuating in inflammatory changes. Excessive exertion, especially of the respiratory organs, occasionally excites effusion into the labyrinth. For example, the writer has had under his care an enthusiastic football player, who, during a keenly contested game of football, was seized with great giddiness. He had also excessive noise in one of the ears, which became deaf, and the latter symptoms—the noise in the ear and the deafness—remained ever after. In another case, excessive blowing with the mouth in the use of a blow-pipe for several hours seemed to be the exciting cause of the disease.

Exposure to Cold, while one is overheated or during exhaustion, may excite neuritis of the auditory nerve, which sometimes affects also the facial nerve or even the fifth cranial nerve.

(2) DISEASE OF THE INTERNAL EAR SECONDARY TO MORBID INTRA-CRANIAL CONDITIONS.

Disturbances in the Brain Circulation. The nutrient artery of the labyrinth, the *internal auditory* from the basilar, is really a brain artery. Hence, disturbances in the vaso-motor control of the arterial system of the brain or meninges are likely also to involve the vessels of the labyrinth. Narrowing or closure of the internal auditory artery or of the basilar, from pressure or other cause, may result in an anæmic condition of the labyrinth. Aneurism of either of these vessels will affect the circulation of the labyrinth. Atheromatous

conditions of the arteries of the brain are usually associated with atheroma of the vessels of the labyrinth, leading sometimes to hæmorrhage into the latter. Again, *the veins of the labyrinth* discharge their contents chiefly into the superior petrosal sinus of the dura mater. Hence, any obstruction of this venous channel or of any of the large venous channels passing out of the interior of the cranium may lead to a passive congestion of the vessels of the labyrinth.

The Auditory Centre, or the stem of the nerve, may be affected by pathological conditions in, or acting upon, the brain, such as hæmorrhage, embolism, inflammation of the brain or meninges, syphilitic, cancerous, or tubercular tumours in the brain, softening of the brain substance, or abscess. In these cases the nerve at its centre, or in its course, is either pressed upon or shares in the pathological process.

Epidemic Cerebro-spinal Meningitis is not unfrequently attended or followed by grave complications in the labyrinth or auditory nerve, leading in many cases to total deafness; and this form of meningitis is one of the most common causes of acquired deaf-mutism. Ten per cent. of those who recover from cerebro-spinal meningitis suffer from deafness, but the frequency seems to vary very much in different epidemics. Apparently the younger the patient the more liable is he to be affected with deafness. Both ears are implicated in the great majority of cases (said to be 90 per cent.). The auditory structures are usually involved in the second or third week of the disease. In the sections of the ear and base of the brain which have been made after death from this disease, changes have been found in some cases in the root and stem of the nerve, and in others in the vestibule, semicircular canals, and cochlea.

There may be purulent infiltration of the stem of the auditory nerve or the nerve may be imbedded in meningeal exudation. The specific pathogenic organism (the meningococcus) may invade the labyrinth along the sheath of the auditory nerve, or more frequently along the aqueductus cochleæ, leading to purulent formation with in many cases necrosis and destruction of the terminal structures of the auditory nerve. The tympanum is in some cases also involved in the purulent process (panotitis). Or the changes in the labyrinth may be of the nature of simple hyperæmia, thrombosis, hæmorrhage or fibrinous infiltration. Later on there is often found in the various parts of the labyrinth new formation of connective tissue or bone. In some cases seen by the writer, during the life of the patient, exudation was found in the tympanic cavity without perforation and, after paracentesis, a diplococcus like the meningococcus was found in the exudate. It is possible that, in some cases, the cerebro-spinal disease may gain admission to the cranial cavity by this route. Bezold says there is an accompanying middle ear catarrh or inflammation in a certain number of cases. In the Glasgow epidemic in 1907 the meningococcus was found in a large number of the cases associated with ear discharge.

(3) *DISEASES OF THE INTERNAL EAR SECONDARY TO AFFECTIONS OF THE MIDDLE EAR.*

Inflammatory Conditions of the Middle Ear, and in some cases of the external meatus, may be associated with hyperæmia, and even serous or hæmorrhagic effusion into the labyrinth. The hyperæmia in the latter region may be due in these cases to vaso-motor reflex influence, but probably it is more frequently owing to direct vascular connection. These hyperæmic conditions of the labyrinth, which may co-exist with congestive conditions of the external or middle ear, are usually temporary, and pass off with the disappearance of the peripheral inflammation. On the other hand, thickening or other changes in the labyrinthine membranes may in this way result, or there may be purulent formation.

Purulent Labyrinthitis (Acute and Chronic) is a well-known consequence of purulent otitis media. This condition is fully described at page 302.

Interstitial Inflammation of the Fenestral Structures in the middle ear frequently extends to the membranous and nervous structures of the labyrinth, causing thickening, induration, atrophy, etc., in the labyrinth similar to the tympanic changes.

Excessive Pressure upon the Labyrinthine Fluid is an important cause of labyrinthine disease, *acting from the direction of the tympanic cavity*. This is exerted through the fenestral membranes, chiefly through the fenestra ovalis, and may be produced both by acute and by chronic diseases of the middle and external ear. The pressure may be due (1) to the foot-piece of the stapes being forced in upon the fluid of the labyrinth; (2) to the presence of air, water, or inflammatory products acting through the fenestral structures, or *through a carious opening*; or (3) to thickening or osseous changes (otosclerosis) of the membrane of the fenestra rotunda or of the annular ligament of the stapes. When we consider that the labyrinthine fluid is contained in a cavity with unyielding walls, except at the fenestral openings, and having no means of exit except through the two very slender aqueducts, it is easy to see that, if exposed to pressure at one of the fenestral openings, especially if the membrane closing the other opening be rigid, the delicate terminal structures of the auditory nerve must suffer. There is little doubt that, if this pressure is continued for a great length of time, permanent changes of the structures exposed to it must ensue. Probably sudden pressure produces greater functional disturbance than gradually increasing pressure.

Atrophy of the Terminal Nerve Structures is said to take place from the absence of the specific nerve stimulation, when a high degree of defective hearing,

due to an affection of some part of the external and middle ear, has existed for a long time. Still it is sometimes found that such a form of deafness may continue for a very long period without injury to the nerve, as shown by ultimate restoration of hearing.

(4) *DISEASE OF THE INTERNAL EAR PRODUCED BY CERTAIN GENERAL AFFECTIONS OR CHANGES WHICH INVOLVE THE BLOOD AND CIRCULATION.*

Acquired Syphilis of the Labyrinth. Syphilis is probably the most important constitutional disease which may give rise to disease in the labyrinth. As we have seen, it may cause sudden exudation into the cavities of the labyrinth with Ménière's series of symptoms, or a more gradual change in the labyrinthine structures. Acquired syphilitic disease of the labyrinth is more often unilateral than inherited syphilis. Males are also more frequently affected, this being the converse of what is found in inherited syphilis. In non-exudative inflammation of the middle ear the poison sometimes exercises a most unfavourable influence upon the course of the disease by its effects on the labyrinth (see p. 389). Syphilis of the labyrinth may manifest itself during the secondary period, but more frequently it affects the organ in the tertiary period, perhaps many years after the primary disease. In some cases no other symptoms of syphilitic disease are present although generally there are other indications present.

Hereditary Syphilis of the Labyrinth. An affection of the labyrinth due to hereditary syphilis, usually following iritis or keratitis or both, is not unfrequently met with in young persons, leading to serious or even total deafness. The deafness may come on suddenly or it may be more gradual. These patients often present notched upper middle incisors (Hutchinson), and also cicatrices radiating from the lips and angles of the mouth (see Fig. 214), the remnants of ulceration in early life. Syphilitic disease of the bony framework of the nose often also co-exists in such cases. Several members of a family may be affected in this



FIG. 214.—Patient (aged 21 years) almost totally deaf from specific disease (hereditary) of the labyrinth, showing cicatrices radiating from the lips and angles of the mouth. She had also notched upper middle incisors, remains of keratitis, perforation of the soft palate, and disease of the bony framework of the nose.

way, leading in some cases to loss of both vision and hearing. It is more frequent in females than in males.

The Zymotic Diseases, especially scarlet fever, enteric fever, smallpox, typhus fever, whooping-cough and diphtheria, are not unfrequently attended by disturbance of the auditory function without apparent disease of the external or middle ear. Labyrinthine deafness is found also to follow epidemic influenza in some cases. It is probable that these disturbances are due to congestive conditions of the labyrinth, which in many cases pass off during convalescence from the general disease, but which sometimes lead to permanent mischief, shown by the persistence of the deafness or subjective sounds in the ear. Malarial fever seems to be followed in some cases by labyrinthine deafness, although the quinine which is given in these cases has probably a share in the production of the deafness. The labyrinthine deafness which sometimes follows rheumatic fever may in like manner be due to the salicin administered.

Degenerative Diseases of the kidneys and liver by their effect on the blood may give rise to changes in the labyrinth, especially in persons predisposed to ear disease.

Anæmia, either due to disease or to rapid loss of blood, may, through the anæmic state of the labyrinth, cause deafness and noises in the ear. The ringing in the ear, which often accompanies post-partum hæmorrhage, is an example of the effect of rapid loss of blood. In leukæmia, pernicious anæmia, and even in simple anæmia, there may be a hæmorrhage into the labyrinth signaled by Ménière's series of symptoms.

Mumps is in some cases associated with sudden and extreme deafness of a permanent character owing to changes, apparently metastatic, as yet unknown, occurring in the interior of the labyrinth.

Herpes of the external meatus or auricle is sometimes accompanied by deafness of the labyrinthine type with, it may be, facial paralysis. The nerve affection is probably a neuritis and generally passes off in time.

In Extreme Emotion sudden deafness may be experienced, and this is probably closely allied to the sudden and temporary deafness accompanied by pallor, sickness, tinnitus and giddiness, which has been called angio-neurotic deafness.

Some Medicinal Substances seem to exercise a disturbing influence upon the labyrinthine circulation, manifesting itself by deafness, or by singing or other sounds in the ear. The chief of these substances are quinine, salicin, salicylate of sodium, opium, and salts of morphia. Large doses of these are usually necessary to produce the effect on the ear, but with persons who suffer already from defective hearing even ordinary doses may aggravate the aural disturbance, and this aggravation *may remain permanent*.

(5) *DISEASE OF THE INTERNAL EAR EXCITED BY INJURIES OF THE EAR OR HEAD.*

A Blow or Fall upon the Head may, with or without fracture of the petrous bone, rupture the tissues in the interior of the labyrinth, cause effusion of blood, and produce great and permanent damage to the delicate terminal structures of the auditory nerve; or there may be tearing of the nerve in its stem or at its origin in the brain. It is to be remembered that the softness of the auditory nerve renders it specially liable to be injured or torn by blows or falls upon the head. The injury may, without fracturing the bone or tearing the soft parts, cause violent concussion of the delicate structures of the labyrinth or of the nerve, setting up great irritation of the terminal nerve structures or paralysis of their receptive power. Chronic inflammatory thickening of the membranous labyrinth may be the issue of such a concussion. In these severe injuries, due to fracture or simple concussion, the effects are not always confined to the labyrinth, but may involve also the middle ear, in which there may be dislocation of the ossicula or rupture of the soft parts with effusion of blood into the cavity of the middle ear, and subsequent inflammatory reaction. In blows upon the ear, it is found that, if the force exerted by the compression of air in the external meatus is partially spent in rupturing or injuring any of the tympanic structures, the labyrinth either escapes altogether or sustains less injury than when the middle ear has not received damage. The effects of injuries to the labyrinth are usually also much more severe if any disease has previously existed. Injury to the labyrinth may also be caused by direct violence, such as by a knitting needle or other instrument thrust through the tympanic membrane into the labyrinthine wall, or a bullet may penetrate the labyrinth; in both cases the facial nerve is likely to be involved.

Loud Sounds as a Cause of Ear Disease. It is familiarly known that boilermakers and others who work amid noisy surroundings are liable to dulness of hearing, and in this way very many persons have their hearing irremediably damaged. The writer examined a hundred men employed in boilermaking, and found that very few had escaped injury. He found also decisive evidence to show that the nervous structures in the internal ear are essentially the seat of the mischief in this form of deafness. In the early stages of exposure there is a tendency for the disturbance of hearing to diminish or pass away if the person abandons the noisy employment.

The sudden report of a piece of artillery or the shock of an explosion, or even the shriek of a railway whistle, may produce serious deafness from injury to the terminal structures of the nerve.

(6) *DISEASE OF THE INTERNAL EAR FROM REFLECTED VASO-MOTOR IMPRESSIONS.*

These impressions may bring about congestive conditions of the labyrinth, manifesting themselves in partial deafness and sounding in the ear, generally temporary in character. The vaso-motor connections of the labyrinth are wide and numerous. The effects of disturbance of the digestive process upon the ear may be explained from such a connection. The aggravation, which is often noticed in an aural affection during menstruation, pregnancy, and lactation, may be accounted for in like manner. So also the deafness and noises in the ear, usually of a very fluctuating character, which are associated with some forms of hysteria, are probably due to reflex disturbance of the circulation of the labyrinth.

Malformations of the Labyrinth. Serious or total absence of hearing may be due to malformations of the labyrinth, such as absence of the fenestral openings, defective formation of the vestibule, semicircular canals or cochlea, defect or excess of otoliths, or absence of the auditory nerve. Congenital deaf-mutism is doubtless sometimes due to such malformations.

SYMPTOMS OF DISEASE OF THE INTERNAL EAR.

Disease of the labyrinth or auditory nerve manifests itself chiefly by one or more of the following symptoms:—(1) Deafness, which is usually severe, associated with defective bone-conduction, defective appreciation of high notes, and partial tone-deafness; (2) subjective sounds in the ear; (3) giddiness or staggering gait, often with nystagmus; (4) nausea or vomiting.

These symptoms when occurring together and suddenly, as in hæmorrhage into the labyrinth, are often termed "Ménière's disease," or "Ménière's series of symptoms."

Primary Labyrinthine Disease often manifests itself by Ménière's Series of Symptoms. Ménière in 1861 described a series of symptoms, which he held to be due to a pathological condition in the semicircular canals. These symptoms consist in a sudden attack of *giddiness or staggering*, frequently accompanied by nystagmus, causing the person to fall to the ground, or to turn or wheel to one side. The disease may come on while the patient is in bed, the sensation of the bed heaving, as if in a ship in a storm, being the first indication of the seizure. *Nausea or vomiting* is frequently present. At the moment of the attack, or immediately after, *deafness*, usually very decided, is experienced on one or seldom on both sides along with *great noises in the ear*. Pallor of the face (occasionally flushing) and cold sweats, with, in some cases, fainting, may be

observed. Unconsciousness is rare and, if present, it is very short in duration. Headache is in some cases complained of. Depression, slowness of thought, and weakness of memory may follow for a time. Guye describes a peculiar trembling of the hand which he has seen in connection with Ménière's symptoms. The suddenness of the attack and the character of the symptoms may give rise to the suspicion of a lesion in the brain. And, as in point of fact it is often due to sudden hæmorrhage into the labyrinth, it is designated by Knapp *apoplecticiform deafness*. The attack may take place in a person previously free from any affection of the ear, or in one who has already had some affection of the middle ear, especially non-exudative inflammation.

In many cases the deafness and noises in the ear prove permanent, while the other symptoms pass off after a period varying from a few minutes to several days. A greater or less tendency to stagger often continues for a time, with some giddiness. Frequently, however, after an interval of variable duration, a renewed seizure takes place, followed by another interval; and these may continue for years. Usually after each attack the deafness becomes more profound. It has been observed in some cases that, when a state of complete and permanent deafness had been reached, the attacks ceased to occur. Ménière based his opinion as to the pathological seat of the disease—(1) On the examination, after death, of the head and ears in a case which presented in a marked form the symptoms just described. In this case while he found no lesion in the brain or interior of the cranium, the semicircular canals were occupied by reddish lymph. (2) On the theory of the special function of the semicircular canals, which ascribes to this part of the ear the power of controlling the equilibrium of the body (see p. 405).

The term Ménière's Disease should only be applied to those cases in which the symptoms come on suddenly in a person previously in good health and with normal hearing, and in which, on examining the ear very soon afterwards, no evidence of recent disease is found in the external or middle ear. The strong presumption in such a case, if there be no disturbance of any of the other cerebral or spinal nerves, is that we have to do with a sudden pathological change in the interior of the labyrinth, probably an effusion of blood or an exudation of lymph, in such a position as to press upon and irritate the vestibular and ampullary nerves. Disease in the middle ear, such as effusion into the cavity of the tympanum, producing great pressure upon the fluid of the labyrinth *through the fenestral membranes*, may excite the symptoms included in the term Ménière's disease. Any kind of pressure acting upon the fluid of the labyrinth, if sudden and severe, may irritate the nerve endings in the ampullæ and vestibule, culminating in a seizure of Ménière's disease.

Syphilis of the Labyrinth is usually characterized by extreme deafness, by great subjective noises in the ear, and by giddiness (Ménière's series of symptoms), with diminution or total abolition of the perception of sound by osseous conduction. In a certain number of cases giddiness and tinnitus are absent. The defective bone conduction may be more marked for the upper and lower limits of hearing, but as the disease advances the middle registers are more and more encroached upon from above and below, until only a small island of hearing is left, and even that may disappear. These symptoms may come on very suddenly, although they sometimes do so gradually, and the disease usually affects both ears, although it is occasionally limited to one ear for months, after which the other may also become affected. It may occur in a person whose ears have been previously quite normal; but we frequently find that catarrhal disease of the middle ear, often originating before the syphilitic disease affected the system, though not of an extreme form, has existed previously. Suddenly, it may be in a night's time, the syphilitic poison attacks the labyrinth, and the moderate deafness, previously due to the catarrhal affection, becomes almost total and attended by distressing noises in the ear. Sometimes, again, we find that while a fresh catarrh evidently exists in the middle ear, the extreme character of the deafness and the indications derived from the state of the osseous conduction raise the suspicion that the catarrhal affection is complicated with mischief in the labyrinth. For hereditary syphilis, see p. 411.

Defective Hearing and other Anomalies. As a rule the deafness associated with disease of the labyrinth or nerve is much more extreme than in disease of the conducting apparatus, and is not confined to the ordinary mode of hearing by aerial conduction, but involves also perception by osseous conduction. The defective hearing means involvement of the cochlea. With involvement as well of the semicircular canals or vestibule, giddiness and nystagmus are superadded; if the cochlea is unaffected the hearing may be but little if at all impaired. From the mere intensity of the deafness it is not possible to distinguish a lesion of the labyrinth or nerve. Very great deafness may exist in consequence of complete rigidity of the stapes and fenestral structures, but in this case it has usually advanced slowly and gradually. On the other hand, in disease of the labyrinth or auditory nerve the deafness frequently comes on suddenly or progresses very rapidly. In Ménière's disease it is sometimes found to precede for a few hours the other symptoms, but in general it comes on almost simultaneously with the giddiness. As a rule, a loudly ticking watch is not heard close to the ear, neither are words whispered into the ear perceived. Bone-conduction is also defective, as tested both by Weber's and Rinne's tests. Objective examination may show nothing abnormal

in either the external or the middle ear; although there may be, and often is, an associated middle ear disease. Fortunately, in many cases, only one ear is affected. When the disease affects both ears in young children, deaf-mutism is generally the result. The deafness, like the noises in the ear, is in a large number of cases permanent, although transient deafness is met with in neurotic forms of labyrinthine disturbance, and after hyperæmia or congestive processes.

Defective bone-conduction, as a symptom of an affection of the auditory nerve, is described at page 420; while partial tone-deafness, false tone-perception, and painful hearing are described at pages 48 and 49.

The Subjective Sounds in the Ear are in most cases well marked, and probably indicate cochlear involvement: they are often most distressing features of the disease. In Ménière's disease they generally come on simultaneously with the vertigo, but sometimes they are not experienced for a few hours after, or, in rare cases, for a day or two. The characters of these sounds are variously described by patients. The following, taken from the writer's note-book, are some examples:—Sound of a shell, waves, railway whistle, bell, rushing, buzzing, loose shutters in the wind, singing, humming, ticking, roaring, rushing water and waving of trees, whistling, factory noise, twittering and whistling of birds and crickets, blowing off steam, howling, hissing, flaring of gas, piano-playing, electric bell. The behaviour of these sounds is sometimes peculiar. For example, in the case of the electric bell, a sound precisely like an electric bell was heard, followed by half a minute or so of silence, then there again came the sound of the electric bell, followed by silence—this alternation going on continuously. In nearly all the writer's cases the sounds in the ear connected with Ménière's disease, while varying in intensity at different times, remained permanent, and he has always found them present years afterwards, when he has had the opportunity of examining the patient. There may be hallucinations of hearing (see p. 53).

Giddiness and Staggering—Auditory Vertigo (see Giddiness and Staggering as Symptoms of Ear Disease, p. 56). In acute labyrinthine disease the giddiness is very sudden and intense, and is usually the first symptom of the seizure. The objects around may seem to rotate, or the ground in front may seem to rise or fall, or there may be a sense of movement only in the patient's body, either that of rotation round a vertical axis or of moving backwards or forwards on a horizontal axis. There may simply be a staggering or want of control in the legs, especially in the dusk or dark, when the movements may resemble those of a drunken man. The patient is generally apt to turn or fall in the direction of the affected ear. If the attack commences while walking in the street, he staggers and tries to hold on by

the wall or lamp-post. If he be in bed he feels as if in a ship in a storm. After a short time, from a few minutes to several days, the giddiness passes off or markedly diminishes, but it may return again, even repeatedly, although generally more slightly. A certain degree of staggering or giddiness is specially apt to return when the patient at first resumes the upright posture. It is apt also to be excited by sudden movement of the head, and it is often much worse in the dark. A gentleman recently informed the writer that in the dark his legs collapse as if paralyzed, while in the light he has no difficulty in walking. Another patient says that in the dark "his legs go all ways," and he takes the whole breadth of the road, so that he avoids going out at night; he walks quite well during the day. The giddiness seems sometimes to be excited by superficial irritations, or by particular postures. A patient said that, when, in combing his hair, the comb touched a particular spot on the side of his head, he dropped on the floor and "felt like a spinning-top."

It is now pretty well established that these disturbances of equilibrium are caused by irritative lesions of the semicircular canals or the vestibule. In affections of the cochlea alone, vertigo is probably absent, and cases have been investigated clinically in which labyrinthine deafness without giddiness existed, where, at the *post-mortem* examination, no evidence of disease of the vestibule or semicircular canals was found, but where there was definite involvement of the cochlea.

Nystagmus. Associated with the giddiness there is often nystagmus (see p. 63). This is generally more marked when the eyes are directed towards the sound ear, and may be regarded as another indication of irritation of the semicircular canals. When the lesion eventually causes destruction, giddiness and nystagmus cease, when neither rotation of the patient on a revolving stool nor Barany's method of syringing the ear with solutions of varying temperature, excites any reactive giddiness or nystagmus.

Giddiness from Excessive Air-Pressure in the Tympanum. Many examples of giddiness due to excessive and especially to sudden air-pressure upon the walls of the middle ear have come under the writer's notice. The act of blowing the nose, by forcing a current of air into the middle ear, sometimes excites giddiness. A medical friend subject to ear giddiness informed the writer that he has to blow his nose with the greatest care, otherwise giddiness and loss of balance are excited. The effects are still more striking where violent blowing of the nose is indulged in during the existence of a nasal catarrh with obstructed nasal passages. The pressing of air into the tympanic cavity by forced expiration, while the nose and lips are closed (Valsalva's experiment), may also produce giddiness. So also temporary giddiness may be excited by inflating the middle ear either by Politzer's method or with the catheter.

Giddiness due to Syringing the Ear. The entrance of water into the middle ear through an existing perforation of the tympanic membrane often induces

giddiness, sometimes of a violent character. Even where the tympanic membrane is intact, syringing the ear, especially if the water be too hot or too cold, or the force too great, may excite giddiness in some persons. The danger, however, is much greater when the membrane is perforated by present or past purulent disease of the middle ear. In such cases, even nausea and vomiting may be excited as well as giddiness. It is possible that, in some of those purulent cases where severe giddiness is excited by syringing the ear, an aperture of communication, carious or otherwise, may exist between the middle ear and the labyrinth through which the fluid may pass into the labyrinthine cavities or even into the interior of the cranium.

Fatal Ear Giddiness while Bathing. If the syringing of the ear is apt, in persons with perforated tympanic membranes, to induce giddiness, it is highly probable that the rush of water into the ear in such persons, while the head is submerged during bathing, may also excite giddiness. It is therefore surmised, and the writer thinks with great probability, that death from drowning during bathing is sometimes connected, in the case of expert swimmers, not with exhaustion or cramp, but with the sudden occurrence of giddiness due to the rush of water into the canal of the ear, and into the tympanic cavity through a perforation which may exist in the membrane.

Giddiness from Disease of the Middle or External Ear. It is now generally recognized that *giddiness may exist with almost any form of disease of the ear*. We have already drawn attention to the fact that the labyrinthine fluid may be exposed to pressure from the direction of the middle ear through the fenestral openings (see page 410). Accumulation of secretion, polypi, thickened mucous membrane, especially that lining the fenestral structures, undue pressure inwards of the ossicular chain—these may produce sudden or gradual pressure upon the fluid in the labyrinth, calling forth sudden and severe giddiness, or milder forms of it. But the irritation of the nerves in both the external and middle ear, without direct pressure upon the labyrinthine fluid, may, in certain cases, give rise to giddiness. The most cautious manipulation of the ear may excite giddiness so severe that the patient falls to the floor; this is probably due to a reflex connection with the semicircular canals.

Middle Ear Giddiness contrasted with Primary Labyrinthine. The whole of the symptoms of a true Ménière's attack may be produced by middle ear pressure, but in some the sickness and vomiting are absent. The vertigo may be extreme, or it may amount to no more than a staggering backwards when the head is suddenly turned round, especially to the affected side, with a tendency to fall forwards when the head is moved again to the front. Some patients complain of a staggering tendency in the dark, while others say they tend to fall if they turn quickly or stoop. An important distinction between this form of vertigo and the labyrinthine variety is that here the whole of the symptoms frequently disappear, the accessibility and nature of the region affected enabling us to remove, by operative or other treatment, the pathological cause. We find also in the class of cases due to primary labyrinthine mischief, that, while the vertigo, sickness, and vomiting usually pass off, the noises and deafness generally remain permanent. In the present class of cases, on the contrary, not only are the vertigo, sickness, and vomiting amenable to treatment, but the noises in the ear are frequently got rid of, while the hearing is in many cases much improved, if not entirely restored. Middle ear giddiness also is frequently preceded by other symptoms of ear disease (unless in cases due to sudden air or water pressure), such

as pain in the ear, defective hearing, subjective sounds, discharge from the ear, etc., in this way contrasting with the labyrinthine class of cases, in which we find that the giddiness is often sudden and the first symptom complained of, although quickly followed by the other symptoms. In middle ear giddiness also the subjective sounds are rarely so distressing, nor is the defective hearing so extreme as in the former class of cases; while bone-conduction of sound, as indicated by the various tests, is, in the great majority of cases in excess of air-conduction. This is, as we have already indicated, contrary to what is usually found in labyrinthine giddiness.

Circumstances outside the Ear which may modify Aural Giddiness.

While irritation of the terminals of the vestibular and ampullary nerves may be the basis, or, at least, the predisposing cause of vertigo, other systemic or distant local conditions may prove important modifying or exciting causes. No doubt, for example, digestive or hepatic disturbance, lithæmia or oxaluria may excite giddiness although the condition in the ear is the primary and central cause, and thus ear giddiness is often confounded with indigestion or biliousness. In some cases we find that the vertigo or the tinnitus is connected in its origin with some nervous shock, such as bereavement or grief, or some mental strain, such as in the case of a student preparing for an important examination. The disease strikes in the case of vertigo at the vestibular nerve, while in the case of subjective sounds the cochlear branch receives the blow. But in most of these a pre-existing and predisposing ear disease has increased the vulnerability of the nerve.

Sickness and Vomiting are usually connected with acute labyrinthine disease, and begin soon after the disturbance of equilibrium, being probably due to reflex action through the vagus nerve. These symptoms naturally suggest the possibility of brain mischief. On the other hand, owing to the symptoms, both patients and practitioners *frequently regard such attacks as purely bilious in their nature*. The sickness and vomiting soon pass off, and rarely extend beyond a day or two.

DIAGNOSIS OF DISEASE OF THE INTERNAL EAR.

In this inquiry, tests applied to determine the power of hearing high and low notes by air-conduction and of tones conducted by the bones of the head are of the very greatest importance. The student is referred to the section on "Methods of Testing the Hearing," p. 34, and on "Defective Hearing," p. 46, for details on this subject.

It is convenient to distinguish two groups of cases—first, those in which examination by the external meatus and Eustachian tube shows little or no departure from health; second, those in which such an examination gives distinct evidence of disease in the external or middle ear.

Cases in which careful examination of the External and Middle Ear yields Negative Results. If a loudly ticking watch placed in contact with the bones of the head is not heard at all, we may suspect

an affection of the nerve; this suspicion is still greater, if Politzer's acoumeter, when applied to the bones of the head, is not perceived by the patient. If the vibrating tuning-fork ($C = 128$ vs.) applied to the mastoid is not heard at all, or for a very short time, and if, after it has ceased to be heard on the mastoid, it is heard when held near to the ear (aerial conduction), and if in addition there is failure to hear the higher notes of the scale, as tested by Galton's whistle or high-pitched tuning-forks, there is great probability of an affection of the labyrinth or auditory nerve. This is confirmed if the patient be afflicted not only with a high degree of deafness, but also with great tinnitus, and especially if the deafness and subjective noises have come on suddenly, with loss or marked diminution of the perception of sound by osseous conduction, as tested by Weber's and Rinne's tests. The presence of giddiness or nystagmus would also point to the labyrinth.

On the other hand, if, after a period of gradually increasing deafness, examination of the external and middle ear yields negative results, and if the tuning-fork by osseous conduction is distinctly heard, or, the affection being confined to one side, is heard better on the affected side (Weber's test) the probability is that the disease is in the conducting part of the ear, and that there is ankylosis of the stapes (otosclerosis) or thickening of the fenestral membranes. This is confirmed if, after the tuning-fork has ceased to be heard near to the ear by aerial conduction, it is heard for some time when transferred to the mastoid process or vertex (Rinne's test). Still further confirmation is gained if low notes are well heard by bone-conduction, and if paracusis Willisii is present. It must not be forgotten that important changes may exist in the fenestral membranes, or in the recesses leading to them, *which cannot be recognized either by ocular inspection or by any other objective mode of examination.*

Cases which show a Decided Affection of the Middle Ear. The affection is in the great majority of cases confined to the conducting apparatus, if the sound by osseous conduction (Weber's test) be heard distinctly louder on the affected or worse side; or, both sides being equally affected, if the tuning-fork yields a negative result by Rinne's test or if the tuning-fork be heard as long as on our own mastoid—our auditory nerves being healthy. On the other hand, secondary disease of the nerve is probably present if we have an affection of the middle ear which has existed during a very long period, perhaps from childhood, with very great deafness, while the sound by Weber's test is heard better on the normal or better side and a positive result is obtained by Rinne's test, especially if we have had the opportunity of tracing the course of the disease, and have noticed gradually increasing difficulty of hearing with gradually diminishing perception

of the tuning-fork on the head. Or again, if a person who has suffered from catarrhal disease of the middle ear, with only moderate deafness, become very much more deaf, with severe tinnitus and diminished osseous conduction, there is great probability of a labyrinthine complication. The presence of defective capacity for hearing high-pitched notes or partial tone-deafness, and the *absence* of the phenomenon of hearing better in a noise, also point to a nerve lesion.

There is no certain means of distinguishing purely labyrinthine disease from disease involving the stem or root of the nerve. No doubt if, in the presence of symptoms pointing to an auditory nerve affection, after a thorough examination of the whole of the cranial nerves, we find no indication of involvement of any of them, and no other sign of intracranial mischief, we may assume that the disease is probably confined to the peripheral parts in the labyrinth.

TREATMENT OF DISEASE OF THE INTERNAL EAR.

Treatment of Acute Lesions in the Labyrinth, or true Ménière's Disease. If the patient be seen in the early stage, when there is great vertigo, perfect rest in bed must be enjoined, along with restricted diet. Intestinal derivatives should be employed, such as a mercurial followed by Carlsbad salts, Hunyadi water, or other saline. Quietness is desirable, as loud sounds are not only intensely unpleasant, but they tend to aggravate the symptoms by irritating the nerve terminals. The bromine compounds are useful, especially dilute hydrobromic acid, in doses of 30 minims, twice or thrice daily, or bromide of potassium or sodium, in 30 gr. doses, at similar intervals of time. Alcoholic stimulants are to be avoided.

External applications may be employed at this stage, such as cold to the head, alcoholic or other stimulating embrocations behind the ear, or sinapisms to the back of the neck or calves of the legs.

After a time, when the violence of the symptoms, especially the vertigo, has abated, other remedies may be resorted to. Iodide of potassium and the hypodermic use of pilocarpine are probably the two most important remedies. The effects sought by these medicines are the stimulation of the absorbents so as to bring about the absorption of effused material in the labyrinth. If there is reason to believe that syphilis is at the root of the disease mercurials with iodide of potassium are strongly indicated (see Formulæ for General Remedies).

Iodide of Potassium and Mercurials. Iodide of potassium may be given in large doses even to the extent of a drachm daily for three or four weeks. The amount should be gradually increased until these large doses are tolerated. The writer has been informed of one and a half drachms being given with benefit thrice daily. A prolonged

course of bichloride or of iodide of mercury may be recommended in syphilitic cases. Inunction of half a drachm of mercurial ointment every day into the armpits and inside of the thighs, varying the place in order to avoid irritating the skin too much, may succeed better in some cases. In hereditary syphilis Siebenmann recommends this as more efficient than iodide of potassium; at best, however, the results of treatment are far from encouraging in the hereditary disease. More success can be hoped for in acquired syphilis by a combination of iodide of potassium and mercury. Ointment of iodoform or mercury rubbed behind the ear over the mastoid process may also be applied in the syphilitic as well as in other cases. Treatment at Aix-la-Chapelle might in such cases be preferred to medicinal treatment at home.

Nitrate of Pilocarpine is conveniently used in the form of the tabloids of Burroughs, Wellcome & Co., beginning with one eighth of a grain and increasing gradually to one fourth of a grain, if such be necessary to produce free salivation and diaphoresis; but sickness and vomiting must be avoided. A course of from fifteen to twenty hypodermic injections, one daily, omitting every seventh day, will give this remedy a fair trial. For a few hours after the injection rest in bed is essential. It is not a remedy which should be used in anæmic or very feeble patients.

While antisyphilitic remedies should usually be tried, we have unfortunately to admit that they do not, as a rule, act so well in syphilitic disease of the labyrinth as in the same disease in most other regions of the body. Indeed, they frequently appear to exercise little or no influence upon the disease. In the acute exudative affections of the labyrinth, pilocarpine is likely to have a useful effect and we are justified in giving it a trial.

Quinine was recommended in Ménière's disease by Charcot to the extent of 15 grs. daily. There is, the writer thinks, distinct danger of aggravating the symptoms by such large doses in the *early* stage of these labyrinthine cases, and he does not employ quinine at all in that stage.

Local Aural Treatment does not afford much prospect of benefit in the acute cases. In the more chronic stages the injection into the tympanic cavity through the catheter and Eustachian tube every third day for two or three weeks, of 8 to 10 drops of a solution of iodide of potassium (5 grs. to the oz.), or a similar quantity of a 2 per cent. solution of pilocarpine, may be employed in the hope of exercising a stimulating effect on the labyrinthine absorbents.

Acute Congestive Processes in the Labyrinth, when suspected, may be rationally treated by local blood-letting over the mastoid region. We know that the stylo-mastoid artery, which supplies the soft parts over the mastoid process, inosculates freely with the internal auditory artery in the tympanic cavity, and in this way a distinct vascular

connection is brought about between the labyrinth and the external parts. When hyperæmia of the labyrinth is associated with cerebral congestion, cold to the head, purgatives, and the usual treatment of cerebral congestion must be employed.

While, by these modes of treatment, it may be impossible in most cases to remove the deafness or the tinnitus, the giddiness is usually very favourably influenced, and there results also a greater sense of clearness in the head and relief of the mental depression so generally associated with these cases.

Chronic and Secondary Forms of Labyrinthine Disease. In regard to the treatment of these, many of which are related to, or extensions from, middle ear disease, we should first examine carefully the external and middle ear to ascertain if any condition exists, the treatment of which might benefit the labyrinth. We may thus find that symptoms of labyrinthine disturbance, such as vertigo (with or without nausea and vomiting) and subjective sounds in the ear may be sometimes removed by such treatment as the removal of a ceruminous collection, incision of the tympanic membrane, inflation by the various methods, the use of the pneumatic tractor, the treatment of a purulent disease, ossicectomy, antrectomy or the radical mastoid operation. Even the treatment of nasal obstruction may have a good effect on labyrinthine disease secondary to middle ear disease. When there is labyrinthine suppuration, operative treatment may be necessary (see p. 130).

Counter-irritants or resorbents over the mastoid process are more likely to be serviceable in labyrinthine disease than in disease of the middle ear. When the symptoms prove persistent, vesication behind the ear repeated three or four times may be tried, and this no doubt sometimes proves advantageous. The writer has found the use of iodine by friction in the form of iodine vasogen over the mastoid surface, as well as further back, apparently useful. Politzer recommends iodoform ointment and also mercurial ointments.

When there is supposed to be Paralysis of the Auditory Nerve vesicants over the mastoid region, iodide of potassium internally, and strychnine used hypodermically or by the stomach are recommended.

Quinine in small doses with hydrobromic acid is probably of more use in chronic and slighter forms of Ménière's disease than in the acute variety.

Medicinal disturbance of the labyrinth must, if possible, be avoided. Where chronic forms of deafness already exist, such medicines as quinine, and salicin with its compounds, should either be entirely abstained from or used with great caution; quinine should always be combined with hydrobromic acid. There is no doubt that permanent increase of deafness is not infrequently due to the use of

these medicines. Subjective sounds caused by quinine are sometimes mitigated and even removed by hydrobromic acid.

Boilermaker's Deafness requires precautionary measures. With boilermakers, riveters, etc., a plug of cotton or an aural protector (see page 97) will help to protect the ear. In some cases abandonment of the noisy employment is essential in the interests of the ear, and is sometimes voluntarily adopted by apprentices.

The writer, in a paper on the "Injurious Effects of Railway Whistles upon the Sense of Hearing," suggested the following precautions:—(1) The high-pitched railway whistle should be discarded as soon as possible in favour of a lower-pitched whistle; (2) some mechanical arrangement should be employed by which the current of steam passing from the boiler to the whistle may be easily regulated so that the tone may be at any time modified in its loudness and pitch; (3) in stations, especially covered stations, and also when alongside passenger trains, at rest or in motion, special attention should be given by the drivers to avoid sudden, loud, high-pitched notes.

The Constant Galvanic Current (see page 87) is sometimes employed in affections of the labyrinth, and especially of the auditory nerve. The most diverse opinions are held regarding its value. It should not be employed in the acute forms of disease, but rather when we suspect a torpid or paralytic condition of the auditory nerve, as shown by simple defect of hearing without subjective noises, and not due to disease of the external or middle ear. In order that this treatment may have a fair chance there should be at least ten or twelve sittings at intervals of three days, and each application should last for eight or ten minutes. When subjective sounds exist as a prominent symptom the continuous current very rarely relieves and in some cases aggravates this symptom. When it is considered that we are still unable to differentiate precisely the pathological conditions present in the labyrinth or auditory nerve, it is easy to see that great diversity must be shown in the effects of such a remedy as galvanism, and it should be used with the greatest caution in labyrinthine disease.

The State of the General Health and the habits must be investigated, because in these the proximate cause may be found, especially in the vaso-motor or neurotic forms. The digestive and hepatic systems may be at fault, and then such remedies as Carlsbad salts with mercurials, along with judiciously regulated diet and habits, would be the true indications. Nerve exhaustion in the overtaxed student or the harassed business man may necessitate a prolonged period of rest or a lengthened holiday. Anæmia may have to be dealt with by means of iron, nourishing food, fresh open air, etc., or the syphilitic cachexia may demand special treatment. If such symptoms as vertigo and subjective sounds are severe, total rest in bed with the use of bromine preparations may be necessary. If, on the other hand, the symptoms are slighter, a moderate amount of open-air exercise may be very desirable. In the case of vertigo, the

cheerful assurance of the physician that the vertigo does not imply any brain affection or impending brain affection, is very helpful to the patient. Noise and excitement must be avoided. The patient should also be warned, if vertigo be a feature of the disease, against climbing ladders, crossing planks, or placing himself in other (for him) similarly dangerous situations. Likewise sea or river bathing must be avoided, while, even in the house, a bath must only be taken in the presence of a second person.

Alcoholic stimulants are as a rule to be avoided, and tobacco should be only very moderately used.

Patients must avoid great bodily exertion or emotional excitement. Quick movements of the head, or stooping or rising up suddenly, are also likely to be injurious.

For the treatment of one of the most frequent symptoms of labyrinthine disease—subjective sounds in the ear—the student is referred to page 429.

Operations for the Relief of Vertigo and Tinnitus. The operative removal of the vestibule and other parts of the labyrinth for the relief of persistent vertigo has been recently practised by Richard Lake and William Milligan in non-suppurative cases. Lake brought forward the first recorded case in March, 1906, before the Otological Society of the United Kingdom, and since that time both Lake and Milligan have operated in a number of cases. The operations seem to have had encouraging results in the relief of the vertigo. In one of the cases both vestibules were ablated; it was found afterwards that when rotated rapidly on a revolving chair, the patient had no sense of rotation. This operation is described in the *Lancet* of 6th January, 1906. For the relief of tinnitus and vertigo, the operation for division of the auditory nerve at the internal auditory meatus has been carried out on three recorded occasions. The latest one, performed by Charles A. Ballance, was reported in the *Lancet* of 10th October, 1908. It was undertaken for the relief of painful tinnitus, and the result seems to have been more satisfactory than in the two previous cases by other surgeons. Further experience is necessary, however, before we can determine the value of this operation, and from the good results in Mr. Ballance's case such experience will no doubt be forthcoming.

CHAPTER XX.

TINNITUS AURIUM.

THE student is also referred to "Sounds in the Ear" as a symptom of ear disease at page 51.

CAUSES OF SUBJECTIVE SOUNDS IN THE EAR.

Nearly all the diseases of the ear—external, middle, or internal—may be accompanied by subjective noises. The purely subjective variety may depend upon some form of pressure or irritation applied to the auditory nerve in the interior of the cranium.

Morbid Growths or Products, such as tumours, hæmorrhagic clots, abscess, and inflammation, may, by pressure upon the roots or trunk of the nerve, give rise to severe forms of tinnitus, even when the organ of hearing is unaffected.

Abnormal Pressure upon the Cochlear Nerve Structures in the Labyrinth is probably the most common cause, and is exerted chiefly through the fenestræ by pathological changes in the tympanic cavity, such as collections of exudation, swelling or thickening of the mucous membrane, or excessive pressure of the base of the stapes upon the labyrinthine fluid. Non-exudative inflammation and otosclerosis are the most frequent and intractable causes. Here we have not only long-continued abnormal pressure upon the fluid of the labyrinth, leading often to nutritive changes in the nerve, but, owing to the rigid state of the membrane of the fenestra rotunda, which is often present, the pressure upon the fenestra ovalis has a more injurious effect upon the nervous structures of the labyrinth. The less severity and the infrequency of tinnitus in children are probably due to the yielding state of the membrane of the fenestra rotunda, and perhaps also to the wide aqueductus cochleæ which exists in the child, the bulging of the former towards the tympanic cavity, and the partial escape of the fluid of the labyrinth through the aqueduct, relieving the delicate nerve structures from the excessive pressure. In addition to pathological changes in the middle ear, excessive pressure of cerumen or of inflammatory products upon the tympanic membrane may push the ossicular chain towards the fenestra ovalis. The terminal structures of the cochlear nerve may also be exposed to pressure, not only from causes existing outside of the labyrinth, but also from dilated vessels, exudations, effusions, and thickenings *within* the labyrinth. A severe and permanent form, associated at the beginning with vertigo, is due to hæmorrhagic or serous exudation into the labyrinth (see p. 407). Subjective sounds are much

less frequent and severe in purulent disease of the middle ear than in interstitial inflammation.

Reflex Causes acting upon the Auditory Nerve or upon the Labyrinthine Vessels may give rise to subjective sounds. This reflex effect is frequently produced through the medium of the trigeminus nerve. Pressure or friction, either upon the mastoid process, the cheek, the tragus, or the back of the neck, may for a moment diminish or remove, or, on the contrary, may actually produce, a sound in the ear. Any irritation in the nasal or pharyngeal mucous membrane, in the gums or teeth, in the cutaneous lining of the external meatus, or in the mucous lining of the middle ear, may excite some form of tinnitus aurium in a reflex way by causing dilatation of the vessels of the labyrinth or by exciting the nerve itself. It is very probable that irritation acting upon more distant parts may affect the labyrinth or nerve. Cold, for example, acting on the soles of the feet, when a person stands with bare feet on the cold ground, may excite a sounding in the ear. It is probable that there are reflex connections between the digestive organs, as the stomach, liver, etc., and the circulation in the labyrinth. We frequently see the auricle reddened from dilated vessels due to sympathetic connection, through the vaso-motor system, with other parts of the body; and the vessels of the deeper parts of the ear may have a similar sympathetic connection.

The Entotic Subjective Sounds, or those actually due to sonorous vibrations originating either within the ear or in its neighbourhood, may come from *blood-vessels*, from the *movements of secretion* in the ear, or from *muscular contraction* in the tympanum or Eustachian tube.

Vascular Sounds. *The jugular vein* under the floor of the tympanum is often the source of the sound. At that point where the lateral sinus passes into the bulb of the jugular vein, the calibre of the venous tube becomes abruptly narrowed, and a murmur in the ear is apt to be produced at this contracted part of the lumen. We find this sound most frequently in anæmic conditions, or when the walls of the vein have become thickened from some morbid process. A *pulsating sound* is sometimes heard in the ear owing to an abnormal state of the *internal carotid artery*, as it lies in the osseous canal in the temporal bone. This is usually caused by some obstruction to the current of blood due to thickening of the inner coat of the artery, or to thickening of the walls of the osseous canal. Again, the dilated condition of the arterioles in congestion of the labyrinth or of the external or middle ear gives rise to a very disagreeable sense of pulsation, which is described as a *beating, hammering, or pumping* in the ear. The sounds originating in the internal carotid artery or internal jugular vein are either stopped or they are changed in character by pressure upon these trunks in the neck. Pressure upon the *posterior auricular artery* behind the ear sometimes also checks or allays these pulsating sounds. Most of these sounds connected with the blood-vessels are intensified when any impediment, such as swelling or thickening of the tympanic mucous membrane, exists to the passage of sound outwards.

Secretion in the Middle Ear often gives rise to sounds in the ear, especially during movements of the head or blowing the nose. These are described by patients as crackling, slight splashing, or the bursting of bubbles. Creaking or rubbing movements may be heard, when excess of cerumen or a foreign body is in the outer canal of the ear.

Contraction of the Muscles of the Middle Ear is frequently attended by noises. Tonic or clonic spasm of the tensor tympani or stapedius may give

rise to a slight drumming or buzzing sensation in the ear. During the contraction of the abductor tubæ in swallowing, even in a normal state of the ear, most persons are conscious of a sound. When, however, the walls of the Eustachian tube are abnormally closely connected by means of catarrhal products, a crack or such like sound often signalizes the sudden separation of the membranous wall by the action of the abductor tubæ in swallowing.

TREATMENT OF SUBJECTIVE SOUNDS IN THE EAR.

There is no actual specific remedy for tinnitus aurium. The treatment is usually that of the particular affection of the ear with which this symptom is associated, and our success will pretty much depend upon the nature of that disease. When connected with affections of the external meatus, with exudative catarrh or purulent inflammation of the middle ear, the effects of treatment are usually very satisfactory. When, on the other hand, they are connected with non-exudative inflammation of the middle ear, otosclerosis, or chronic disease of the labyrinth and auditory nerve, the prospect of completely removing the noises is in most cases very slight. The most we can hope for, in the majority of such cases, is a certain measure of relief. This symptom is found in practice most frequently conjoined with non-exudative inflammation and otosclerosis, and the treatment already described for these conditions, at p. 389 and p. 399, is the most generally applicable. Such treatment will frequently mitigate the symptoms temporarily or permanently, and this mitigation is usually accompanied by improvement of hearing, although it is sometimes otherwise. When the subjective sounds are attendant upon disease of the internal ear (and this is the case with the most severe forms), the treatment described for these affections must be resorted to (see p. 422).

We shall here refer to the use of external applications and certain special internal medicines, as well as to one or two points in general treatment.

Counter-Irritation and Embrocations behind the ear have, in some cases, a mitigating influence on the noises. These may consist of vesication, or the application of the tincture or the ointment of iodine or iodide of potassium (Formula 91), or of a spirituous embrocation (Formula 97) employed over the mastoid process. The writer has often found friction or massage behind the ear and over the tragus with an ointment composed of camphor, oil of peppermint and vaseline (Formula 91) grateful to patients.

While some patients state that they find partial relief to the sounds from pouring warm water or warm diluted glycerine into the ear, the pouring of fluids into the interior of the ear is generally useless and may be injurious.

The subcutaneous injection of Morphia into the back of the neck is rarely resorted to, and then only in very violent and paroxysmal noises.

The Vapour of Chloroform or of Acetic Ether inflated through the Eustachian catheter (see p. 85) has sometimes a mitigating influence upon severe tinnitus, but only temporarily.

Ligaturing the Posterior Auricular Artery is proposed in those cases of pulsating sounds, which are removed by pressure on this vessel. The writer has been successful in one case treated in this way.

Hydrobromic Acid (Formula 128), suggested at first by its effect in counteracting the aural symptoms produced by quinine, has been much advocated by Dr. Woakes, especially for vascular tinnitus, on the theory that it leads to contraction of the labyrinthine vessels. The effects of this drug are often disappointing, and the writer has found it more useful in cases associated with vertigo (Ménière's disease) than in other forms of tinnitus.

Bromide of Potassium, Bromide of Sodium, or Bromide of Ammonium is often of service, especially in cases associated with great irritability of the nervous system. From thirty to sixty grains of either of the first two, or ten grains of each of the three bromides dissolved in a large quantity of water every evening have often, for a time at least, a distinctly alleviating influence upon severe tinnitus.

Chloride of Ammonium in twenty grain doses, three times a day, was proposed and strongly recommended by Hinton. When useful, which, in the experience of the writer, is but seldom, its effects are probably due to its action on the naso-pharyngeal mucous membrane.

Salicylate of Sodium in fifteen grain doses, thrice daily, has been spoken of favourably by some writers, especially in the subjective sounds of Ménière's disease, or when the tinnitus is supposed to be associated with a gouty or rheumatic condition. The effects must be carefully watched, as this medicine may in some cases aggravate the tinnitus.

Digitalis may be tried in the severely pulsating form, due to some morbid condition of the blood-vessels; it has, no doubt, in some cases a mitigating effect.

On the merits of nitrite of amyl, strychnine, arsenic, nitro-glycerine, convallaria, tincture of arnica, valerianate of zinc, etc., we need not descant. To discuss the merits of the multifarious medicinal remedies suggested for the relief of noises in the ear would neither be profitable nor interesting. The aural practitioner unfortunately has been too often impressed with their feebleness and inefficiency. They may be tried when other measures are without effect.

Electric Treatment may sometimes prove beneficial from the action of the electricity upon the intrinsic muscles of the middle ear. We know the far-reaching influences of disturbance of the muscular apparatus of the middle ear upon the tension of the tympanic structures, and, secondarily, upon the tension of the labyrinthine fluid. The writer has consequently seen better results from the faradic current (see p. 87) than from the constant current. On the whole, however, the effects of electric treatment of tinnitus aurium are generally disappointing, and if incautiously used there is always the fear of aggravating the tinnitus.

Tone Treatment. Luce of Berlin observed that a striking influence was exerted upon certain subjective sounds, of a musical character, by bringing to bear upon them objective sounds coming from a tuning-fork, especially if these be as far removed as possible in pitch from the subjective ones. For example, if the sounds in the ear are high-pitched notes, such as hissing, ringing, and whistling, a deep-toned tuning-fork (such as C or C₁) is employed; on the other hand, if the sound be low-pitched, such as rushing, buzzing, humming, or a low-toned bell, then a tuning-fork of a high pitch (such as C³ or C⁴) is used. The vibrating fork is applied either by placing the end of its handle into the external meatus, or, in order to augment the sound, the vibrations are passed

through a resonator fixed into the orifice of the ear. The duration of the application may extend from one minute to five minutes, and, in order to ensure a continuous sound, the tuning-fork may be connected with a magneto-electric apparatus. The writer has often found from this method of treatment a temporary diminution or even disappearance of the sound, the respite varying from five minutes to several hours. He has not yet found a case in which a permanent effect was produced.

Pilocarpine, applied hypodermically, is useful in a limited number of cases, especially, as Politzer first pointed out, in recent exudation into the cavities of the labyrinth (see p. 423). Its action is probably due to its stimulating effect on the absorbents in contact with the effused products before these have become organized. This resorbent effect has probably some connection with its remarkable powers of exciting the cutaneous and salivary secretion.

Operations on the labyrinth and division of the auditory nerve at the internal auditory meatus have been carried out for the relief of this symptom (see p. 426).

General Treatment of Subjective Sounds. In the treatment of the persistent forms of subjective sounds in the ear, *the state of the whole body* should come under review, and appropriate medicinal, hygienic, or dietetic treatment should be employed to rectify, if possible, any departure from the healthy condition. The use of cathartics or mercurial preparations is in some cases very efficacious in giving relief, for a time at least, to the patient's distress. Some patients say that after a dose of Gregory's mixture, or a blue pill, followed by a saline, they enjoy a day or two's respite from the noises. If the hepatic functions are disturbed, and a torpid state of the bowels exists, a course of aperient waters, especially Carlsbad, or its salts in the finely powdered form, with an occasional mercurial, may temporarily relieve, if not altogether remove, the tinnitus. In anæmia or neurasthenia appropriate remedies should be employed (see General Formulæ). *The patient should be enjoined to withdraw his mind from the sounds and to ignore them as much as possible.* He should also be assured that they do not mean anything wrong with the brain, nor involve danger to life. Many patients aggravate matters very much and worry themselves greatly by dwelling upon imaginary dangers and constantly directing their minds to the sounds. Even when cure cannot be promised, the patient should be encouraged to expect gradual mitigation as time goes on.

The student is referred further to Formulæ Nos. 128 to 135.

CHAPTER XXI.

DEAF-MUTISM.

DUMBNESS must not be looked upon as a separate or isolated disease. It is, in the vast majority of cases, simply *a consequence of total, or a high degree of, deafness*, which has either been congenital, or has originated in the early years of life. Deafness for speech coming on under four years of age is certain to be attended by dumbness; and even between four and eight years of age, if great care is not exercised, and especially if the child has not learned to read, or is of less than average intelligence, serious deafness is liable to be followed by loss of speech.

The deafness, which leads to mutism, may be *congenital* in its origin, or it may be *acquired* after birth.

Congenital Deaf-Mutism. Recent investigation seems to prove that the *congenital* form is somewhat less frequent than the acquired. The pathological conditions found in the congenital form are either defective formation of the ear, such as closure of the external auditory canals (very rare), absence of the fenestral openings, or partial or complete absence of the semicircular canals; or they are the results of intra-uterine inflammation of the labyrinth or middle ear. It is held by some that syphilis is responsible for a certain number of congenitally deaf-mutes. In nearly all cases epithelial degeneration has been found particularly in the organ of Corti; changes in the lumen of the ductus cochlearis are also frequently noticed. Hereditary influences probably play an important part in the production of these defects or diseases. It is somewhat remarkable, however, that only a very small proportion of the children of deaf-mutes have the affliction of their parents. On the other hand, several members of a family may be deaf-mutes, and yet no defect of hearing exist in either of the parents. Indirect relation of hereditary tendency to deaf-mutism seems to be much more frequent than direct. It is more common to find that the uncle or grand-uncle has been a

deaf-mute, than the father or grandfather. The inter-marriage of relatives is said to be productive of a large number of deaf-mutes. According to Hartmann 8.1 per cent. of deaf-mutes are the offspring of consanguineous marriages. Some authorities, on the other hand, deny this. Probably these marriages are liable to produce defects in the descendants, only when serious constitutional anomalies exist in the family from which both parents spring, in which they would both share. The probability is that, when the lineage of the two is healthy, the offspring do not suffer from the relationship of the parents. Congenital deaf-mutism is slightly commoner among females than males.

In the Acquired Form of Deaf-Mutism, that is, where the deafness causing the mutism has originated after birth, the causes and pathological conditions are very various. The three most common causes in order of frequency are cerebro-spinal meningitis, scarlet fever and measles. Other causes are ordinary meningitis, labyrinthitis, hereditary syphilis, mumps, diphtheria, typhoid fever, and injuries. The changes in the internal ear in the acquired form are chiefly the results of inflammation or suppuration, and consist of destruction of a part or the whole of the membranous labyrinth, the normal structures being replaced by fibrous or even osseous tissue. Pathological changes are not unfrequent also in the middle ear, as the consequences of catarrhal or inflammatory diseases. The most common are thickening or rigidity of the fenestral membranes, extensive adhesions, ankylosis of the stapes, and other effects of adhesive catarrh. At other times we find, owing to purulent inflammation, destruction of the tympanic membrane and ossicular chain. In all these cases, both ears must be seriously affected before leading to such a degree of deafness as to hinder the hearing of loud speaking. Hereditary influence probably also plays a part in the causation of the acquired form. Acquired deaf-mutism is more common amongst males.

It is useful to recognize two forms of acquired deaf-mutism. First, when the deafness arises so early in life (in the first year or two years), that the child has never spoken. It is evident that, if he does not hear words, he cannot learn to speak. Second, when the deafness affects the child after the power of speech has been partially or completely acquired, depriving him of speech. This may happen up till the seventh or eighth year of life.

Deafness less disastrous in the Adult than in the Child. A degree of deafness, which would rob the child of speech, or which would prevent him acquiring it, would probably in the adult interfere very little with his social intercourse. The adult, who becomes very deaf, retains his power of speech, because (1) it is so firmly implanted in his memory that he can never forget it; (2) his knowledge of

language, and of the lip and facial movements made in speaking, enables him to guess, from the words which he does hear, the sense of those he fails to hear, and also partially to understand what is said from the visible movements of the lips; (3) he insists on hearing and understanding by asking the speaker to articulate loudly and distinctly; and (4) his ability to read maintains and even extends his knowledge of language.

Serious Effects of Deafness in Childhood. *It is very different with the young child*, who has only recently acquired, and that very partially, a knowledge of spoken language. For years this knowledge remains very limited and defective. His knowledge of the various and multiform sounds, with their meanings, which constitute spoken language, is attained very gradually and slowly, by frequent repetition of words in the hearing of the child, in conjunction with the exhibition of the objects, qualities, or actions, which they represent. With a healthy mental condition and a normal state of the vocal organs (the latter are very rarely abnormal) the naturally strong imitative faculty of a child enables him to repeat the sounds, at first imperfectly; gradually, as he repeatedly and accurately hears the same sounds, his intonation and pronunciation become more and more perfect. But, when the hearing of words becomes distinctly impaired, although far from being totally lost, a less perfect articulation is very early observed, as he fails to hear all the shades of sound which make up articulate speech.

The Proportion of Deaf-Mutes to the Population, so far as statistical investigation informs us, is 7·77 to every 10,000. In Great Britain the proportion is 5·70 to the 10,000. In mountainous districts the proportion is very much greater than in the plains. In Europe the largest number is in Switzerland, where there are 24·5 deaf-mutes for every 10,000 of the population. The Netherlands show the smallest proportion, 3·35 in the 10,000. It is conjectured that the excess in the mountain districts is due to the greater tendency in these regions to consanguineous marriages.

Diagnosis of Total Deafness in the Child. If a dumb child is brought before us for the first time, after the age at which speech should begin to be acquired, it is difficult to ascertain with certainty whether the child ever had the power of hearing. Parents are very unwilling to think that their child has never heard. Besides it is not easy to determine positively, in the first year of life, especially in the first few months, whether a child hears. The mother may find that the child sleeps more soundly, and is found to be unaffected by noises which disturb and waken other infants. But at this age, if we find the organs to be normal, so far as they come under objective examination, we cannot arrive at certainty. We shall often find by objective

examination pathological states of the tympanic membrane, such as chalky deposits, indrawn membrane, cicatrices, or even perforations. These are in most cases merely accidental, having nothing to do with the serious deafness, the causes of which are more deeply seated. After the first year, it is generally possible to determine whether or not marked deafness exists. The mother's anxiety is aroused by *the delay of the child in beginning to speak*, and by its inattention to loud sounds produced in its neighbourhood. Suspicion being excited, the child should be tested in various ways. While its eyes are turned away from the source of sound, a bell or whistle is sounded, or the hands are clapped, or vowel sounds are loudly pronounced. If the attention of the child is not excited, as shown by the head not being turned round towards the source of the sound, it may be concluded that there exists no actual power of perceiving sound. It is well that such tests should also be applied by the parents at home. In testing the child's power of hearing a tuning-fork we should first apply it to the forehead or near the ear, while it is silent, when the child's features will probably remain impassive; but if applied afterwards while vibrating, the child's smile, or cry of surprise will inform us that he hears the sounding-fork. In this way we may generally ascertain if a tuning-fork is heard by a child over two years of age. Testing with an extensive series of tuning-forks ranging from the lowest to the highest notes may, in children of sufficient age, demonstrate at certain places in the scale islands of hearing, with, at other places, gaps of no hearing.

Some modicum of hearing is possessed by a large number of deaf-mutes, probably by 75 per cent. Bezold found in 276 ears of deaf-mutes tested by him only 79 absolutely deaf. Loud, sharp sounds are most frequently heard, or the loud pronunciation close to the ear of vowel sounds. In a smaller number complete words are heard when shouted loudly into the ear. The use of the hearing tube may be in these cases of great service, and should be utilized in the instruction of deaf-mutes in articulate speech.

Without Training or Education, deaf-mutes are apt to become violent and possessed of little self-restraint. Their tempers are often ungovernable, and their passions uncontrolled.

The prognosis of the deafness in deaf-mutism is very unfavourable. If the middle ear be diseased, suitable treatment may improve the hearing. In Politzer's experience deaf-mutism from congenital causes is more hopeful than total deafness, if acquired. He has seen a number of cases of total deafness, of a congenital nature, during the first few years of life, in which ultimately partial, and in one case complete, hearing existed. The writer has not seen a single case of improvement in cases due to cerebro-spinal meningitis, probably the most frequent cause of the acquired form.

TREATMENT OF DEAF-MUTISM.

We shall consider this under two heads : (1) The medical treatment, and (2) the educational treatment.

The Medical Treatment is mainly suitable for the acquired form of deaf-mutism, and may in these cases be of great value. The ear and the naso-pharynx should be carefully examined, and, if any disease exist, appropriate treatment should be employed. When, for example, exudative catarrh or chronic purulent disease of the middle ear is associated with the deafness, there is hope of improving the hearing power with possibly subsequent partial recovery of speech. If post-nasal growths be found, their removal may improve the hearing, and will, in any case, improve the breathing, articulation, and general condition of the child. Every aural surgeon meets with cases now and again of delay in learning to speak, or of loss of speech in the young child, due to such remediable causes, where the child is much improved, and even rescued from what appears to be pronounced deaf-mutism. If greater attention were given to the treatment of diseases of the ear in childhood, mutism might in some cases be averted or cured.

The Educational Treatment of Deaf-mutes ;

(a) **Prevention of Dumbness.** We shall first look at the efforts which should be carried out to prevent dumbness in children whose hearing is not completely lost. When a young child, who has commenced to speak, becomes deaf to the extent of not hearing words spoken in an ordinary tone of voice, he drifts gradually into mutism. In order to avert this, most diligent and painstaking efforts should be made to maintain his knowledge of spoken words, and even to add to his stock of them. A considerable amount of time should be devoted daily to speaking slowly, clearly, and in a sufficiently loud voice close to the ear of the child, who must also be made to repeat the words frequently. When the deafness is very marked, the aid of a hearing tube may be of service. In the severe forms, instruction in lip-reading should also be carried out, and, by utilizing what hearing there is, the modulation and pronunciation may be corrected and improved. By efforts of this kind we may in some cases prevent the child lapsing into dumbness, and at the same time prevent that injury to the mental faculties which is likely to result from his being partially or wholly shut out from spoken language at the most valuable educational period of life. We would here point out the importance of giving special attention to school children, who may suffer from defective hearing. The writer has found, as the result of the examination of a large number of school children, that 27 per cent. suffered from defective hearing. Many children are regarded as stupid or inattentive, when defective hearing is the *real cause* of their

seeming stupidity or inattention. When the hearing of a child attending school is found to be imperfect, the parents should be informed; and he should occupy a place near to the teacher, and should otherwise receive special attention. It would be an advantage if there were institutions or schools, *distinct from ordinary deaf and dumb institutions*, where partially deaf children might be trained and educated, with special regard to their defects and wants.

There are two systems now in use for the education of deaf-mutes:

- (1) *The French system*, by the manual alphabet and signs—*Dactylology*;
- (2) *The German system*, by lip-reading and articulate speech.

(b) **Manual Signs and Gestures.** This system, which is based upon a natural tendency, has always been practised in the institutions for the deaf and dumb, and it has been a great blessing to deaf-mutes. It is improbable that the system of lip-reading will ever entirely supersede this old method of communicating by visible signs.

(c) **Lip-reading and Articulate Speech.** Nearly all persons, suffering from dulness of hearing, instinctively and almost unconsciously read the face of the speaker. They hear with the eye, as an old authority has it, and are often astonished at their apparently greater deafness in the dark or when their eyes are shut. Children are sometimes brought, whose parents suppose them to be suffering from simple dulness of hearing with indistinctness of speech, but who, on examination by the aural specialist, are found to be almost totally deaf. Their power of lip-reading and speech, owing to a natural aptitude, has been such as to deceive the parents, who are dismayed at the serious character of the deafness of their child when tested with the eyes blindfolded. It is, however, very important to remember that the perfection of speech and lip-reading attained by this method varies very much according to the intelligence and aptitude of the child, the qualifications of the teacher, the age at which it is commenced, the length of time during which it is carried on, and *whether or not the child possesses any modicum of hearing*. There is no doubt there are some deaf-mute children, who, although free from any mental defect, lack the intelligence and quickness necessary to make them proficient in lip-reading or in articulation. The qualities of the teacher have also a great influence on the results. He should be actuated by enthusiasm in his calling, and possessed of a painstaking perseverance of no ordinary kind, besides having received a thorough training in all the details of the system. It is of importance that the child should begin early—in the seventh year, if possible—and that the teaching should extend over ten or twelve years. If the child possess a small amount of hearing, so as to distinguish words or vowels loudly spoken into the ear, the modulation and pronunciation

can be made much more natural than in the totally deaf child, whose pronunciation has usually a disagreeable harshness. Probably in some cases the use of the hearing tube would assist in utilizing any modicum of hearing power remaining, not only by enabling the child to hear the teacher's voice, but also by correcting his own articulation, when speaking or reading into the tube while the latter is inserted into his own ear.

The Combined Methods. Some authorities recommend the use of *dactylology* in conjunction with the oral method, during the first year or two, as facilitating the acquirement of the meanings of words, while others put great stress upon the importance of *entirely excluding* manual signs as a condition of success with the German method. The present tendency of opinion among those who have had much experience in the education of deaf-mutes is in favour of the old method by signs combined with the new method when practicable. For the great majority of deaf-mutes a knowledge of the old method is essential; but when the necessary amount of time, aptitude, and intelligence is available, instruction in lip-reading and articulate speech will prove a great advantage. It is right to say that probably no one has ever by the new method acquired the power of following an ordinary public speaker.

Grouping of Deaf-mutes. In order that deaf-mutes belonging to the humbler classes may derive the advantage of being instructed on this system, legislation has very properly extended grants to School Boards to meet the additional expense of educating deaf-mutes, to whom are now extended the privileges of the Education Act. As it has been found that a considerable number of deaf-mute children will never acquire, owing to lack of aptitude, any useful power of lip-reading or articulate speech, it would economize teaching power, if, after a period of probation, such children were separated from those receiving instruction in the new method who showed good aptitude and whose hearing is such that loudly spoken words are heard close to the ear. It is of very great importance, as has been so well pointed out by Dr. Kerr Love, of Glasgow, that, in regard to education, all deaf-mutes should not be treated alike, but that a proper division into groups or classes is most desirable, so that each child may be placed in the division to which he belongs, and receive the instruction suitable for his particular case and circumstances.

Instruction in Lip-reading by Adults is perhaps not sufficiently taken advantage of. In the case of adults who have become seriously or totally deaf after the age of childhood, and who, though able to talk themselves, can make out very little of what is spoken by others, it might prove of considerable advantage if they received methodical instruction from qualified teachers of lip-reading.

APPENDIX.

I.

OTALGIA

PAIN is not unfrequently complained of in the ear, when objective examination shows no inflammatory process to be present. The pain is usually sharp and darting, disappearing and recurring, sometimes at regular but more commonly at irregular intervals. In this intermittent way otalgia may prove troublesome for days, months, or even years. It is in some cases simply a part of a general neuralgic affection of the fifth nerve. It is often also reflex in its character, frequently having its origin in the teeth, the pharynx, or the tongue. Pressure upon the nerves, either inside or outside the ear, also excites otalgia. In the ear the pressure may be exerted by catarrhal thickening of the mucous membrane, which may excite pains in the side of the head. The pain is in some cases, though not commonly, localized to the auricle. It most frequently, however, affects the tympanic plexus (glosso-pharyngeal and trigeminus) in the mucous lining of the tympanum. It is to be remembered that inflammation in the middle ear is not unfrequently regarded by medical men as neuralgia, if no objective examination be made. As in the case of neuralgia elsewhere, it may here be caused by anæmia, syphilis, or the action of cold.

Treatment. Vesicants behind the auricle are often useful. The application to the neighbourhood of the ear of a sedative liniment (Formula 95) is generally attended by relief, or a few drops of a sedative liniment, on a plug of cotton inserted into the external meatus, may prove more useful. The subcutaneous injection of morphia may be required in intense and persistent forms. *The teeth should be examined*, and, if caries with pain on pressure be discovered in a tooth, it should be extracted or filled. Galvanism may be effective in removing neuralgia, which has resisted every other method of treatment.

Large doses of quinine (Formula 133) should be tried; its combination with iodide of potassium, especially if syphilis is suspected, may be of great advantage. If the patient be anæmic, iron or arsenic (Formula 105) should be prescribed, along with nutritious food and fresh country air.

II.

NERVOUS AND VASCULAR SUPPLY OF THE EAR.

(a) NERVOUS SUPPLY OF THE EAR.

The sensory nerves supplying the various parts of the ear are derived from:—

- (1) The great auricular from the cervical plexus; (2) the pneumogastric; (3) the

third division of the fifth cranial nerve; (4) the glosso-pharyngeal; (5) the large and small superficial petrosal nerves.

1. The *great auricular nerve* supplies the posterior part of the auricle, the outer surface of the lobule, and a small part above the lobule, as well as the integument over the mastoid process.

2. A twig, the nerve of Arnold, is given off from the jugular ganglion of the *pneumogastric*, pierces the bone, is distributed chiefly to the skin of the posterior wall of the external canal of the ear, and joins the facial nerve behind the auricle. This share of the *pneumogastric* in the innervation of the canal of the ear accounts for certain reflex phenomena, such as coughing, etc., not unfrequently observed when the canal of the ear is touched with a speculum or other instrument, or pressed upon by a foreign body.

3. The *third division of the fifth cranial nerve* gives off the auriculo-temporal, which distributes branches to the outer surface of the auricle, to the walls of the external auditory canal, and to the outer layer of the tympanic membrane. The ramifications of this nerve impart to the canal of the ear and to the dermoid layer of the tympanic membrane their acute sensitiveness.

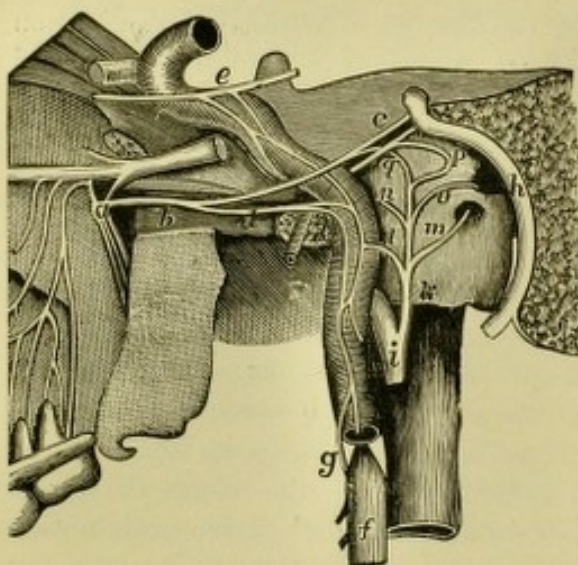


FIG. 215.—View of the tympanic plexus of nerves (after Hirschfeld and Leveillé). *a*, Spheno-palatine ganglion; *b*, Vidian nerve; *c*, great superficial petrosal nerve; *d*, carotid branch of the Vidian nerve; *e*, part of the sixth nerve, connected by twigs with the sympathetic; *f*, superior cervical ganglion of the sympathetic; *g*, carotid branch; *h*, facial nerve; *i*, glosso-pharyngeal nerve; *k*, nerve of Jacobson; *l*, its twig to the sympathetic; *m*, filament to the fenestra rotunda; *n*, filament to the Eustachian tube; *o*, filament to the fenestra ovalis; *p*, union of external deep petrosal nerve with the lesser superficial petrosal; *q*, internal deep petrosal twig uniting with the great superficial petrosal.

4. The *glosso-pharyngeal nerve*, by means of Jacobson's nerve branching off in the jugular fossa, has the most important share in forming the tympanic plexus, which occupies the grooves on the inner wall of the tympanum, and supplies the lining of the middle ear with sensation. In making applications to the inner wall of the tympanum, patients not unfrequently feel as if the throat were touched, which is due to this twig from the glosso-pharyngeal nerve.

5. The *large and small superficial petrosal nerves*, from the spheno-palatine and the otic ganglion respectively, are connected with the tympanic plexus.

The *tympanic plexus* (Fig. 215) is made up of—(1) Jacobson's nerve;

(2) twigs from the sympathetic plexus surrounding the carotid artery in its canal; (3) a communication with the great superficial petrosal nerve (a branch which connects the Vidian nerve, from *Meckel's ganglion*, with the facial nerve in the Fallopiian canal); (4) the small superficial petrosal nerve, which connects the nerve of Jacobson with the otic ganglion and the facial nerve.

The *chorda tympani* nerve gives off no branch to the tympanum, merely passing through that cavity. If the view, held by some anatomists, that its fibres are really a continuation of the large superficial petrosal nerve, be correct, there is a connection between the chorda tympani and the plexus supplying the middle ear. The position of the chorda tympani on the inner surface of the tympanic membrane probably accounts for the anomalies of taste, sometimes found in patients

suffering from chronic purulent inflammation of the middle ear, and also for peculiar sensations in the tongue, sometimes excited when the nerve is touched with a probe.

The motor nerves supplying the muscles of the ear are derived from the following sources, and have the following distribution:

1. The muscles of the auricle are supplied chiefly by the posterior auricular and temporal branches of the facial nerve. 2. The tensor tympani and the abductor tubæ receive their nervous supply from the otic ganglion through the nerve to the internal pterygoid from the motor root of the fifth nerve. 3. The stapedius is supplied by the facial nerve. 4. The levator palati is supplied by the pneumogastric, and, according to some authorities, also by twigs from Meckel's ganglion.

The *otic ganglion*, situated at the outer part of the cartilaginous Eustachian tube, controls and regulates the reflex and sympathetic relations of the different parts of the organ of hearing to one another, and to near or distant regions of the body. This ganglion is formed of: (1) Motor and sensory fibres from the third division of the fifth cranial nerve, namely, the internal pterygoid and the auriculo-temporal nerves; (2) fibres from the sympathetic round the middle meningeal artery; (3) fibres from the glosso-pharyngeal and facial nerves through the small superficial petrosal.

The otic ganglion also gives off branches to supply the tensor tympani and abductor tubæ muscles. This ganglion is thus connected with the nerves which supply the various parts of the external and middle ear. In this way also, from a distant centre of irritation, such as the teeth, vaso-motor changes are produced through the sympathetic, leading to dilatation of vessels and ultimate inflammation in the linings of the ear, or in the labyrinthine blood-vessels.

(b) VASCULAR SUPPLY OF THE EAR.

1. **The arterial supply** of the external and middle ear is derived almost altogether from the *external carotid artery*. Only one or two twigs are given off by the *internal carotid*, in the carotid canal, to a part of the Eustachian tube and tympanum. The following are the branches and terminal divisions of the external carotid supplied to the different sections of the ear.

a. The *posterior auricular artery* supplies chiefly the inner surface of the auricle, and partially the external auditory canal. It gives off the stylo-mastoid artery, which is distributed to the neurilemma of the facial nerve, to the mastoid cells, and to the posterior part of the tympanum and stapedius. A few twigs also penetrate the inner wall of the tympanum to the labyrinth, and anastomose with the internal auditory artery.

b. The *occipital artery* provides an auricular branch to the back of the concha.

c. The *temporal artery* gives off the anterior auricular to the fore-part of the auricle, to the lobule, and a small part of the external auditory canal.

d. The *internal maxillary artery* provides several branches to the ear—1. The deep auricular, supplying the tragus, the deep parts of the external auditory canal, and the outer layer of the tympanic membrane. The chief branches to the membrane pass down from the roof of the canal. 2. A tympanic branch is sent off, chiefly to the inner layer of the membrane. 3. From the middle meningeal the petrous branch penetrates to the tympanum and Eustachian tube, through the

hiatus Fallopii and petro-squamosal fissure. 4. The Vidian sends small branches to the Eustachian tube and tympanum.

e. The *ascending pharyngeal artery* supplies small twigs to the Eustachian tube and tympanum.

The internal ear receives its chief vascular supply from the *internal auditory artery*, a branch of the basilar. A few twigs are provided by the stylo-mastoid artery, by which also the circulation of the external and middle ear is connected with that of the internal ear.

2. **The venous blood** from the external and middle ear is discharged partly into the external and partly into the internal jugular veins, by means of branches corresponding to the arteries.

The venous blood from the labyrinth is discharged by the superior petrosal sinus into the lateral sinus.

FORMULÆ OF REMEDIES RECOMMENDED IN THE COURSE OF THIS WORK.

A.—LOCAL REMEDIES.

Remedies for the Nose (Nos. 1 to 30).

- I. Nasal Inhalations, Steam and Dry (Nos. 1 to 8).
- II. Atomized or Spray Applications (Nos. 9 to 15).
- III. Solutions for Irrigating or Syringing the Nose (Nos. 16 to 22).
- IV. Ointments (Nos. 23 to 27).
- V. Powders or Snuffs (Nos. 28 to 30).

Remedies for the Throat (Nos. 31 to 43).

- I. Gargles or throat sprays (Nos. 31 to 35).
- II. Pigments (Nos. 36 to 38).
- III. Lozenges (Nos. 39 to 43).

Remedies for the Ear (Nos. 44 to 102).

- I. Solutions for applying through Eustachian Tube (Nos. 44 to 48).
- II. Solutions for Syringing or Irrigating the Ear (Nos. 49 to 54).
- III. Instillations for External Meatus—"Ear-drops" (Nos. 55 to 67).
- IV. Solutions applied by Painting or Touching (Nos. 68 to 73).
- V. Powders for Ear (Nos. 74 to 78).
- VI. Ointments for Ear (Nos. 79 to 91).
- VII. Lotions, Liniments, and Counter-Irritants (Nos. 92 to 98).
- VIII. Caustic Applications (Nos. 99 to 102).

B.—GENERAL REMEDIES.

- I. Remedies for Anæmic or Neurasthænic conditions (Nos. 103 to 111).
- II. Remedies for Syphilitic conditions (Nos. 112 to 116).
- III. Remedies for Dyspeptic, Rheumatic or Gouty conditions (Nos. 117 to 122).
- IV. Diaphoretics, Sedatives, Febrifuges (Nos. 123 to 127).
- V. Remedies chiefly employed for the Relief of Vertigo and Subjective Sounds in the Ear (Nos. 128 to 135).

A.—LOCAL REMEDIES.

REMEDIES FOR THE NOSE.

I. Nasal Inhalations, Steam and Dry.

(See p. 153.)

The first four Formulæ are steam inhalations and a teaspoonful should be added to a pint of water at a temperature of 140° F. In inhaling, an india-rubber nasal piece is placed over the mouthpiece of an ordinary inhaler; or the vapour may be inhaled from a narrow mouthed jug. Both steam and dry inhalations are useful chiefly in acute rhinitis with nasal obstruction.

1. R. Tinct. Benzoin. Co. $\bar{\text{ij}}$.
2. R. Sp. Camphoræ. $\bar{\text{ij}}$.
Spirit. Ment. Pip. $\bar{\text{ij}}$.
Ol. Eucalypt. $\bar{\text{ij}}$.
Tinc. Benzoin. Co. *ad* $\bar{\text{ij}}$. M.
3. R. Menthol. $\bar{\text{ss}}$.
Spirit. Rectif. $\bar{\text{iv}}$.
Magnes. Carb. levis gr. xvi.
Aquæ *ad* $\bar{\text{ij}}$. M.
4. R. Ol. Eucalypt. $\bar{\text{ij}}$.
Menthol. gr. xl.
Sp. Chloroformi $\bar{\text{ij}}$.
Sp. Rectif. *ad* $\bar{\text{ij}}$. Solve.
5. R. Acid. Carbolici Liquefacti $\bar{\text{ij}}$.
Ammon. Carb. $\bar{\text{ij}}$.
Liq. Ammon. Fort. $\bar{\text{ij}}$.
Pulv. Carbonis Ligni $\bar{\text{ij}}$.
Tinc. Benzoin. Co. $\bar{\text{ij}}$.
Ol. Lavandulæ \mathfrak{mvi} . M.
Carbolized smelling salts. To be kept in a glass-stoppered wide-mouthed bottle. Frequent nasal inhalations from unstopped bottle.
Use—Convenient remedy in acute rhinitis.
6. R. Menthol. gr. xl.
Ol. Eucalypti } $\bar{\text{aa}}$ $\bar{\text{ij}}$.
Ol. Terebinth. }
Æther. } $\bar{\text{aa}}$ $\bar{\text{iv}}$. M.
Spirit. Rectif. }

May be inhaled from a few drops sprinkled on the palms of the hands or on the inner surface of a cone of blotting-paper (Dr. Newman).

7. Menthol is conveniently used for nasal inhalation by means of Maw's Menthol Inhaler. Eucalyptus or Pine oil may be added by pouring a few drops on the cotton in the tube. Wool impregnated with 5 per cent. of Menthol may be usefully inserted into the nostrils.

8. Ammonii Chloridum.

Conveniently produced and applied in its nascent state by means of Burroughs' or Godfrey & Cooke's Inhalers.

Use—Frequently employed in the treatment of middle ear catarrh.

II. Atomized or Spray Applications.

(See pp. 157 and 158.)

In addition to the following Formulæ, some of the solutions used for syringing the nose (such as Nos. 16 to 18) may be employed in the form of spray. The following Formulæ may also be applied with a brush or cotton on a cotton holder to the nasal mucous membrane. See also Gargles.

9. R. Menthol. gr. iv.
Camphor. gr. ij.
Paroleine $\bar{\text{iv}}$. M.

To be applied to nasal passages as a fine nebula with oil atomizer twice daily.

The inhalants of Parke, Davis & Co., especially Chloretone inhalant (Chloretone, Camphor, Menthol, Oil of Cinnamon, and Liquid Petroleum); Acetozone and Adrenalin inhalants, are employed in the same way.

10. R. Adrenalin Inhalant $\bar{\text{iv}}$.
Menthol. gr. iv.
Thymol. gr. vi.
Eucalyptol $\mathfrak{m x}$.
Paroleine *ad* $\bar{\text{ij}}$. M.

To be used in the same way as previous Formula.

11. R. Menthol. gr. viij.
Camphoræ gr. vj.
Ol. Cassiæ \mathfrak{mij} .
Paroleine *ad* $\bar{\text{iv}}$. M.

To be used in the same way as previous Formula.

12. R. Ung. Hydrarg. Nitratis gr. xl.
Ol. Amygdalæ $\bar{\text{iv}}$.
Paroleine *ad* $\bar{\text{ij}}$. M.

Use—For softening crusts in nasal passages. Employed with oil atomizer or brush.

13. R. Cocainæ Hydrochloridi gr. xij.
Acidi Salicylici gr. ss.
Aque ʒij. M.

The solution of Adrenalin (1-1000) may be added to this Formula.

Eucaine Hydrochloride gr. x. may be substituted for the Cocainæ Hydrochloride.

Use—In acute rhinitis, where great nasal obstruction, or as preliminary to operations in the nasal passages. It is probably safer to apply with cotton wool than by spraying.

14. R. Phenol. gr. iv.
Sodii Bicarb. gr. xv.
Boracis gr. x.
Glycerini ℥xl.
Aque Rosæ ad ʒi. M.

Use with an equal quantity of very hot water for spraying (coarse spray) nasal passages twice daily—in chronic rhinitis especially with swelling and secretion. Listerine (ʒij) may be used instead of Phenol, omitting the Glycerine.

15. R. Sodii Bicarbonatis
Sodii Chloridi
Sodii Biboratis āā gr. iv.
Sacchari Albi gr. vj.
Aque ʒi. M.

Use—The same as previous Formula.

III. Solutions for irrigating or syringing the Nose.

(For methods of irrigating see p. 155.)

16. R. Sodii Chloridi
,, Bicarb.
,, Biboratis
Sacchar. Alb. āā ʒiv. M.

Use—Ten grains to an ounce of tepid water, but for different persons the strength may require to be modified; in chronic rhinitis, especially with nasal secretion or swelling.

17. R. Sodii Chloridi
Ammonii Chloridi
Sacchar. Alb. āā ʒiv. M.

Use—As above.

18. R. Potassii Chloratis
Potassii Bicarb.
Sacchar. Alb. āā ʒiv. M.

Use—As above, only that fifteen grains are used instead of ten.

The medicaments included in these three Formulæ, as well as others, are prepared in the form of tabloids by Burroughs Wellcome & Co., for convenience of patients when travelling.

19. R. Liq. Hamamelidis ʒi.
Boracis ʒij.
Glycerini ʒij.
Aque ad ʒvj. M.

Use—A tablespoonful to be added to four tablespoonfuls of tepid water, for use with irrigator. The hazeline imparts a useful astringency.

20. R. Liq. Potass. Permanganatis ʒij.

Use—Two drachms to a pint of tepid water. Especially suitable in ozæna.

21. R. Sanitas (contains peroxide of hydrogen) ʒj.
Sodii Chloridi ʒiss.
Aque ad ʒiv. M.

Use—A drachm to be added to a pint of tepid water. Especially suitable in ozæna.

22. R. Glycerini Boracis ʒij.
,, Acidi Carbolici ʒij. M.

Use—Two drachms to be added to a pint of tepid water. Also suitable in ozæna. Glycethymoline forms a pleasant and popular aromatic saline solution for douching the nasal passages.

IV. Ointments for Nasal Passages.

(Applied on camel's hair pencil to inside of nostrils and then sniffed in.)

23. R. Menthol. gr. j.
Cocainæ gr. ij.
Vasellini ʒj. M.

Use—Valuable in acute rhinitis, nasal obstruction, and after cauterization of the nasal mucous membrane. If desirable the menthol may be omitted.

24. R. Menthol gr. iv.
Camphor gr. ij.
Vasellini ʒj.
Lanolini ʒi. M.

Use—Same as preceding Formula.

25. R. Ung. Atropinæ ʒj.
Vasellini ʒij. M.

Use—Small quantity applied to nasal mucous membrane in excessive watery discharge from the nose.

26. R. Ol. Eucalypti. ʒj.
Vasellini ad ʒj. M.

Use—Applied to nasal mucous membrane for dry conditions.

27. R. Ung. Hydrargyri Nitratis ʒj.
Vaselini *ad* ʒj. M.
Use—For softening crusts in nostrils after operation or otherwise.

V. Powders for Nasal Passages.

(See p. 159.)

28. R. Morphine Hydrochlorid. gr. ij.
Bismuthi Subnitratis ʒvj.
Pulv. Acacia ʒij. M.
Use—"Ferrier's Snuff." Insufflated into the nose in acute rhinitis.
29. R. Menthol. gr. x.
Pulv. Acidi Borici (vel
Pulv. Cetacei) ʒiv. M.
Use—Same as preceding Formula.
30. R. Aristol gr. viij.
Menthol.
Camphoræ
Cocain. Hydrochlor. āā gr. iij.
Acidi Borici ʒiv. M.
Use—Same as preceding Formula, especially when great sense of nasal obstruction.

REMEDIES FOR THE THROAT.

I. Gargles or Sprays.

(See p. 175.)

Employed in "relaxed," swollen, or softened states of the mucous membrane of the throat. *They may also be used in form of spray.*

31. R. Boracis ʒij.
Acidi Carbolici gr. xvj.
Glycerini Puri ʒij.
Aque Rosæ *ad* ʒviiij. M.
Use—Mild alkaline and antiseptic gargle or throat spray.
32. R. Acidi Borici ʒiss.
Boracis ʒj.
Glycerini ʒiss.
Aque *ad* ʒviiij. M.
Use—Same as previous Formula.
33. R. Glycer. Acid. Tannic. ʒvj.
Spirit. Rectif. ʒij.
Aque *ad* ʒviiij. M.
Use—Astringent application.
34. R. Boracis ʒj.
Potass. Chloratis ʒj.
Glycerini ʒj.
Aque *ad* ʒviiij. M.
Use—Same as Formula No. 31.

35. R. Glycerini Acidi Carbolici ʒss.
Potas. Chloratis ʒij.
Aque Rosæ *ad* ʒviiij. M.

A portion to be used with an equal quantity of hot water frequently; for septic conditions of the mouth as a mouth wash.

II. Pigments for Throat.

(See p. 175.)

Suitable in cases of congestive swelling and general thickening of the pharyngeal mucous membrane, or in granular pharyngitis. The throat should be painted once or twice daily.

36. R. Iodi gr. vj.
Potass. Iodidi gr. xij.
Acidi Carbolici gr. xv.
Ol. Menth. Pip. ℥v.
Glycerini ʒj. Solve.
37. R. Ferri Perchlorid. ʒss.
Glycerini ʒij.
Aque *ad* ʒj. M.
38. R. Glycerini Acid. Carbol. ʒij. M.
Glycerini Acidi Tannici *ad* ʒij.

Painful, septic tonsils may with advantage be painted with Formula 13, or a 20% solution of menthol in olive oil or paroline.

III. Lozenges.

Suitable for congested, "relaxed," or septic states of the throat.

These should be dissolved slowly in the mouth, and no liquid swallowed for a short time afterwards.

39. R. Troch. Krameria ʒj.
Use—One every four hours forms a good astringent.
40. R. Troch. Guaiaci ʒj.
Use—One every two hours may be given in acute inflammation of tonsils.
41. R. Pastilli Menthol. ($\frac{1}{8}$ gr. in each).
42. Menthol and Cocaine Pastilles ($\frac{1}{8}$ gr. Cocaine in each), (Allen & Hanbury's).
43. Compressed tablets of Chlorate of Potassium, Borax, Chloride of Ammonium, etc., are sometimes to be preferred to gargles. Some of these are combined with Cocaine.
- Formamint tablets are said to have bactericidal effects upon septic conditions of the tonsils and throat.

REMEDIES FOR THE EAR.

I. Solutions for applying through Eustachian Tube.

Six to eight drops are injected.

(For mode of application see p. 84.)

44. R. Ammonii Chlorid. gr. v.
Aque 3j. Solve.

45. R. Sodii Bicarb. gr. xx.
Glycerini 5ij.
Aque ad 3j. Solve.

46. R. Pilocarpinæ Nitratis gr. ij.
Aque 3ij. Solve.

Use—Supposed to assist the absorption of syphilitic products in the labyrinth (see p. 423); also useful in chronic dry catarrh.

47. R. Potassii Iodidi gr. v.
Aque 3j. Solve.

48. R. Ol. Vaselini (steril.) 3j.

Use—First suggested by Delstanche for adhesions in the tympanic cavity.

Various solutions may also be employed in the nebulized form (see p. 391).

II. Solutions for syringing or irrigating the Ear.

(For method of syringing see p. 79, also p. 274.)

49. R. Acidi Borici Calend. 3iv.

Sig.—Thirty grs. to be dissolved in two ounces of warm water which has been boiled (see p. 274).

50. R. Lysol 3ij.
Aque ad 3ij. M.

Sig.—One drachm to be mixed with two ounces of warm sterilized water.

51. R. Glycerini Acidi Carbolici 3ij.

Sig.—A drachm to be added to two ounces of warm sterilized water.

52. R. Liq. Potass. Permanganatis 3ij.

Sig.—Forty minims to be added to four ounces of warm sterilized water.

53. R. Acidi Salicylici 3jss.
Spirit. Rectif. 3ij. Solve.

Sig.—A drachm to be added to two ounces of warm sterilized water.

54. R. Hydrarg. Perchlor. gr. v.
Spirit. Rectif. 3ij. Solve.

Sig.—A drachm in two ounces of warm water.

Normal sterilized saline solution (45 grains of chloride of sodium to a pint of water) may be used, especially in the after treatment of the radical mastoid operation.

Politzer recommends 15 to 20 drops of formaline to a litre (35 oz.) of boiled water.

III. Instillations into the external meatus. "Ear-drops."

(See p. 276.)

55. R. Acidi Borici (vel Resorcin.) gr. x.
Spirit. Rectif. 3iv.
Aque ad 3j. Solve.

Use—Fifteen drops are instilled into the ear, after thorough cleansing and drying; frequently used in chronic purulent inflammation of middle ear; also for injecting into attic.

If interior of ear be painful a drachm of the liquor opii sedativus may be added. May go on to the full strength of rectified spirit.

56. R. Acid. Carbolic. gr. xx.
Spirit. Rectif. 3j. Solve.
Aque aa

Use—Same as previous Formula; especially indicated when discharge offensive.

57. R. Zinci Sulphatis gr. viij.
Acid. Carbolic. gr. viij.
Glycerini 5j.
Aque ad 3ij. Solve.

Use—Same as previous two Formulæ, but combines the astringent with the antiseptic effect.

Burow's solution (combination of alum and acetate of lead) is recommended by Politzer.

58. R. Hydrarg. Perchlorid. gr. j.
Spirit. Rectif. 3j. Solve.

Use—In syphilis, fungi or furunculi of the external meatus. May begin with diluted spirit.

59. R. Spirit. Rectif. 3j.

Use—Excellent remedy in cases of purulent disease of the middle ear associated with granulations or polypi (see p. 276), and for roots of polypi (see p. 281); also with 5 % of boric acid for boils in meatus; also used for fungi and larvæ in external meatus; also in the after-treatment of the radical mastoid operation (see p. 136); should at first be diluted with water to the extent of equal parts or two-thirds of water.

60. R. Acid. Salicylic. gr. ij.—x.
Spirit. Rectif. ʒj. Solve.

Use—In chronic purulent inflammation of middle ear. It may prove irritating in the larger proportions.

61. Peroxide of Hydrogen (10 vols. strength).

Use—In certain forms of purulent middle ear disease (see p. 277).

62. R. Acid. Borici gr. xl.
Spirit. Rectif. ʒj.
Hydrogen Peroxid. ad ʒiv. M.

Use—For softening epidermic masses after the radical mastoid operation (see p. 136).

63. R. Sodii Bicarb. gr. x.
Glycerini ʒj.
Aque ad ʒiv. Solve.

Use—For softening ceruminous collections prior to syringing (see p. 193).

64. R. Sodii Bicarb.
Acidi Carbolici āā gr. vj.
Glycerini ʒij.
Aque ʒij. Solve.

Use—For softening desquamative and cholesteatomatous masses in inner end of external meatus.

65. R. Acidi Carbolici Liquefact. ℥iv.
Cocainæ Hydrochlor. gr. viij.
Menthol gr. viij.
Spirit. Rect. ℥lxxx. M.

Use—For local anæsthesia before incising tympanic membrane. Ten minims (warmed) to be instilled into the ear 10 minutes before operation.

66. R. Acidi Carbolici gr. x.
Glycerini ʒij. Solve.

Use—A few drops to be instilled into the ear when there is great pain from purulent inflammation of middle ear (see p. 269).

67. R. Acidi Carbolici
Cocainæ Hydrochlor. āā gr. x.
Glycerini ʒij. Solve.

Use—Same as preceding Formula (M'Bride).

IV. Solutions Applied by Painting or Touching Meatal Lining.

Apply with camel's hair pencil or cotton wool on cotton holder (see p. 5).

68. R. Argent. Nitrat. gr. xl.
Aque Destill. ʒj. Solve.

Use—As an application to the outer orifice of the ear in chronic scaly eczema; also for painting the walls of the external canal when the cutaneous lining is thickened.

69. R. Argent. Nitratis gr. xv.
Sp. Æther. Nitrosi ʒj. Solve.

Use—Same as preceding Formula, but should be followed by the repeated application of a soothing lotion, such as No. 93.

A stronger solution may be used in dry chronic cases.

70. R. Ol. Cadini ℥x.
Glycerini ʒiv. M.

Use—For applying to external meatus when epidermis hardened and thickened.

71. R. Liniment. Belladon.
„ Opii āā ʒiv. M.

Use—A few drops placed on a pellet of cotton wool and laid in the outer orifice of the ear gives relief in painful inflammatory affections of middle ear, or in simple otalgia.

Ordinary laudanum is popularly used in the same way and for the same purpose with benefit.

72. R. Acidi Carbolici gr. viij.
Spirit. Rectif. ʒij.
Glycerini ʒj. Solve.

Use—For painting external meatus in pruritus or scaly eczema frequently.

73. R. Acidi Salicylici gr. x.
Spirit. Rectif. ʒij.
Glycerini ʒj. Solve.

Sig.—Same as preceding Formula. Or it may be dropped into the ear at intervals.

V. Powders for the Ear.

(See p. 275.)

74. R. Acid. Borici Calend.¹ ʒiv.

Use—Invaluable in acute and chronic purulent inflammation of the middle ear (see p. 275).

¹ Boric Acid impregnated with a Concentrated Tincture of *Calendula officinalis*.

75. R. Acidi Borici 5iij.
Iodoform. 5j. M.
Use—In certain forms of purulent middle ear disease (see p. 277), and for mastoid cavities after operation.

76. R. Acidi Borici Calend. 5iv.
Acidi Carbolici gr. x. M.
Use—Recommended by Politzer for insufflation in purulent middle ear disease associated with great fetor of the discharge.

77. R. Acidi Borici Calend. 5iv.
Acidi Salicylici gr. x. M.
Use—Same as preceding Formula.

78. R. Pulv. Amyli 5iij.
Zinci Oxidi 5j.
Calaminæ 5ss. M.
Use—For dusting parts in acute eczema of auricle or meatus.
Other fine powders for blowing into the ear are sometimes used with benefit, such as aristol (with three times as much boracic acid), zeroform, and formidine (see p. 275).

VI. Ointments for Ear.

79. R. Hydrarg. Oxid. Rub. gr. iv.
Hydrarg. Ammoniat. 5iij.
Adipis Benzoat. 5ij.
Ol. Olivæ Opt. 5j. M.
Use—For dry, scaly eczema of the auricle; also for the same condition of external meatus, when the ointment may be applied on cotton plugs.

80. R. Hydrarg. Oxid. Rub. gr. iv.
Ol. Rusci 5vj.
Vasellini 5j. M.
Use—Same as preceding Formula.

81. R. Emplastri Plumbi 5ss.
Vasellini gr. xv.
5iv. M.
Use—In the more acute forms of eczema (after the first few days), when the parts are to be frequently anointed and the ointment kept constantly applied on a piece of soft rag.

82. R. Zinci Oxidi 5ss.
Calaminæ gr. xv.
Ung. Aq. Ros. 5iv. M.
Use—In the more acute forms of eczema of external meatus or auricle.

83. R. Vasellini 5ss.
Ung. Hydr. Nitratis 5jss.
Liq. Carbonis Detergent. 5xij.
Ung. Zinci ad 5j. M.
Use—For chronic scaly eczema of the auricle or external auditory canal; may be brushed over the parts.

84. R. Ung. Picis 5ss.
„ Zinci 5iv. M.
Use—In dry or scaly eczema of the auricle; brushed over the parts.

85. R. Bismuthi Subnitratis (vel Oleatis) gr. xx.
Adipis Benzoat. 5iv.
Vasellini 5iv. M.
Use—For applying to eczematous surface of auricle.

86. R. Zinci Oxid. 5ss.
Acidi Carbolici gr. v.
Vasellini Alb. 5iv. M.
Use—For furunculi in the meatus associated with eczema. Insert a cylindrical tampon of cotton wool, covered with the ointment, into the meatus.

87. R. Menthol gr. ij.
Iodoformi gr. iv.
Lanolini 5ij.
Vasellini 5ij. M.
Use—Applied on cotton plugs inserted into external meatus, for furunculi in the latter.

88. R. Ung. Acidi Salicylici 5iv.
Use—In pruritus of the external meatus.

89. R. Iothion gr. xlviii.
Vasellini 5j. M.
Use—Portion as large as a bean to be applied with friction to mastoid surface; for the relief of tinnitus.

90. R. Ung. Iodoformi 5ij.
Ol. Menth. Pip. 5v. M.
Use—For applying with friction to mastoid process in syphilis of labyrinth.

91. R. Camphoræ gr. vj.
Ol. Menth. Pip. 5v.
Ung. Potass. Iodidi 5iv. M.
Use—Applied with friction to mastoid surface for the relief of tinnitus aurium.

VII. Lotions, Liniments and Counter-Irritants.

92. R. Liquor. Carb. Deterg. ʒj.
Aque ad ʒvj. M.

Use—In chronic scaly eczema of auricle or external meatus. The parts affected should be sponged or painted every six hours.

93. R. Liquor. Plumbi Subacet. Fort. ʒj.
(Goulard's Extract)
Glycerini ʒij.
Aque ad ʒiv. M.

Use—In acute eczema or diffuse inflammation of auricle, the parts affected to be gently but frequently sponged; or pieces of soft cloth dipped in the lotion may be kept constantly in contact with the morbid surface.

94. R. Zinci Oxidi.
Calaminæ aa ʒiv.
Glycerini ʒss.
Spirit. Rectif. ʒss.
Aq. Calcis } aa ad ʒvj. M.
Aq. Rosæ }

Use—In eczema of auricle, parts affected should be gently sponged two or three times a day.

95. R. Menthol ʒij.
Chloroform. (Methyl.) ʒiv.
Ol. Olivæ ad ʒij. M.

Use—Applied to neighbourhood of ear in middle ear inflammations, also in otalgia.

96. R. Iodine Vasogen (10%).

Use—To be rubbed night and morning over a considerable surface behind the ear in labyrinthine affections, especially syphilitic; also in facial paralysis.

97. R. Liniment. Sinapis ʒj.

Use—For rubbing behind the auricle in tinnitus and labyrinthine disturbance.

98. R. Liquor. Epispast. ʒj.

Use—For painting over mastoid process to produce vesication. Especially useful in facial paralysis, in labyrinthine disease, in paralysis of auditory nerve, and in distressing forms of tinnitus aurium. May be also useful in otalgia.

VIII. Caustic applications.

99. R. Acid. Chromic.
Aque aa ʒj. M.

Use—Apply on the end of a probe after anæsthetizing the part with solution of cocaine. For destroying roots of aural polypi or hypertrophied mucous membrane; also to hypertrophied spongy bodies in chronic rhinitis; or to the roots of nasal or aural polypi. Chromic acid may also be employed fused as in the case of nitrate of silver. (For precautions see p. 280.)

100. Argenti Nitras.

A probe made of aluminium is made red hot at the point and pressed on to the salt, so that a coating of the fused salt will remain attached.

Use—Same as preceding Formula.

101. Perchloride of Iron (crystals) applied on the end of a probe is a useful application to granulation tissue.

102. Trichloroacetic acid is applied to the edges of old dry perforations with the object of closing them; also applied to granulation tissue or roots of aural polypi.

B.—GENERAL REMEDIES.

I. Remedies employed chiefly when the Ear Affection is associated with Anæmia or Neurasthænia.

103. Bi-palatinoids of Blaud's Pill (Ferrous Carbonate).

104. R. Liquoris Arsenicalis m℥xxx.
Syrupi Aurantii ʒj.
Aque ad ʒiv. M.

Sig.—A teaspoonful in water thrice daily after food.

105. R. Ferri et Ammon. Citrat. ʒij.
Liquor. Sodii Arsenatis ʒj.
Glycerini Puri ʒj.
Aque ad ʒiv. Solve.

Sig.—Two teaspoonfuls in water twice daily after food.

Use—In chronic eczema of auricle or external auditory canal; in recurrent furunculi in external auditory canal; also in tinnitus associated with anæmia.

106. R. Ext. Aloes Barb.
 Ferri Sulphatis
 Pulv. Zingib. āā gr. i.
 Ext. Gentian. q.s. M. Fiat pilula.
 Sig.—One thrice daily after food.

107. R. Tinct. Ferri Perchlorid. 5ij.
 Liq. Strychninæ Hydroch. ℥xlviij.
 Aquæ ad 5vj. M.
 Sig.—A tablespoonful in water thrice daily after food.

108. R. Syrup. Ferri Iodid. 5j.
 Glycerini Puri 5jss.
 Aquæ ad 5iv. M.
 Sig.—One or two teaspoonfuls thrice daily.

109. R. Syrup Hypophosphit. } 5vj.
 Co. (Fellows') }
 Sig.—For an adult, a teaspoonful in half a wineglassful of water morning and evening after meals.

110. R. Syr. Glycerophos. Co. } 5vj
 (Robin) }
 Sig.—One to two drachms in water three times a day.

111. R. Potassii Iodid. 5ss.
 Ferri et Ammon.
 Citrat. gr. xxiv.
 Syrupi. 5j.
 Aquæ ad 5iv. Solve.
 Sig.—For children, one or two teaspoonfuls thrice daily. Without the Iodide of Potassium, this forms an easily assimilable preparation of iron.

Many of these remedies can be given very conveniently and accurately in the palatinoid or bi-palatinoid form.

II. Remedies employed chiefly where Syphilis complicates an Ear Affection.

112. R. Hydrarg. Perchlorid. gr. ij.
 Potassii Iodid. 5ij.
 Tinct. Calumbæ 5ij.
 Aquæ ad 5vj. Solve.
 Sig.—Two teaspoonfuls in a glass of water three times a day after meals.

113. R. Hydrarg. Perchloridi gr. ij.
 Infus. Calumb. 5iij. Solve.
 Sig.—A teaspoonful in water thrice daily.

114. R. Potassii Iodid. 5ij.—5vi.
 Ammon. Carb. 5j.
 Syrup. Aurant. 5vj.
 Infus. Calumbæ ad 5vj. Solve.
 Sig.—A tablespoonful thrice daily after food in a wine-glassful of water.

Use—In the larger doses, given in syphilitic disease of labyrinth; also in facial paralysis.

115. R. Potassii Iodid. 5j.
 Ferri et Ammon. Citrat. 5ij.
 Infus. Calumbæ ad 5vj. Solve.
 Sig.—A tablespoonful in water thrice daily after meals.

116. R. Sol. Pilocarpin. Nitrat. } 5j.
 (2 per cent.) }
 Use—Four to ten minims for each injection, used hypodermically (antagonized by atropine). Employed in syphilitic disease of labyrinth; also in Ménière's disease (see p. 423).

Burroughs Wellcome & Co.'s tabloids of Pilocarpine are very convenient, beginning with $\frac{1}{12}$ of a grain and going on to $\frac{1}{4}$ or $\frac{1}{2}$.

III. Aperients, Antacids, and Tonics, when the Ear Affection is associated with Dyspeptic, Rheumatic, or Gouty conditions.

117. R. Hydrarg.c. Cretâ gr. i.
 Sodii Bicarb. gr. ij.
 Pulv. Rhei Opt. gr. iij. M. Fiat pulvis.
 Use—Suitable aperient and antacid for a child. Larger doses according to age. This or four grains of calomel at night, followed by a saline in the morning, useful in toxæmia from purulent ear disease.

118. R. Magnes. Carb. Pond. 5jss.
 Magnesii Sulphatis 5iv.
 Tinct. Cardam. Co. 5iij.
 Tinct. Zingib. 5iij.
 Aquæ Menthæ Pip. ad 5vj. M.
 Sig.—A tablespoonful in a glass of water twice daily on empty stomach.

Use—In auditory vertigo or tinnitus associated with hepatic or intestinal sluggishness.

119. Carlsbad Salt (in fine powder).

Sig.—A teaspoonful in a large tumblerful of hot water sipped half an hour before breakfast.

Hunyadi János, Püllna, or Apenta Water.

Sig.—Half a tumblerful filled up with hot water in the early morning.

Use—Frequently beneficial in allaying subjective sounds in the ear.

120. R. Pilulæ Hydrargyri

Pilulæ Rhei Comp.

Extracti Hyosecyami āā gr. xx. M.

Divide in pilulas xij.

Sig.—Two to be taken occasionally at bedtime while going through a course of iron or other tonic.

121. R. Tinct. Nucis Vomicae 5ijss.

Acid. Nit.-Hydrochlor.

Dil. 5ij.

Tinct. Aurantii 5vi.

Infus. Gentianæ Co. ad 5viii. M.

Sig.—A tablespoonful in a wine-glassful of water thrice daily before food. (In suitable cases bicarbonate of potassium may be substituted for the acid.)

122. R. Ferri Citratis Ammon. 5ij.

Lithii Citratis 5ij.

Tinc. Nuc. Vomicae 5ij.

Syr. Aurant. 5iv.

Aquæ ad 5vi. M.

Sig.—Two teaspoonfuls in water twice daily after food.

Use—When the ear disease is associated with debilitated conditions in gouty persons.

IV. Diaphoretics, Sedatives, Febrifuges.

123. R. Pulv. Ipecac. Co. gr. xij.

Full dose for an adult.

Use—In acute naso-pharyngeal catarrh, it may shorten the attack; sometimes required for the relief of painful inflammatory affections of the ear.

Nepenthe in twenty minim doses is valuable in similar conditions.

124. R. Phenacetin. gr. x.
Exalgin. gr. ij. M.

Use—For relief of pain and feverishness in acute stage of purulent inflammation of middle ear.

Phenacetine may also be employed in the form of compressed tablets (5 grs. in each).

125. R. Antipyrin. Cryst. gr. xv.

Use—Same as above. Frequency of dose to be regulated by prescriber.

126. R. Antipyrin.

Ammon. Bromid. āā 5i.

Caffeine gr. xij.

Glycerini 5ss.

Aquæ ad 5i. M.

Sig.—One or two teaspoonfuls in water; frequency of dose to be regulated by prescriber.

Use—For severe otalgia and headache.

127. R. Inject. Morphinae Hypodermic. P.B. 5ij.

Sig.—One to six minims to be subcutaneously injected.

Use—Sometimes called for in very painful inflammatory affections of the ear; may be required for the relief of intense otalgia.

V. Special Remedies chiefly employed for the relief of vertigo and subjective sounds in the Ear.

(See p. 429.)

128. R. Acid. Hydrobromic. Dil. 5i.

Aquæ ad 5iv. M.

Sig.—Two teaspoonfuls in a tablespoonful of water at bed-time and once during the day before a meal.

Use—In auditory vertigo this remedy has a beneficial effect; also in certain forms of tinnitus.

129. R. Potassii Bromidi (vel Sodii Bromidi) gr. xx.—5j.

Sig.—To be dissolved in a large quantity of water and take at night.

Use—Should be employed if cerebral symptoms or vertigo arise in connection with ear disease; also in severe forms of tinnitus, especially when associated with nervous excitement; drachm doses at bed-time may give great relief.

Bromide of Ammonium being less depressing is preferred by some, in 15 grain doses.

130. R. Ammon. Chloridi 5iv.
Infus. Gentian Co. 5viij. Solve.

Sig.—A tablespoonful in a wine-glassful of water twice or thrice daily. Whittaker recommends this to be combined with 15 grain doses of Bromide of Ammonium.

Use—In persistent cases of tinnitus.

131. R. Sodii Salicylatis 5ij.
Tinc. Nuc. Vomicae 5iss.
Infus. Gent. Co. ad 5viij. M.

Sig.—A tablespoonful in a wine-glassful of water twice or thrice daily.

Use—Where the arthritic tendency exists along with vertigo and tinnitus.

132. R. Infus. Digitalis ℥iv.

Sig.—Two teaspoonfuls twice daily.

Use—In certain pulsating forms of tinnitus aurium.

133. R. Quininæ Sulph. gr. xij.—℥j.

Acid. Sulphurici Dil. q.s.

Syr. Aurant. ℥vj.

Aquæ ad ℥vj. M.

Sig.—A tablespoonful for a dose.

Use—In smaller doses every three or four hours, given in simple otalgia; the larger doses to be given every two or three hours in phlebitis, thrombosis, or pyæmia; also recommended by Charcot in Ménière's disease after the first few weeks.

134. R. Acid. Hydrobromici Dil. ℥iss.

Liquor. Arsenici

Hydroch. ℥ij.

Liquor. Strychninæ ℥iij.

Aquæ Camphoræ ad ℥vi. M.

Sig.—A drachm thrice daily in a wine-glassful of water after meals.

135. R. Potass. Iodidi ℥iss.

Potass. Bromidi ℥iv.

Glycerin. ℥ij.

Infus. Calumb. ad ℥viij. M.

Sig.—A tablespoonful in a wine-glassful of water thrice daily after food.

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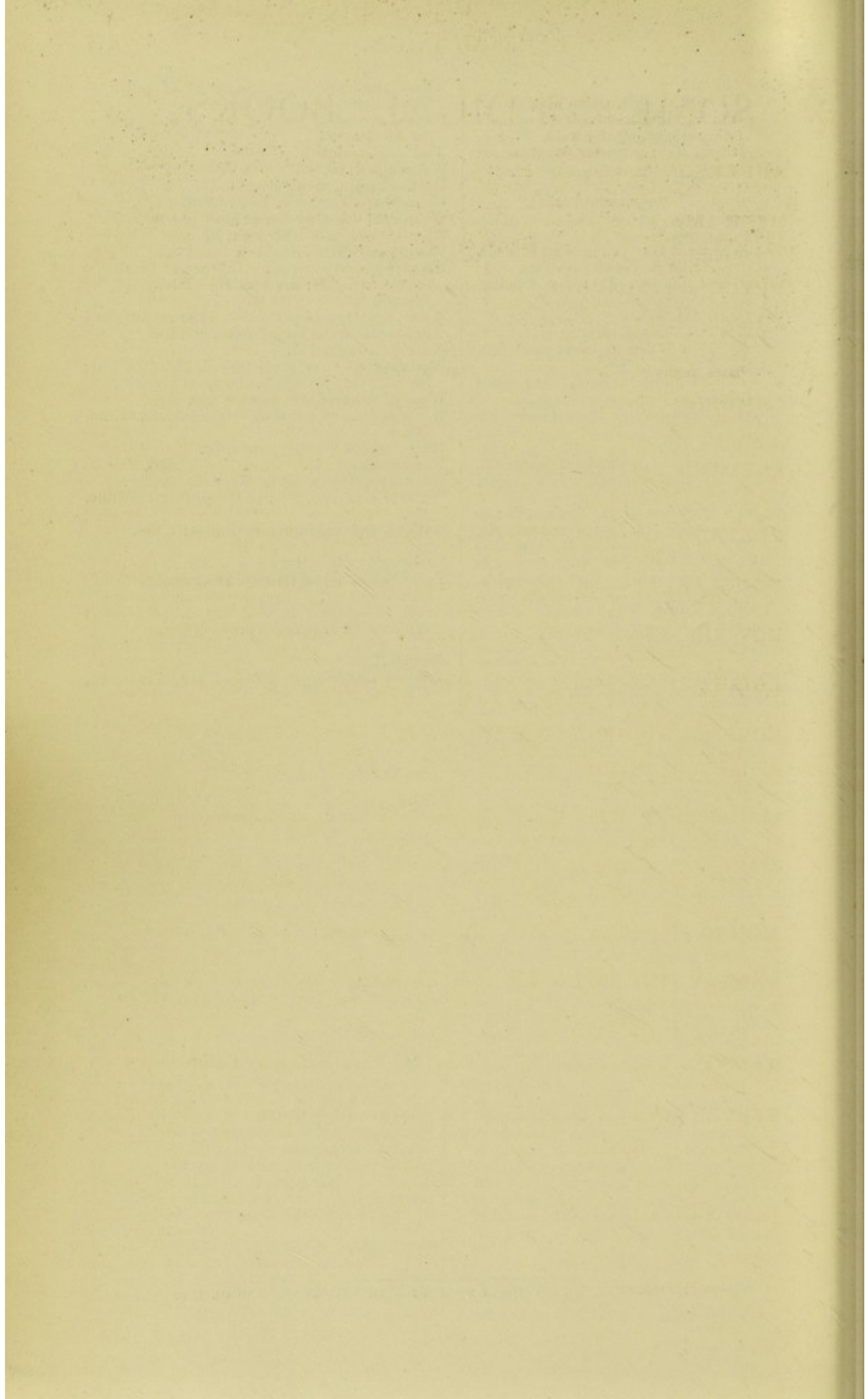
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