A PROSPECTIVE STUDY ON OSSICULAR PATHOLOGY IN CHRONIC OTITIS MEDIA AND ITS RECONSTRUCTION WITH RESHAPED OSSICLE AND CARTILAGE

Dissertation submitted to

THE TAMILNADU DR. M. G. R. MEDICAL UNIVERSITY

Submitted in partial fulfillment of the requirement

for the award of the degree of

M.S. DEGREE BRANCH IV
OTORHINOLARYNGOLOGY

Registration No: 221914202

THANJAVUR MEDICAL COLLEGE

THE TAMILNADU DR. M.G.R. MEDICAL UNIVERSITY

CHENNAI – TAMILNADU

MAY 2022

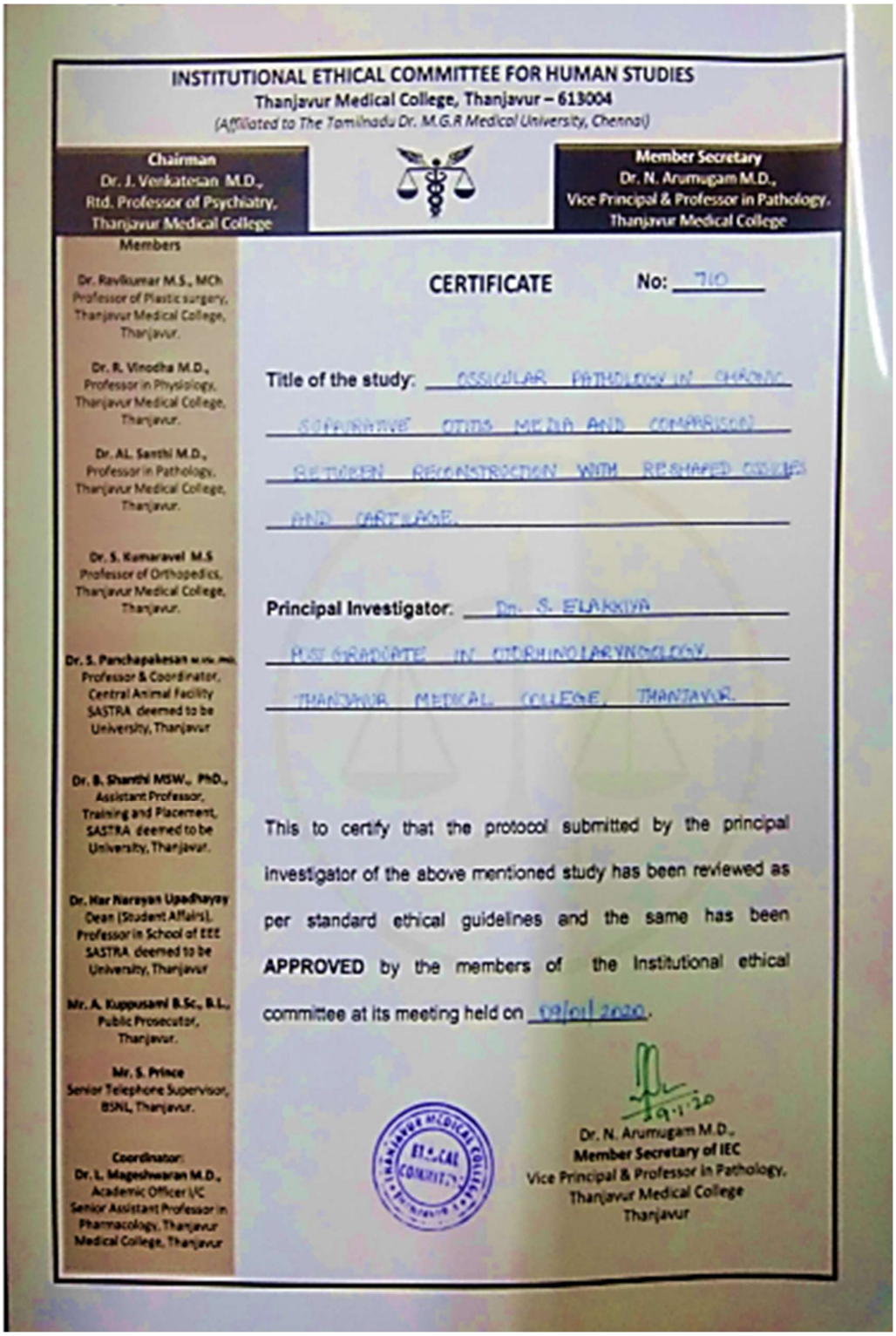
CERTIFICATE - I

This is to certify, that this dissertation titled "**A PROSPECTIVE STUDY ON OSSICULAR PATHOLOGY IN CHRONIC SUPPURATIVE OTITIS MEDIA AND ITS RECONSTRUCTION WITH RESHAPED OSSICLE AND CARTILAGE" by Dr. Elakkiya S**, is an original work done in the Department of Otorhinolaryngology, THANJAVUR MEDICAL COLLEGE, THANJAVUR-613004 in partial fulfilment of rules and regulations of **The Tamilnadu Dr. MGR Medical University for the award of degree of MS (Otorhinolaryngology) branch IV** under my supervision during the academic period 2019 – 2022.

Prof. Dr. C. BALASUBRAMANIAN MS (ENT)
Professor and Head of the Department,
Department of Otorhinolaryngology,
Thanjavur Medical College and Hospital,
Thanjavur- 613004

Prof. Dr. G. RAVIKUMAR MS, MCH,
DEAN,
Thanjavur Medical College and Hospital,
Thanjavur- 613004

ETHICAL COMMITTEE CERTIFICATE



INSTITUTIONAL ETHICAL COMMITTEE FOR HUMAN STUDIES
Thanjavur Medical College, Thanjavur – 613004
(Affiliated to The Tamilnadu Dr. M.G.R Medical University, Chennai)

Chairman
Dr. J. Venkatesan M.D.,
Rtd. Professor of Psychiatry,
Thanjavur Medical College

Member Secretary
Dr. N. Arumugam M.D.,
Vice Principal & Professor in Pathology,
Thanjavur Medical College

Members

Dr. Ravikumar M.S., MCh
Professor of Plastic surgery,
Thanjavur Medical College,
Thanjavur.

Dr. R. Vinodha M.D.,
Professor in Physiology,
Thanjavur Medical College,
Thanjavur.

Dr. AL. Santhi M.D.,
Professor in Pathology,
Thanjavur Medical College,
Thanjavur.

Dr. S. Kumaravel M.S
Professor of Orthopedics,
Thanjavur Medical College,
Thanjavur.

Dr. S. Panchapakesan M.Sc., M.Ed.
Professor & Coordinator,
Central Animal Facility
SASTRA deemed to be
University, Thanjavur

Dr. B. Shanthi MSW., PhD.,
Assistant Professor,
Training and Placement,
SASTRA deemed to be
University, Thanjavur.

Dr. Har Narayan Upadhayay
Dean (Student Affairs),
Professor in School of EEE
SASTRA deemed to be
University, Thanjavur

Mr. A. Kuppusami B.Sc., B.L.,
Public Prosecutor,
Thanjavur.

Mr. S. Prince
Senior Telephone Supervisor,
BSNL, Thanjavur.

Coordinator:
Dr. L. Mageshwaran M.D.,
Academic Officer I/C
Senior Assistant Professor in
Pharmacology, Thanjavur
Medical College, Thanjavur

CERTIFICATE No: 710

Title of the study: OSSICULAR PATHOLOGY IN CHRONIC SUPPURATIVE OTITIS MEDIA AND COMPARISON BETWEEN RECONSTRUCTION WITH RESHAPED OSSICLES AND CARTILAGE.

Principal Investigator: Dr. S. ELAKKIYA
POST GRADUATE IN OTORHINOLARYNGOLOGY,
THANJAVUR MEDICAL COLLEGE, THANJAVUR.

This to certify that the protocol submitted by the principal investigator of the above mentioned study has been reviewed as per standard ethical guidelines and the same has been **APPROVED** by the members of the Institutional ethical committee at its meeting held on 09/01/2020.

ETHICAL COMMITTEE

Dr. N. Arumugam M.D.,
Member Secretary of IEC
Vice Principal & Professor in Pathology,
Thanjavur Medical College
Thanjavur

Curigional

Document Information

Analyzed document	OSSICULAR PATHOLOGY IN CHRONIC SUPPURATIVE OTITIS MEDIA AND ITS RECONSTRUCTION WITH RESHAPED OSSICLE AND CARTILAGE.docx (D123796054)
Submitted	2021-12-30T05:11:00.0000000
Submitted by	Elakkiya s
Submitter email	luckyblue1794@gmail.com
Similarity	13%
Analysis address	luckyblue1794.mgrmu@analysis.urkund.com

Sources included in the report

W	URL: http://repository-tnmgrmu.ac.in/9734/1/220400815pratheesh.pdf Fetched: 2021-11-19T08:32:17.5170000	8
W	URL: http://www.ijss-sn.com/uploads/2/0/1/5/20153321/ijss_aug_oa19_-_2017.pdf Fetched: 2021-12-21T15:55:13.4930000	1

CERTIFICATE- II

This is to certify, that this dissertation titled "**A PROSPECTIVE STUDY ON OSSICULAR PATHOLOGY IN CHRONIC SUPPURATIVE OTITIS MEDIA AND ITS RECONSTRUCTION WITH RESHAPED OSSICLE AND CARTILAGE"** is done by the candidate **Dr. Elakkiya S, with Registration number: 221914202** for the award of MS degree in the branch of Otorhinolaryngology. I personally verified urkund.com website for the purpose of plagiarism check. I found that uploaded thesis contains from the introduction to conclusion pages and results shows 13% of plagiarism in the dissertation.

Guide and Supervisor Sign with Seal:

DECLARATION

I, **Dr. Elakkiya.S** solemnly declare that this dissertation, titled **"Ossicular pathology in chronic suppurative otitis media and its reconstruction with reshaped ossicle and cartilage"** is a bonafide record of work done by me in the Department of Otorhinolaryngology, Govt. Thanjavur Medical College, Thanjavur, under the guidance of Prof. Dr. C. Balasubramanian, M.S. (E.N.T), HOD ofOtorhinolaryngology, Govt. Thanjavur Medical College, Thanjavur.

The Dissertation is submitted to The Tamilnadu Dr. M.G.R. Medical University, Chennai in partial fulfillment in regulations for the award of M.S. branch IV of (Otorhinolaryngology) examination to be held in April 2022.

Place: Thanjavur

Date:

Dr. Elakkiya S
Post graduate, MS ENT,
Thanjavur Medical College and Hospital,
Thanjavur- 613004

ACKNOWLEDGEMENT

I would like to express my sincere gratitude to The Dean, **Prof. Dr.G. Ravikumar M.S. MCh, (Plastic Surgery)** Thanjavur Medical College, Thanjavur for allowing me to use the materials available in the hospital for the study.

I wish to extend my grateful thanks to the Professor and HOD of Otorhinolaryngology **Prof. Dr.C.Balasubramanian M.S. (E.N.T).,** Thanjavur Medical College, Thanjavur for giving me an opportunity to conduct this study and for the valuable guidance, constant encouragement and valuable advise at every stage of this study.

I am very grateful to **Associate Professors. Dr. C.Karuppasamy M.S. D.LO and Dr. B. Ganeshkumar M.S. D.LO** for their inspiring suggestions and encouragement at every stage of this study.

I feel deeply indebted to our **Assistant. Professor. Dr. D.PrincePeterDhas M.S. E.N.T** for supporting, guiding and encouraging me in this study.

I am extremely thankful to my **Assistant Professors, Dr.A.Amirthakani M.S(ENT)., Dr.S.Gerald Parisutham M.S. D.LO., Dr. S.Amrutha M.S (ENT)., Dr. D.Dharmaraja M.S.(ENT)** for their valuable suggestions & help.

Last but not the least I extend my heartfelt thanks to the patients, my parents and fellow post graduates and CRRI's for their untiring support and valuable suggestions.

TABLE OF CONTENTS

INTRODUCTION

- Chronic otitis media (COM) is most prevalent middle ear disease, in developing countries especially in India [1,2]. It is defined as the chronic inflammation of the mucoperiosteal lining of the middle ear cleft more than 3 months. It is characterized by a persistent otorrhea, with permanent perforated tympanic membrane and presents with conductive hearing loss.
- Broadly classified into 2 types –
- 1. Tubotympanic disease (mucosal) -most common
- 2. Atticoantral disease (squamosal).
- Erosion of ossicles is common in **COM**, which is corrected by ossiculoplasty. Ossiculoplasty may be defined as a surgical technique, restoring the hearing mechanism between the tympanic membrane and the oval window by re-establishing a functioning ossicular chain. Type of ossicular destruction varies in each patient depending on the pathology of the disease and its management with ossicular reconstruction. Ossiculoplasty is done with various materials such as reshaped ossicles, conchal cartilage, septal cartilage, tragal cartilage, bone, prosthesis etc., In previous studies, ossicular reconstruction was tried with various types of autografts and prosthesis.

In this study, we compare the outcome of ossicular reconstruction with reshaped ossicles and cartilage in detail.

AIMS AND OBJECTIVE OF THE STUDY

1. To find the incidence of ossicular erosion in mucosal and squamous types of COM
2. To study audiological outcomes of ossicular reconstruction with reshaped ossicles and cartilage.
3. To analyze surgical outcomes by MERI scoring.

REVIEW OF LITERATURE

EMBRYOLOGY OF THE EAR

The human ear starts developing at the fourth week of embryonic life.

External ear

Auricular hillocks are six in number, which develops at sixth week of embryonic life. The 1st and 2nd branchial arches give rise to these auricular hillocks. These auricular hillocks give rise to the Auricle. The external auditory meatus is formed by deepening of the groove between the two arches. The external meatus is formed by the thickening of ectodermal cells of the first branchial groove at its dorsal end. These ectodermal cells proliferate to form a meatal "plug" which progresses medially. In the centre of the meatal plug, the cells undergo resorption to form a tube-like structure called the ear canal. When the canalization is incomplete, it leads to External canal atresia [16]

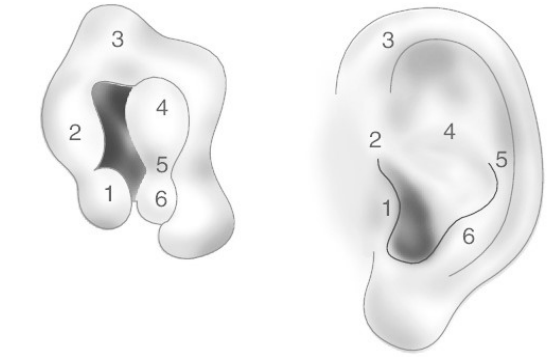


Figure 1: Auricular hillocks

Middle ear

The lateral extension of the first pharyngeal pouch forms the middle ear cavity. The eustachian tube develops from the proximal end of this extension. The lateral extension and the ectoderm of the meatal plug joins to form the tympanic membrane. The malleus, incus, tensor tympani muscle and anterior malleolar ligaments are derived from the mesoderm of first branchial arch. Stapes and stapedius muscle are derived from the mesoderm of second branchial arch.[16]

Inner ear

It consists of,

1.Membranous labyrinth – is a derivative of otic placode. Otic placode is a thickening of ectoderm adjacent to the hindbrain.

2.Bony labyrinth – is a derivative of the mesoderm and neural crest.

ANATOMY OF MIDDLE EAR CLEFT

Middle ear cleft has three components:

(i) Tympanic cavity

(ii) Eustachian tube

(iii) Mastoid air cell system

TYMPANIC MEMBRANE :

- It is a semitransparent structure, 0.1 to 0.15 mm thickness and pearly white in colour.
- Shape- Elliptical disc, Vertical diameter – 9 to 10 mm

  Horizontal diameter – 8 to 9 mm
- Vibrating surface area - 55 sq.mm
- The tympanic membrane lies at an angle of 55^0 on the floor of meatus.
- Divided into 2 parts namely pars tensa and pars flaccida by the anterior and posterior malleolar folds.
- The greater part of tympanic membrane is formed by the pars tensa.

Figure 2: Tympanic membrane

3 layers :

- An outer epithelial layer which is continuous with the epithelium of the EAC.
- A middle fibrous layer – contains a spider's web arrangement of radial and circular fibers (parabolic & transverse fibers also)

- An inner mucosal layer is continuous with the middle ear cavity mucosa.
- The pars tensa is thickened peripherally into a fibrocartilaginous annulus, fits into the groove called tympanic sulcus, which is a ring-like groove lodged in the tympanic ring of the temporal bone.
- The pars flaccida, also known as Shrapnell's membrane is located above the lateral process of malleus. It consists of irregularly arranged collagen and elastic fibers, where the sulcus is deficient posteriorly which occupies the notch of Rivinus.[16] The fibrous layer is absent in the pars flaccida.

ARTERIAL SUPPLY:

Internally :

(a) The arteria nutrica malleo-icudei, a twig from the Middle meningeal artery, which supplies the Shrapnell's membrane.

(b) The vascular circle at periphery, formed by –

- Anterior tympanic artery, a branch of internal maxillary artery.
- Posterior tympanic artery, a branch of stylomastoid artery.
- a tubal twig, from the ascending pharyngeal anastomosis.

Externally- The membrane is supplied by the arteria manubrii - uncertain origin

VENOUS DRAINAGE:

Superficial part -External jugular vein

Deep part - Transverse sinus and Dural venous plexus around ET

NERVE SUPPLY:

(a) Internally (medial surface), from the tympanic plexus of IX cranial nerve

(b) Externally, (i) from the auriculotemporal nerve(V3), in its anterior half, (ii) from Auricular branch of vagus(X) nerve- (Arnold's/ Alderman's nerve) in its posterior half.

MIDDLE EAR – BOUNDARIES : ROOF :

The roof of the middle ear cavity separates it from middle cranial fossa. It is normally a thin plate of bone, the Tegmen tympani – formed partly by the petrous and squamous part of temporal bone.

FLOOR :

The floor is also a thin plate of bone separating it from jugular bulb. Occasionally, the bony floor is dehiscent. At the junction of the floor and the medial wall is an opening called inferior tympanic canaliculus for the entry of Jacobson br. of glossopharyngeal nerve to middle ear.

ANTERIOR WALL :

- The anterior wall is narrow as the lateral and medial walls converge anteriorly. Upper part is pneumatized and houses supratubal recess.

  4 OPENINGS :- From above downwards;

  (i) The small orifice of Canal of Huguier – through which chorda tympani escapes from the middle ear.

  (ii) The canal for the tensor tympani muscle.

  (iii)The tympanic orifice of the eustachian tube.

  (iv)The Glasserian fissure – containing the tympanic artery and the anterior malleolar ligament

- Lower part is related to a thin bone of the carotid canal. It is pierced by superior and inferior carotico tympanic nerves and tympanic branches of ICA

- The septum between the tubal orifice and canal for tensor tympani prolonged backwards along medial wall cavity as shelf of bone known as *processus cochleariformis* – which acts as a pulley for tensor tympani tendon which turns abruptly to insert into the handle of malleus.

POSTERIOR WALL :

Main structures are :

- *The Aditus ad antrum* of mastoid – an opening between epitympanic recess and mastoid antrum.
- *Fossa incudis* is a small depression, consists of short process of the incus and its suspensory ligament.
- *Pyramidal eminence* – It is small, hollow conical projection, which lies below fossa incudis and medial to the opening of the chorda tympani nerve. Its apex is pointed anteriorly. The stapedius muscle and tendon emerges here, which inserts into the posterior aspect of the head of stapes.
- *The facial recess* is a groove between the pyramid and facial nerve and the annulus of the tympanic membrane. Its boundaries are facial nerve medially, tympanic annulus laterally, chorda tympani nerve running obliquely between these two.
- *The sinus tympani* is a deep recess, where the two labyrinthine windows communicate at their posterior extremity. It is a posterior extension of the mesotympanum into the posterior wall. The sinus tympanum is very difficult to access surgically, as it lies deep to the facial nerve, pyramid and stapedius muscle. Its medial wall is continuous with the posterior

portion of the medial wall of the tympanic cavity in the retrotympanum, and is bounded by ponticulus superiorly and subiculum inferiorly.

MEDIAL WALL:

The medial wall separates the middle ear cavity from the internal ear.

The *promontory* is a smooth rounded bony projection covering the basal turn of the cochlea and usually has small grooves on its surface containing the tympanic plexus.

The *oval window (fenestra ovale)* lies above and slightly behind the promontory. It is a slightly kidney-shaped opening, which opens into the vestibule of inner ear and is closed in life by the footplate of the stapes and its surrounding annular ligament.

The oval window and round window niches are separated by a bony ridge called the *subiculum,* which is a posterior extension of the promontory. Above the subiculum, another ridge of the bone called the *ponticulus* leaves the promontory and runs to the pyramid on the posterior wall of the cavity.

The *facial nerve canal* also known as Fallopian canal runs above the oval window and promontory in an anteroposterior direction. It is marked anteriorly by a curved projection of bone- the *processus cochleariformis*, which is concave anteriorly, houses the tendon of the tensor tympani muscle as it turns laterally to the handle of the malleus. In the posterior portion of the

epitympanum lies the dome of the semicircular canal, which is posterior and lateral to the facial canal. In front and a little below the dome of semicircular canal and above the processus cochleariformis, there is a slight swelling corresponding to the geniculate ganglion, with the bony canal of the greater superficial petrosal nerve runs anteriorly for a short distance.

LATERAL WALL :

It is formed:

i) Superiorly by - the bony lateral wall of the epitympanum (outer attic wall/scutum)

ii) Centrally by - tympanic membrane

iii) Inferiorly by - the bony lateral wall of the hypotympanum.

3 holes and their contents:

i) *Anterior canaliculi/Canal of Huguier/iter chordae antterius* - chorda tympani carrying taste sensation from anterior 2/3rds tongue, leaves tympanic cavity.

ii) *Petrotympanic fissure* – transmits anterior tympanic branch of maxillary artery and anterior malleolar artery

iii) *Posterior canaliculi/iter chordae posterius* – chorda enters tympanic cavity.

MASTOID REGION :

- At birth the mastoid lies superficially and surrounded by a diploic bone. It forms a single cavity including the antrum and small mastoid. Gradually the mastoid may become fully pneumatized, diploic or sclerotic in the adulthood.
- Divided into 2 regions, the squamous portion of the temporal bone forms the anterolateral potion of the mastoid, while the petrous part gives rise to the posteromedial portion including the mastoid tip.
- Koerner's septum or the petrosquamous septum is an incomplete plate of bone, which is the internal junction of the anterolateral and posterolateral portion of the mastoid. The *aditus ad antrum* connects the large superior central space of mastoid antrum with the epitympanic space of the middle ear.[16] The facial nerve lies on a plane below and deep to the opening of aditus from the attic.
- Mastoid is the largest and permanent air cell of mastoid. It measures about 14mm from front to back, 9 mm from top to bottom, 7 mm from side to side.
- Medial wall- related to posterior and horizontal semicircular canals
- Roof- tegmen antri separated the antrum from temporal lobe and its meningeal coverings, in the middle cranial fossa.

- Lateral wall - squamous portion of temporal bone, supra meatal triangle or MacEwen's triangle.
- Posterior wall and floor- mastoid portion of the temporal bone.
- *Boundaries of the MacEwen's triangle :*
    - Superiorly – Suprameatal crest,
    - Antero-inferiorly- posterior margin of external auditory canal
    - Posteriorly- a tangential line from the suprameatal crest to the posterior canal wall.
    - This area can be palpated through the cymba concha.

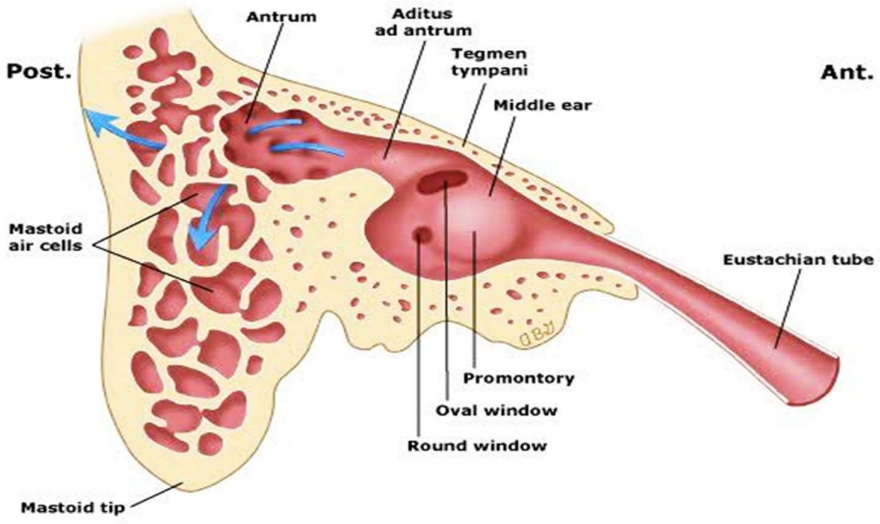


Figure 3:Middle ear cleft

TYMPANIC CAVITY :

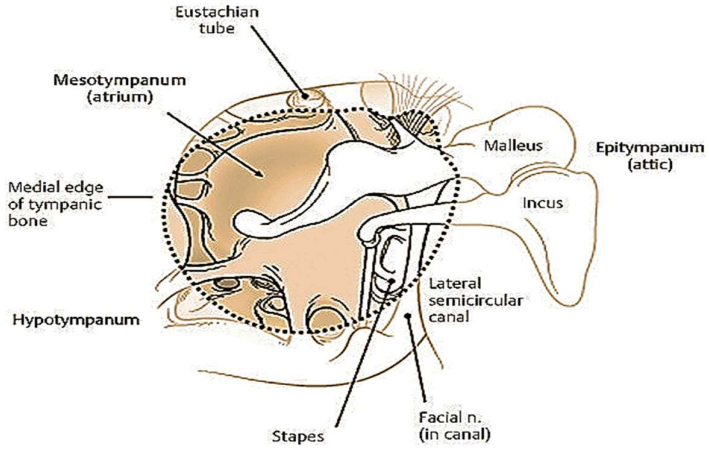


Figure 4:Middle ear

Biconcave disc shaped and measures 15mm above downwards and 13mm from behind forwards.

3 parts :

A) the middle and biggest part, *mesotympanum,* medial to the pars tensa of the TM

B) the upper part, *epitympanum,* middle ear cavity lying above the former, and also known as the epitympanic recess or attic,

C) the lower part, *hypotympanum,* middle ear cavity lying below the TM level.

(A) EPITYMPANUM/ ATTIC: lies above the level of short process of malleus, within notch of Rivinus.

Boundaries: The tympanosquamous suture line anteriorly, tympanomastoid suture line posteriorly, medial wall of mesotympanum above level of facial canal, ampullated ends of superior and lateral SCCs medially, pars flaccida and outer attic wall- scutum laterally and tegmen tympani in the roof.[16]

Contents :

(i) Head of malleus

(ii) Body of incus

(iii) Associated ligaments and mucosal folds

COG – it is a coronally oriented bony process in the middle ear cavity of the temporal bone that projects from the tegmen tympani, separating the anterior epitympanic recess from the posterior epitympanum. The cog ends anterosuperior to the head of the malleus and superior to the cochleariform process.

<u>Anterior epitympanum:</u>

- Also known as "anterior epitympanic recess/ sinus epitympani/ Supratubal recess"
- Bounded superiorly by anterior part of tegmen tympani, anteriorly by root of zygoma, posteriorly by cog, laterally by scutum, medially by anterior portion of the tympanic portion of facial

nerve and geniculate ganglion, and in the floor by cochleariform process and tensor tympani fold.

- Common site for attic cholesteatoma and its recurrence
- Pars flaccida (lateral wall of epitympanum) is prone for retractions due to the negative middle ear pressure as middle collagen layer absent

Epitympanum communicates with mesotympanum via 2 openings in mucosal folds – Anterior isthmus tympani and posterior isthmus tympani

(B) MESOTYMPANUM :

- Mesotympanum consists of protympanum, mesotympanum proper and posterior tympanum.
- Boundaries: medially- promontory, laterally- pars tensa, anteriorly- protympanum, posteriorly- retrotympanum, inferiorly- hypotympanum, superiorly- tympanic diaphragm.
- Eustachian tube exits from the anterior aspect

CONTENTS :

- Handle of the malleus
- Long process of the incus

- Stapes

- Oval and round window

Posterior tympanum – divided into four sinuses in relation to second genu/vertical segment of facial nerve and pyramidalis process.

Lateral to the facial nerve lies two sinuses namely *facial recess and lateral sinus.*

- Facial recess/ suprapyramidal recess may be entered from the mastoid by opening up small cells usually present between the fossa incudis, the deeper posterior bony canal and the descending portion of the facial nerve. It is bounded by pyramid below, chorda tympani laterally and facial nerve medially.[16]
- Lateral sinus lies below the facial recess and is bounded by annulus- laterally, facial nerve- medially and pyramid above.

Medial to the facial nerve, there are two sinuses namely the *posterior tympanic sinus and sinus tympani.*

- Sinus tympani starts above at the oval niche; it occupies a groove deep to the descending portion of the facial nerve and to the pyramid and passes behind the round window niche to the hypotympanum. It is bounded by subiculum below, ponticulus above and facial nerve laterally.

- Posterior tympanic sinus is bounded by footplate anteriorly, ponticulus below and facial nerve and pyramidalis process laterally.

- **(C) HYPOTYMPANUM :**

  - Middle ear cavity below the level of bony ear canal, lies below a horizontal plane from inferior margin of fibrous annulus to inferior margin of Promontory.

  - Contains group of air cells inferior to labyrinth and extending anterior to cochlea.

Five walls:

- Anterior wall- carotid canal medially and dense bone laterally.
- Posterior wall- inferior part of styloid complex and vertical segment of facial nerve in its canal
- Outer wall- tympanic bone.
- Medial wall- lower part of promontory and petrous bone.
- Inferior wall- thin bony plate separating from jugular bulb.

CROTCH/ JUGULOCAROTID CREST

When the floor of the hypotympanum is deficient, the jugular bulb, which is in close relation to the inferior part of tympanic fibrous annulus gets exposed. On elevation of the annulus, the jugular bulb starts bleeding.

(D) PROTYMPANUM :

- Portion of middle ear around tympanic orifice of eustachian tube.

Boundaries:

Anteriorly- eustachian tube, Posteriorly- Mesotympanum, Laterally- lateral lamina, Medially- cochlea posteriorly and carotid canal anteriorly, Roof- bony semicircular canal for Tensor tympani muscle.

- Internal carotid artery passes inferomedial to bony eustachian tube covered by thin plate of bone

CONTENTS OF MIDDLE EAR CAVITY:

Ossicles- Malleus, Incus and Stapes.

Muscles- Stapedius and Tensor tympani.

Nerve- Chorda tympani nerve and tympanic plexus of glossopharyngeal nerve.

OSSICLES: The three ossicles form a semi rigid bony chain that transmit sound energy from the tympanic membrane to the inner ear [16]. Malleus is the most lateral and is incorporated into the layers of the tympanic membrane, whereas stapes is attached to the oval window.

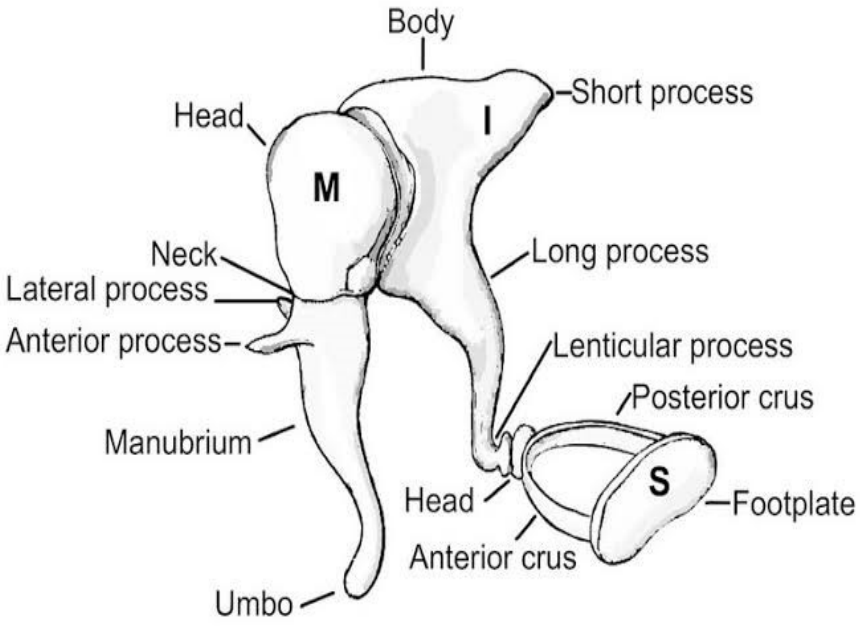


Figure 5:ossicles

Malleus (hammer):

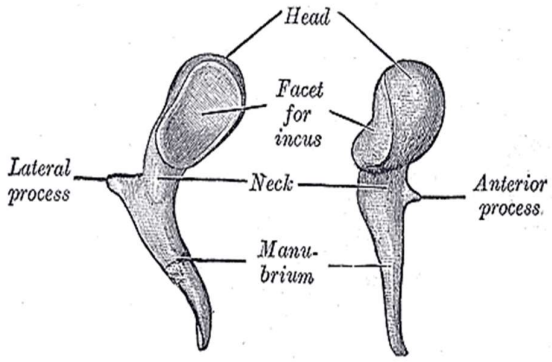


Figure 6:malleus

- The malleus is the largest of the three ossicles measuring 9 mm in length.
- It consists of head, neck, handle or manubrium.
- The head is suspended by the superior ligament, in the epitympanum running upwards to the tegmen tympani. It articulates with the incus by a saddle shaped facet on its posteromedial surface, forming a synovial joint.
- Below the neck, the bone broadens to give rise to the lateral process, the anterior process and the handle.
- 2 process – (i) Lateral process – it receives anterior and posterior malleolar folds from the annulus and forms a prominent landmark on the tympanic membrane.

  (ii) Anterior process – A slender anterior malleolar ligament arises form it and gets inserted into the petrotympanic fissure.
- The malleus handle runs downwards, medially and slightly backwards between the mucosal and fibrous layers of the tympanic membrane.
- The chorda tympani cross the upper part of the handle medially above the insertion of tendon of tensor tympani, but below the neck itself. So the amputation of the head through the neck leaves both chorda tympani and tensor tympani intact.

- The malleus supported by five ligaments, one articulation, the tensor tympani tendon, and the tympanic membrane. Three of the five ligaments have a suspensory function. They are:
    - The anterior suspensory ligament
    - The lateral suspensory ligament
    - The superior suspensory ligament [16]

Incus (anvil):

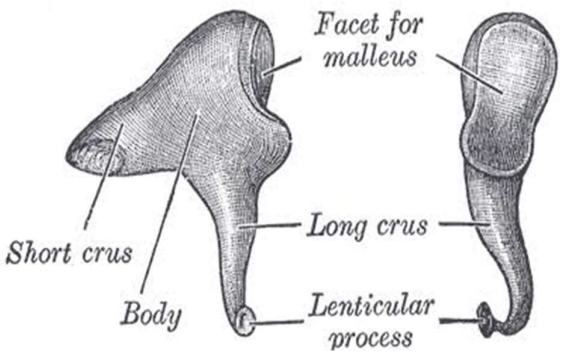


Figure 7: Incus

- Incus articulates with the malleus and made up of a body and two processes.
- The Body of the incus is suspended by the superior incudal ligament that is attached to the tegmen tympani, in the epitympanum. It articulates with the malleus by a cartilage covered facet corresponding to that in the malleus.

- The Short process is attached by a short suspensory ligament to lie in the fossa incudis, where it is projected backwards from the body.
- The Long process descends into the mesotympanum behind and medial to the handle of the malleus, and at its tip is a small medially directed lenticular process.
- The lenticular process is also known as the *fourth ossicle* because of its incomplete fusion with the tip of the long process, giving the appearance of a separate bone. It articulates with the head of the stapes.

Stapes (stirrup):

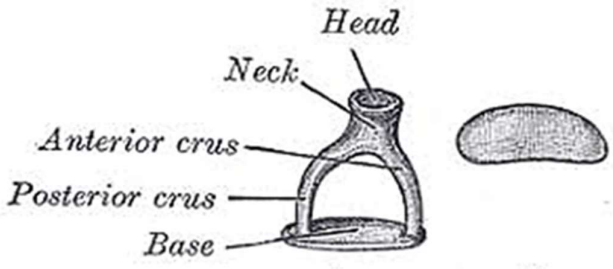


Figure 8: Stapes

- It is Stirrup shaped and consists of head, neck, anterior and posterior crus, foot plate

- Head and the lenticular process of incus forms a synovial articulation by a small cartilage covered depression in the lateral aspect.
- The Stapedius tendon inserts into the posterior part of the neck and upper portion of posterior crus.

- The two crura arise from the broader lower part of the neck and the anterior crus is thinner and less curved than the posterior one.
- The two crura join the footplate, which usually has a curved anterior and posterior end and an almost straight inferior margin and a convex upper margin.
- The footplate measures 3 mm in length, 1.4 mm in width. It is attached to the bony margins of the oval window by the annular ligament. Its long axis is almost horizontal, with the posterior end being slightly lower than the anterior.

MUSCLES:

STAPEDIUS:

The stapedius muscle arises from the walls of the conical cavity within the pyramid as well as from the downward curved continuation of this canal in from of the descending portion of the facial nerve. A slender tendon emerges from the apex of the pyramid and inserts into the stapes. A small branch of the facial nerve supplies the stapedius muscle.

TENSOR TYMPANI MUSCLE:

Origin: cartilaginous portion of eustachian tube,

Wall of bony canal above the eustachian tube,

Greater wing of sphenoid.

Course- passes backwards into tympanic cavity, lies below the facial nerve, hooks around the processus cochleariformis[16].

Insertion- medial aspect of upper end of the handle of malleus.

Nerve supply- Mandibular nerve from its branch, the medial pterygoid nerve.

CHORDA TYMPANI :

At the junction of the lateral and posterior walls, the *chorda tympani* nerve enters the tympanic cavity from the posterior canaliculus. It then runs forwards over the tympanic membrane in between fibrous and mucosal layers on the medial surface and crosses the root of the handle of malleus above the tensor tympani tendon. It leaves the middle ear through petrotympanic fissure via anterior canaliculus and enters the infratemporal fossa, where it joins the lingual nerve.

TYMPANIC PLEXUS:

In the tympanic cavity, tympanic nerve (Jacobson's nerve), a branch of the glossopharyngeal nerve along with the sympathetic fibres from the carotid plexus, forms the tympanic plexus. It is located on the surface of the promontory.

This tympanic plexus provides sensory branches to the mucosa of the tympanic cavity and internal surface of the tympanic membrane. It also forms

the lesser petrosal nerve, which forms the preganglionic parasympathetic axons to the otic ganglion.

THE MUCOSA OF THE TYMPANIC CAVITY:

A thin, delicate mucous membrane lines the whole of the middle ear cavity. It is reflected on to the ossicles and the tendons of the tensor tympani and stapedius muscles. It is continuous with the mucous membrane of the eustachian tube and the mastoid antrum.

In general, it consists of a single non ciliated cuboidal epithelium, two or three cells deep, without a basement membrane, but in parts the cells may be of the simple or ciliated columnar type, especially near the entrance of the eustachian tube and in the hypotympanum.

Three distinct mucociliary pathways identified – epitympanic, promontorial and hypotympanic, the latter being the largest.

Major mucosal folds:

1. Superior malleolar
2. Lateral malleolar
3. Lateral incudal
4. Medial incudal
5. Superior incudal
6. Inter ossicular[16]

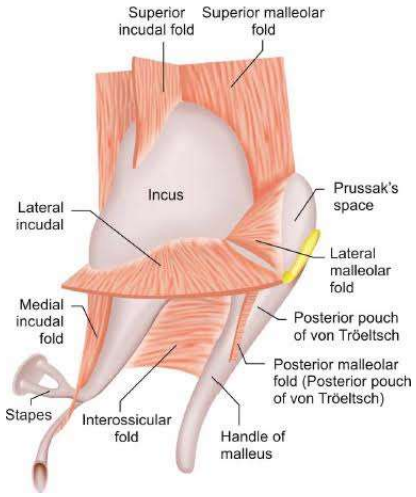


Figure 9: Mucosal folds

The mucosal folds may limit the infection to one or several of the compartments in the middle ear; and if disease is thus limited it may be possible to control it in the affected compartment while preserving the integrity and function of adjacent structures.

ANATOMY OF TEMPORAL BONE

Temporal bone is a composite structure.

It includes:

Tympanic bone,

Mastoid process,

Squama and petrosal part,

Styloid process (not definitive)

With the pores of external acoustic meatus as topographical reference, the tympanic part is directed forward, the mastoid part backward, the squamous part is directed upward and the petrous portion is medially.

Squamous Portion:

- The squama is a vertical plate, the semi-circular free border of which is serrate on anterosuperior portion and bevelled from within.

  Lateral surface:

- It is smooth and gives attachment to temporalis muscle.
- Zygomatic process projects from the lower part of the surface for attachment of masseter muscle.
- Mandibular fossa is situated below the root of the zygomatic process.
- The sulcus for middle temporal artery passes upward on the posterior part of the squama.

Medial surface:

- It is directed towards the middle cranial fossa, presents with impressions for the cerebral sulci and gyri and a deep sulcus for the middle meningeal artery.

Mastoid Portion:

- It is the inferiorly extending projection seen on the lateral surface of the temporal bone. It is composed of a squamous portion (laterally) and a petrous portion (medially) separated by Korner's (petrosquamous) septum.[16]

Lateral surface:

- It is rough and gives attachment to posterior auricular and occipital muscles.
- Behind the spine, on the posterior surface is the mastoid foramen, which is traversed by the mastoid emissary vein and one or two mastoid arteries.
- MacEwen's triangle is defined by the linea temporalis (temporal line), the posterosuperior margin of the external auditory canal, and a tangent to the posterior margin of the external auditory canal.
- The mastoid fossa is a depressed surface, a cribriform area, identified by its numerous perforating small blood vessels.

- Inferiorly, the sternocleidomastoid muscle attaches to the mastoid tip.

Medial surface:

- It presents a groove, the sigmoid sulcus for lodgement of the sigmoid sinus.
- The mastoid process contains numerous mastoid cells that differ in size and number. Tympanic antrum is the largest among the mastoid air cells, which is connected by the aditus ad antrum with the attic(epitympanum).

Tympanic bone:

- It forms the anterior, inferior and pats of posterior wall of the external auditory canal.
- It interfaces with

  Squama at the tympanosquamous suture line,

  Mastoid at the tympanomastoid suture line, traversed by Arnold's nerve.

  Petrosa at the petrotympanicfissure, traversed by the chorda tympani nerve, anterior process of the malleus, and anterior tympanic artery. It constitutes the posterior wall of the glenoid fossa for the temporomandibular joint.

- Inferiorly the vaginal process, a projection of the tympanic bone forms the sheath of the styloid bone.

- Laterally, the tympanic bone borders the cartilaginous EAC, whereas medially, it bears a circular groove, the annular sulcus. The annular sulcus houses the annulus of the tympanic membrane except superiorly, where it is deficient, known as the notch of Rivinus.[16] Here the tympanic membrane attaches directly to the squama.

Petrous Portion

It is a three-sided pyramid, the base united with the mastoid part is inserted into the angle between the occipital and sphenoid bones. The apex is directed medially and forward. It is a highly dense bone containing the sensory organs of the inner ear. The foramen lacerum intervenes between the apex and the sphenoid bone.

Contents:

- Meningeal branch of ascending pharyngeal artery, emissary veins pass through whole length.
- Internal carotid artery with venous and sympathetic plexus around it,
- Greater petrosal nerve unite with the deep petrosal nerve to form nerve to pterygoid canal.

The Petrous part has three surfaces- Anterior, Posterior and Inferior.

Anterior surface:

- This smooth surface, is directed forward and downward, laterally fused with squama at the petrosquamous suture. This surface forms part of the middle cranial fossa.
- The anterior margin is free and roughened, with the greater wing of the sphenoid bone bounds an opening, the musculotubal canal. A leaflet of bone divides this canal into upper smaller semicanal for the tensor tympani muscle, and a lower larger semicanal for eustachian tube.
- In the middle of anterior surface, the underlying semicircular canal forms the Arcuate eminence.
- Tegmen tympani lies anterolateral to arcuate eminence, forming the roof of the tympanic cavity.
- Openings:
    i) Medially- Hiatus of the facial canal- transmits superficial petrosal branch of the middle meningeal artery and the greater superficial petrosal nerve.
    ii) Laterally- superior aperture of the tympanic canaliculus- transmits superior tympanic artery and the lesser superficial petrosal nerve.

Posterior surface:

- The posterior surface is bounded above at the superior angle, by the sulcus for superior petrosal sinus and below at the posterior angle, the pyramid unites with the occipital bone along with the line of fusion accommodating the sulcus for inferior petrosal sinus. It lies in vertical plane. It forms the part of surface of posterior cranial fossa.

  Openings:

  i) Opening of internal acoustic meatus- between the base and apex- short canal for acoustic and facial nerves and internal auditory blood vessels.

  ii) Subarcuate fossa- behind and above internal acoustic meatus- carries blood vessels to otic capsule in fetal life. In adults, it is of pinpoint caliber, transmitting small veins to duramater.

  iii) Vestibular aqueduct- further laterally and downwards- transmission of endolymphatic duct and sac.

Inferior surface:

- It lies in horizontal plane, forming the jugular foramen along with occipital bone.

  Jugular foramen:

- Lateral part- contains the junction of sigmoid sinus and the internal jugular vein

- Medial part- contains inferior petrosal sinus and middle portion contains cranial nerves IX, X, XI.
- *Jugular fossa* - in front of the lateral compartment, lodges for the bulb of jugular vein
- *Cochlear canaliculus* -funnel shaped, medial to jugular fossa, contains perilymphatic duct.
- *External carotid foramen*- in front of jugular fossa- entrance to the canal for internal carotid artery and its plexus of veins and sympathetic nerves.
- *Caroticotympanic canaliculi*- small openings near external carotid foramen- transmits caroticotympanic artery and nerves into the middle ear.
- *Carotid ridge*- separates external carotid foramen and the jugular fossa. On its edge is petrosal fossula- for lodgement of petrosal ganglion of the glossopharyngeal nerve.
- *Tympanic canaliculus*- at the bottom of petrosal fossula- transmits tympanic branch of glossopharyngeal nerve (Jacobson's nerve) and the tympanic branch of ascending pharyngeal artery.
- A rough jugular surface behind the jugular fossa articulates with the jugular process of the occipital bone. Lateral to this surface, a downward directed cylindrical spur, the *styloid process* is present

- *Stylomastoid foramen*- at the posterior aspect of styloid process- external orifice of facial canal, transmits facial nerve, the stylomastoid artery, auricular branch of the vagus nerve.
- *Mastoid incisure/notch*- for digastric muscle attachment and *temporal/ occipital groove*- for occipital artery are present in the posterior direction.[16]

EUSTACHIAN TUBE :

- It connects the middle ear cavity with the nasopharynx, dynamic in nature.
- It is directed downwards, forwards and medially at 45^{o} from the middle ear. Its adult length of 36 mm is reached by the age 7 years.
- Medial 2/3rd is cartilaginous- 24 mm in length and lateral 1/3rd is bony- 12 mm in length, with the junction forms the narrowest portion called the isthmus, which is 0.5 mm in diameter.
- Mucosa- respiratory mucosa, lined by ciliated epithelium, contains goblet cells and mucinous glands.
- Boundaries- roof is formed by a thin plate of bone separating the tube from the tensor tympani muscle, carotid canal lies medially impinging on the bony eustachian tube.

- In the cartilaginous part, the apex is attached to the isthmus of the bony portion, while the wider medial end protrudes into the nasopharynx, lying directly under the mucosa to form **torus tubarius.**
- The eustachian tube opens into the nasopharynx 1-1.25 cm below and behind the posterior end of the inferior turbinate. This opening is triangular in shape and is surrounded above and behind by the torus.
- Behind the torus is the pharyngeal recess or **fossa of Rosenmuller.**
- Muscle attachments:
    1. Tensor veli palatini or dilator tubae,
    2. Salpingopharyngeus
    3. Levator veli palatini muscle.

- The normal eustachian tube is closed at rest. Intermittent active dilation (actively by contraction of tensor veli palatini and passively by contraction of levator veli palatini) of the tube leads to the exchange of gas between the middle ear and nasopharynx, which maintains near ambient pressures in the middle ear.

The eustachian tube has at least three physiologic functions:

- Ventilation and maintenance of atmospheric pressure in the middle ear for normal hearing,
- Drainage of middle ear secretions into nasopharynx by mucociliary clearance, pumping action of eustachian tube and presence of intra luminal surface tension,
- Protecting the middle ear from nasopharyngeal pressure changes, loud sound coming through pharynx and ascending nasopharyngeal secretions due to narrow isthmus and angulation between 2 parts of eustachian tube at isthmus.

PHYSIOLOGY OF HEARING:

The sound is transmitted through the external auditory canal and reaches the tympanic membrane. The middle ear transmits sound through ossicles, oval window and thereby maintaining a phase difference between the round and the oval windows. This leads to stimulation of inner hair cells of cochlea, which produces electrical stimuli, carried over by the auditory pathway to the auditory cortex [10].

PHYSIOLOGY OF MIDDLE EAR:

IMPEDANCE MATCHING: The impedance quality of air and fluid varies largely, such that there would be a 99.9% loss- around 30 dB, during transmission of sound energy from Air to Fluid medium. Impedance matching

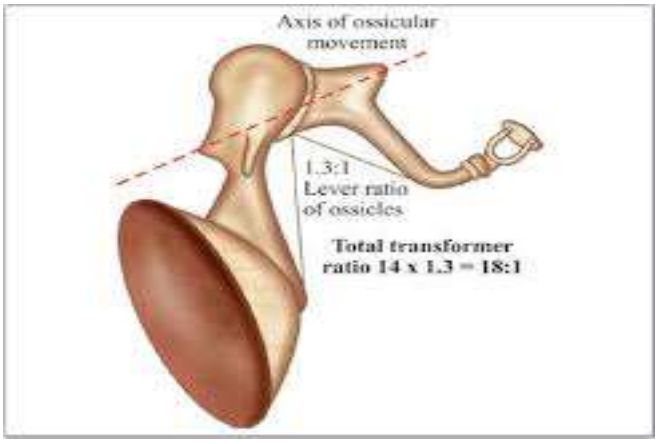
overcomes this loss, allowing optimum sound energy transmission, through 3 major transformer mechanisms in the middle ear namely

i) Cantenary lever

ii) Ossicular lever

iii) Hydraulic lever.

CANTENARY LEVER:



Here, the lever action is provided by the curvature of the tympanic membrane. The fibrous annulus remains fixed, thus the sound energy gets magnified two times at its central attachment, to the malleus.

OSSICULAR LEVER:

The ossicles themselves constitute a lever mechanism, which acts through the rotational axis of malleus and incus. The handle of malleus is 1.3 times longer than the long process of incus, hence the lever ratio of 1.3: 1 is obtained.

HYDRAULIC LEVER:

Acoustic energy collected by the larger area of tympanic membrane (45mm) is applied through the ossicles to the small area of stapes footplate (3.2 mm). The effective ratio of these area is about 14:1.[10]

The product of areal and lever ratio is known as transformer ratio i.e 14x 1.3= 18.1. By its effect, the amplitude of vibration of the stapes is reduced compared with that of membrane, while the force exerted by the stapes upon the labyrinthine fluid are increased in the same proportion.

Bone Conduction:

Bone conduction hearing is by following mechanisms:

- Inertia of ossicular chain,
- Compression effect of labyrinth due to distortion of the skull bones,
- Inertia of the mandible, which causes acoustic vibrations in the external auditory canal.

CHRONIC OTITIS MEDIA:

It is a chronic inflammation of mucoperiosteal lining of the middle ear cleft with perforation of the tympanic membrane and persistent discharge lasting more than 12 weeks.

CLASSIFICATION OF CHRONIC OTITIS MEDIA

1. Healed chronic otitis media - tympanosclerotic patch/ healed perforation of TM will be present.

2. Inactive (Mucosal) COM - Permanent perforation of the pars tensa but the middle ear mucosa is not inflamed.

3. Inactive (Squamous)COM - Retraction of pars flaccida or pars tensa (usually posterosuperior) which has the potential to become active with retained debris.

4. Active (Mucosal) COM - Permanent defect of the pars tensa with an inflamed middle ear mucosa which produces mucopus that may discharge.

5. Active (Squamous) COM - Retraction of pars flaccida or tensa that has retained squamous epithelial debris and is associated with inflammation and the production of pus, often from the adjacent mucosa.[20]

CHRONIC OTITIS MEDIA – MUCOSAL TYPE: It is characterized by profuse, intermittent, mucoid/mucopurulent, non-foul smelling discharge with mild to moderate conductive hearing loss.

Pathophysiology:

- Chronic inflammation with in the mucosa of the middle ear with varying degrees of edema, submucosal fibrosis, hypervascularity and infiltration with lymphocytes, plasma cells and histiocytes.

- Mucoid nature of the discharge is due to increased number of goblet cells in the middle ear epithelium and there is also a basal cell hyperplasia in the mucosa. This leads to increased secretions and persistent ear discharge & eventually cause permanent perforation of the TM.
- Granulation tissue can occur due to this inflammation, which protrudes in to the external auditory canal and is often clinically described as Aural polyp.
- Active mucosal COM is associated with destruction of ossicular chain, the affected ossicles show a typical area of hyperemia with proliferation of capillaries and prominent granulation tissues.
- The long process of incus, stapes crura, body of incus and manubrium are involved in decreasing order of frequency. Bone resorption or destruction occurs by osteoclastic activity.

Tympanic membrane perforation:

TM perforation includes pars tensa and pars flaccida perforation. The pars tensa perforation is divided into central and marginal perforation.

Types of perforations and their significance:

1. CENTRAL PERFORATION: This is commonly seen in tubotympanic variety of COM in pars tensa. The rim of residual TM always surrounds the

perforation. They can present as central, anterior, subtotal and posterior perforations.

2. MARGINAL PERFORATION: It involves postero-superior region of the pars tensa, where one side of the perforation lies on the bony annulus. It is commonly seen in squamous type of COM.

3. ATTIC PERFORATION: It involves pars flaccida, commonly seen in squamous type of COM. [16]

Fig 4: TYPES OF PERFORATION SEEN IN CHRONIC OTITIS MEDIA

Clinical features:

- Hard of hearing- depends on the size and location of the TM perforation and middle ear status.
- Otorrhoea- profuse, mucoid or mucopurulent discharge which may be active or inactive (no ear discharge for 6 continuous weeks)

- Pain – associated with acute infection causing complications, may also be in otitis externa.

Preoperative Evaluation:

1. Otoscopic examination
2. Examination under operating microscope
3. Aural swab for culture and sensitivity in refractive cases
4. Audiological evaluation by **pure tone audiometry,** to be conducted within 3 months prior to surgery, to evaluate and document:

- The degree of hearing loss
- Type of hearing loss
- To determine the Air Bone Gap

- Perforations of the tympanic membrane – 15 to 20 dB conductive hearing loss, total perforation accounts for 40-45 dB hearing loss- in such cases ossicular chain status will not add upon the hearing loss,[40]
- Perforation with ossicular chain damage- increases upto 30-50 dB hearing loss,
- Ossicular chain discontinuity with an intact tympanic membrane- 55-65 dB hearing loss.

Other investigation done is **Speech discrimination testing -** to decide whether the patient is a candidate for middle ear reconstructive surgery.

Imaging :

HRCT scanning in both the coronal and axial planes of the temporal bone, helps to assess the extent of disease, pneumatization of mastoid, level of sinus plate and tegmen tympani, to rule out intracranial involvement, facial canal anatomy and to decide the type of surgical approach to be used.

Management:

Medical management:

- Aural toilet by (i) dry mopping, (ii) wet mopping, (iii) suction clearance.
- Appropriate antibiotic ear drops. In refractory cases culture & sensitivity is indicated in prior to instillation of antibiotic ear drops.

Surgical management:

- Adequate management of septic foci (chronic adenotonsillitis, chronic rhinosinusitis, nasal obstruction due to deviated nasal septum, etc.,) is must to prevent surgical (tympanoplasty) failure.

Myringoplasty

It is defined as repair of tympanic membrane perforation in dry ear with an intact ossicular chain. If hearing loss is less than 40 dB, myringoplasty is preferred.[17]

Objectives: To improve hearing, to enable proper hearing aid usage.

Indication: Tympanic membrane perforation and associated hearing loss.

Contraindications:

Absolute: Squamosal type of CSOM, middle ear malignancies, extensive tympanosclerosis, in case of complications like meningitis, lateral sinus thrombosis, etc.

Relative: Acute upper respiratory tract infections, otitis externa, only hearing ear with severe sensorineural hearing loss of opposite side, marked loss of speech discrimination, pregnancy, children below 12 years of age.

Pre-requisites: Ear should be dry at least for 3 months, healthy middle ear mucosa, patent eustachian tube, no septic foci in paranasal sinuses, nose and nasopharynx, good cochlear reserve.

Graft materials: Auto grafts- temporalis fascia (most commonly used), tragal perichondrium, conchal perichondrium, tragal and conchal cartilage, periosteum, vein graft, ear lobule fat, subcutaneous tissue, fascia lata, dura. Treated acellular dermal homografts, xenografts derived from bovine pericardium [10]

Techniques:

- Onlay technique
- Underlay technique

Approaches:

- Trans-canal
- Post-aural

Surgical steps in myringoplasty:

- General or local anaesthesia can be chosen according to the patient.
- Patient head is placed on the edge of the table and turned approximately 120^{o} away from the surgeon.
- Freshening of margins of the perforation.
- Tympanomeatal flap elevated.
- Graft placement either with onlay or underlay technique.

Tympanoplasty:

It is a surgical procedure where clearance of mucosal disease from middle ear and attic, with reconstruction of tympanic membrane and ossicular chain.[17]

Indications: Dry central perforation associated with ossicular necrosis, post traumatic perforation with ossicular discontinuity, congenital ossicular discontinuity.

Contraindications: Same as myringoplasty.

Classifications:

Zollner and Wullstein's classification(1953):

- Type 1 – Done in cases of perforated tympanic membrane with intact ossicular chain.
- Type 2 – Done in cases of malleus erosion, here the graft placed over the incus.
- Type 3 – Done is cases of eroded malleus and incus and with intact and mobile stapes
- Type 4 – Done in cases of erosion of suprastructure of stapes with mobile footplate (cavum minor)
- Type 5 – Done in cases with Fixed footplate of stapes, hence fenestration is made in horizontal semicircular canal with round window shielding.
- Type 6 – Sono inversion

Austin's classification (1971):

Incus is absent and tympanic membrane requires repair in all cases.

- Type A: M+S+

Here the reconstruction of the ossicular chain from handle of malleus to stapes suprastructure.

- Type B: M+S-

  Here the reconstruction of the ossicular chain from handle of malleus to stapes footplate.

- Type C: M-S+

  Requiring reconstruction of tympanic membrane with partial ossicular replacement prosthesis (PORP)

- Type D: M-S-

  Requiring reconstruction of tympanic membrane with total ossicular replacement prosthesis (TORP)

Farrier's classification

- Tympanoplasty type 1- Done in cases with intact ossicles
- Tympanoplasty type 2- Reconstruction of a new eardrum placed in contact with a normal mobile incus in cases with a missing malleus handle,
- Tympanoplasty type 3- Interposition of a bone graft between the intact stapes and the drum or the malleus handle

- Tympanoplasty type 4- Reconstruction by a columella in cases with a missing stapedial arch
- Tympanoplasty type 5- Fenestration of the lateral semicircular canal
- Tympanoplasty type 6- Myringoplasty in cases with no ossiculoplasty and no restoration of the hearing

Approaches

1.Postaural approach – large perforation, narrow ear canal.

2.Transcanal approach – small posterior perforation, large ear canal, to avoid post auricular incision and related scar.

3. Endaural approach – here 2 incisions are made, one along the entire posterior half of the EAC at the bony cartilaginous junction and the second one is made in the incisura and connects in the previous incision. Indicated in cases with pauci pneumatisation of temporal bone.

Prerequisites for primary ossiculoplasty:

Factors included are- type of mastoidectomy, prosthesis type, presence of infection, status of mucosa, eustachian tube function were found to be predictive of ossicular reconstruction success.

Five factors that can influence the performance of any ossicular prosthesis:

1. Stiffness
2. Mass (50 mg)
3. Position
4. Tension imposed by the prosthesis on tympanic membrane and annular ligament
5. Coupling of process on tympanic membrane and stapes, 3 to 4 mm of prosthesis diameter contacts the drum in the postero superior quadrant gives an acceptable result.[10]

Merchant and Rosowski's presentation of the basic science of mechanics of ossicular reconstruction [10]

Five principles:

- Tension under which the implant is placed. Excessive laxity in the ossicular chain results in the sound energy loss. This degree of tension is usually achieved by adjusting the length of prosthesis to be slightly greater than the visible gap. Excessive tension dampens the sound energy and worsens hearing results.
- Round window protection is important.
- Angle of prosthesis should be 45 to 90 degree in contact with tympanic membrane or malleus.

- Prosthesis should be kept in contact with centre of tympanic membrane, if placed closed to annular ligament, it dampens the sound transmission.
- The air space around the ossicular chain should be more than 0.3 ml to optimise hearing and to prevent the development of adhesions.

Ossicular reconstruction techniques and results:

- For M+S+: In cases of lenticular process erosion, Short columella ossiculoplasty/Myringostapediopexy can be done. Long process is removed to minimise mass and to reduce the possibility of undesired fixation to the fallopian canal or promontory. A groove is made for articulation with malleus surface with a 1.5 mm diamond burr following the natural groove of the joint and an acetabulum is created in its short process with 0.6mm burr. The sculptured incus might slightly exceed the size of the graft, in order to create the appropriate tension. The incus is rotated on to the capitulum, and the pressure is slowly released to fix with the malleus handle, making sure that incus does not exert excessive pressure on the stapes.
- For M-S+: In cases of partially eroded malleus, malleus head is reshaped by removing the handle and drilling a hole to fit the stapes capitulum. Disadvantage of this type of ossiculoplasty is Head of malleus is heavy and reconstruction using it is highly unstable.

Alternative for this is partial ossicular replacement prosthesis or autologous cartilage grafting can be done.

- For M+S-: Here long columella ossiculoplasty or myringoplatinoplexy can be done with reshaped malleus, autologous reshaped cartilage, PORP.
- For M-S-: Here TORP or autologous reshaped cartilage can be used.[10]

Reasons for ossicular reconstruction failures

1. Recurrent or residual middle ear disease
2. Persistent dysfunction of eustachian tube
3. Due to improper size or flaws in designing, prosthesis may get extruded
4. Movement exerted by the prosthesis

Guidelines for successful ossiculoplasty

1. For good healing of the tympanic membrane and stability of the graft, under surface temporalis fascia grafting is essential.
2. Mostly in all cases, one stage ossiculoplasty should be carried out.
3. Proper sculpturing of the ossicle and cartilage tip.
4. Procedure should be staged if indicated.

MIDDLE EAR RISK INDEX, MERI 2001: score of 0 to 16.

OTOLOGIC FACTOR	MAXIMUM SCORE
1. Otorrhoea	3
2. Perforation	1
3. Cholesteatoma	2
4. Ossicular status	4
5. Middle ear granulations	2
6. Previous surgery	2
7. Smoking	2

MATERIALS AND METHODS

Study setting

This was a prospective study, conducted in Department of Otorhinolaryngology, Thanjavur Medical College, Thanjavur.

Study duration

This study was carried out during November 2019 to November 2021

Study design

Prospective study conducted for 2years of duration

Study population - Patients prepared for surgical management for chronic suppurative otitis media in the Department of Otorhinolaryngology, Thanjavur Medical College and Hospital, Thanjavur.

50 such patients are included in my study

Method of data collection

The proforma was designed based on objective of the study. According to the proforma, detailed history was taken, thorough ENT and systemic examination was done. The ears were examined by otoscopy initially and otoendoscope to establish a preoperative diagnosis of mucosal or squamosal disease. All patients underwent a preoperative pure tone audiometry, to find out the hearing status and obtain documentary

evidence for the same, and X-ray mastoid (bilateral Schueller's view) to assess the pathology and surgical anatomy of the mastoid. CT temporal bone was also taken for preop evaluation. Per operatively, tympanic membrane findings and middle ear findings like granulations, ossicular status, ossicular mobility, middle ear mucosa, eustachian tube patency were noted. Ossiculoplasty methods were noted and documented. In my study, only underlay technique for tympanic membrane reconstruction by temporalis fascia is done. Ossiculoplasty was done using reshaped autologous ossicles and autologous Tragal cartilage. Patient was discharged after advising about a 3rd month and 6th month follow up. During the follow up, patient was subjected to otoendoscopic examination and audiological evaluation and it was documented.

Analysis of data

Ossicular erosion in each case of chronic otitis media (Tubotympanic and Atticoantral disease) were assessed. MERI scoring is also done for all cases. In each type of surgery, pre op audiogram mean value of patients is taken and is compared to mean post op audiology on 3rd and 6th month visit and mean difference is measured to assess the audiological outcome in each type of surgery. Data collected was analyzed and presented in the form of figures, tables, pie charts, etc., and inferences were made based on the analysis.

Inclusion criteria:

1. AGE: 16 to 45 years.

2. SEX: Both sexes selected.

3. All cases of CSOM- mucosal and squamous type, active and inactive stages planned for surgery.

Exclusion criteria:

1. Patients with history of intracranial and extracranial complications

2. Patient with congenital deafness and ear anomalies

3. Previous history of ear surgeries.

4. Malignancy of ear.

5. Patients with sensory neural hearing loss.

6. Patients with systemic illness.

ANALYSIS AND RESULTS.

This is a prospective study on incidence of ossicular pathology in chronic otitis media and its reconstruction using autologous reshsaped ossicles and autologous tragal cartilage.

Observation of 50 chronic otitis media patients who underwent ossicular reconstruction surgery with reshaped ossicles and cartilage, reviewed after 3rd and 6th months.

The following observations were made of the data collected from this study.

Results are divided into two sections:

1) Descriptive statistics using frequency distribution.
2) Inferential statistics using chi square test and Fisher exact test.

Descriptive statistics using frequency distribution:

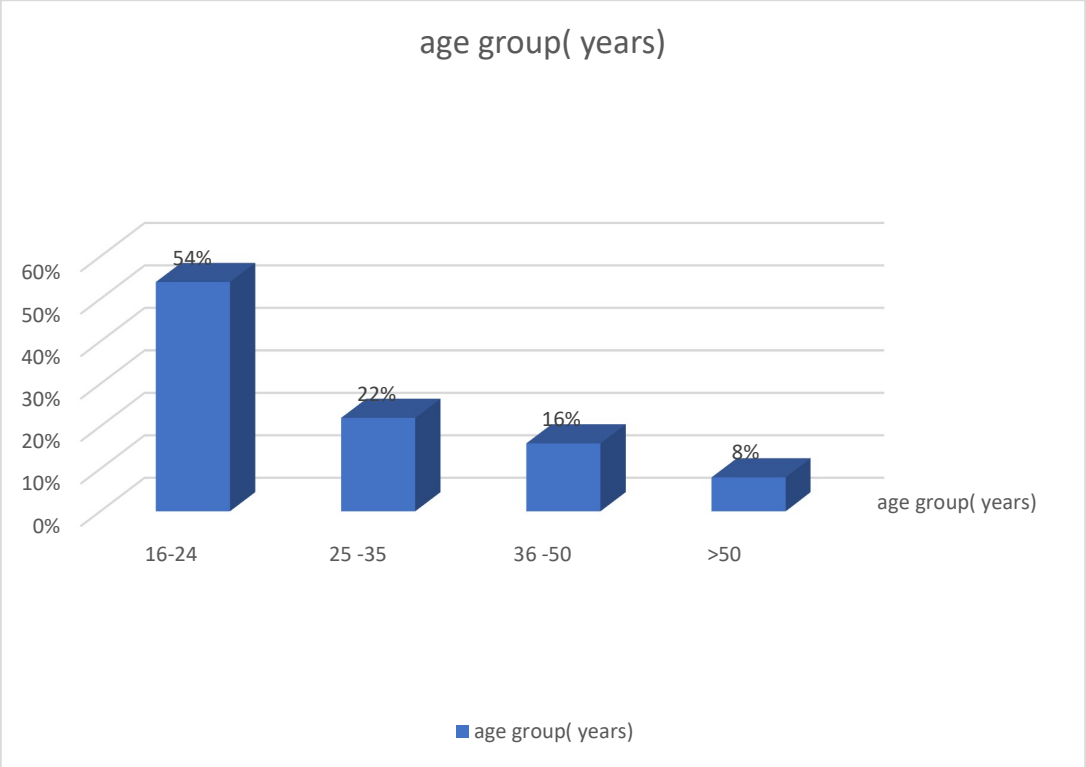
Age group

Table 1.frequency distribution of age group

S.no	Variables	Frequency (50)	Percent (%)
	Age group(years)		
1.	16 to 24	27	54
2.	25 to 35	11	22
3.	36 to 50	8	16
4.	>50	4	8

Among the study populations , Age ranged from 16 to 58 years with mean age 28 years of age and SD-11.56 , Maximum cases(54%) were in 16 to 24 years of age group .

Chart 1. frequency distribution of Age group



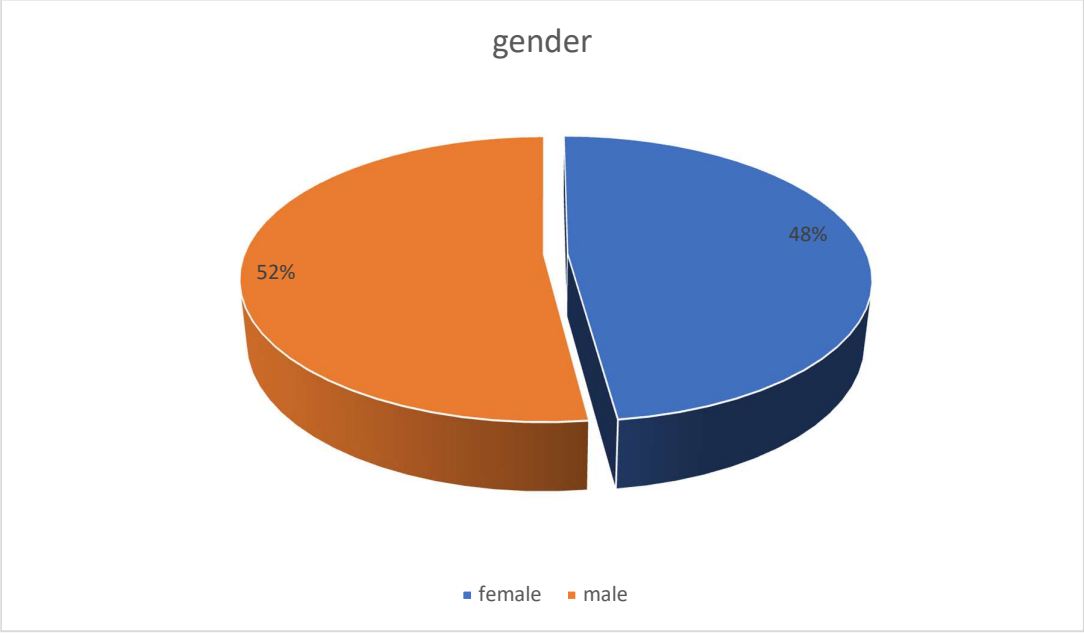
Gender

Table 2.frequency distribution of gender

S.no	Variables	Frequency (50)	Percent (%)
	Gender		
1.	Male	26	52
2.	Female	24	48

Among the study populations , more than 50% were male.

Chart 2. frequency distribution of gender



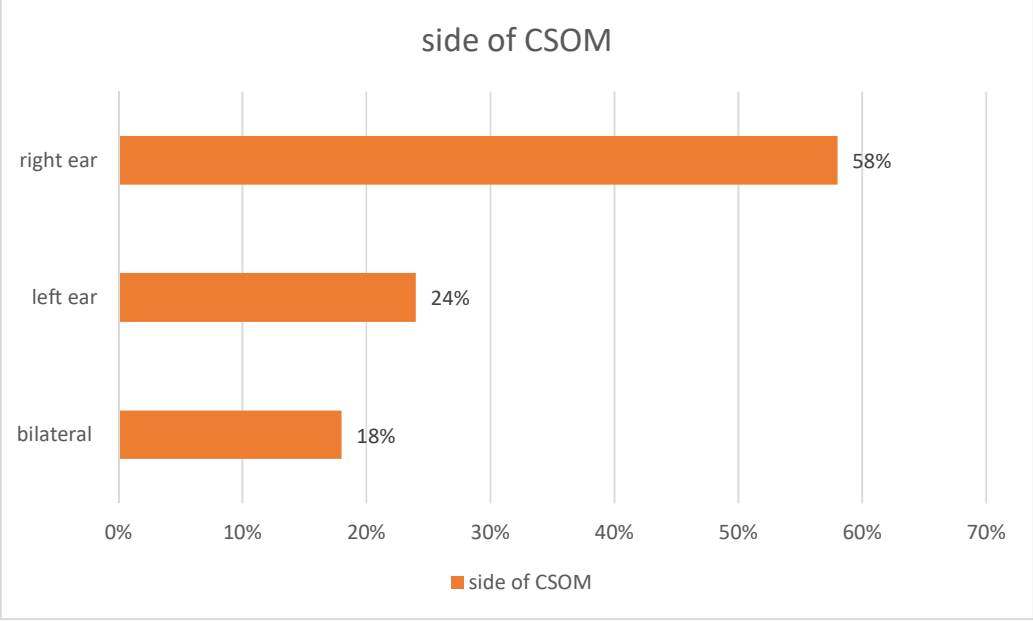
Side of CSOM

Table 3.frequency distribution of side of CSOM

S.no	Side of CSOM	Frequency (50)	Percent (%)
1.	**Bilateral**	9	18
2.	Right ear	29	58
3.	Left ear	12	24

Among the study populations , nearly 60% of the patients had right side CSOM

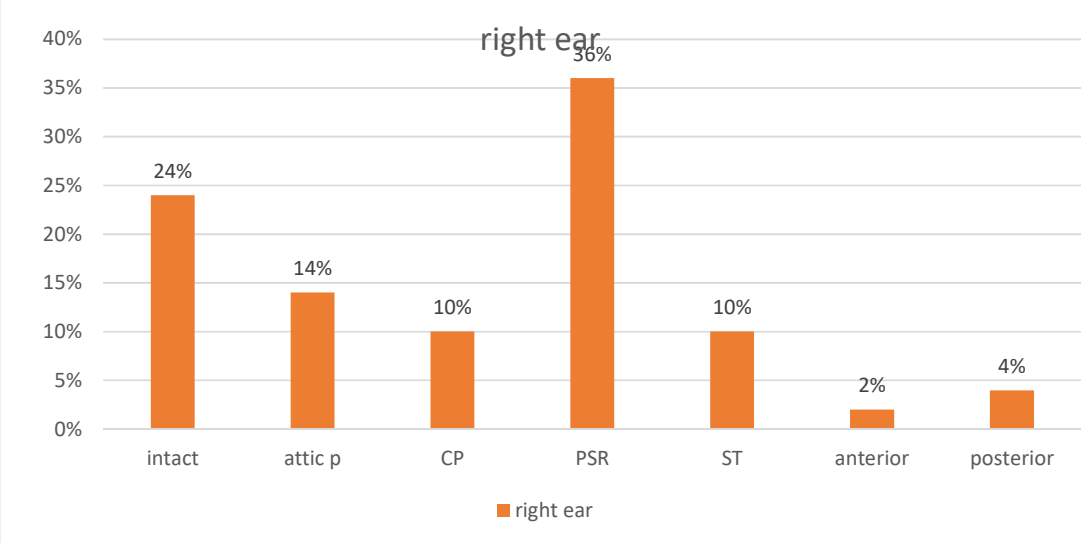
Chart 3. frequency distribution of side of CSOM.



Right ear TM findings:

Table 4. frequency distribution of right ear TM findings

S.no	**Right ear**	Frequency (50)	Percent (%)
1.	Intact TM	12	24
2.	Attic P	7	14
3.	CP	5	10
4.	PSR	18	36
5.	ST	5	10
6.	Anterior	1	2
7.	posterior	2	4



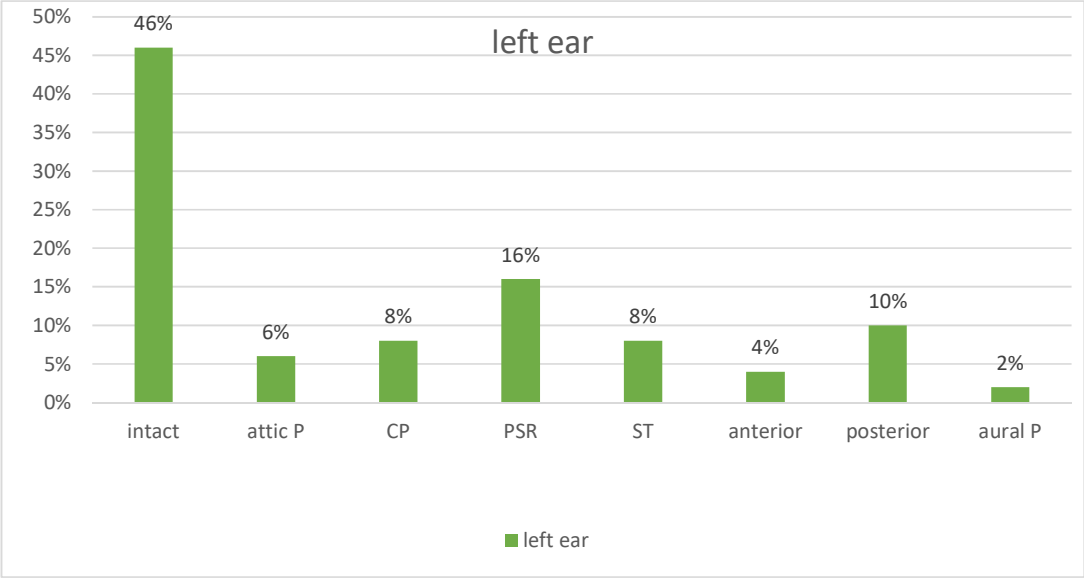
Among the study population, 36% have posterosuperior retraction of TM, followed by attic perforation, central perforation, subtotal perforation. Chart 4. frequency distribution of right ear TM finding

Left ear TM finding

Table 5. frequency distribution of left ear TM finding

S.no	**Left ear**	Frequency (50)	Percent (%)
1.	Intact	23	46
2.	Attic P	3	6
3.	CP	4	8
4.	PSR	8	16
5.	ST	4	8
6.	Anterior	2	4
7.	Posterior	5	10
8	Aural P	1	2

Among the study populations, 16% have posterosuperior retraction, followed by posterior quadrant perforation, central perforation. Chart 5. frequency distribution of left ear TM finding.



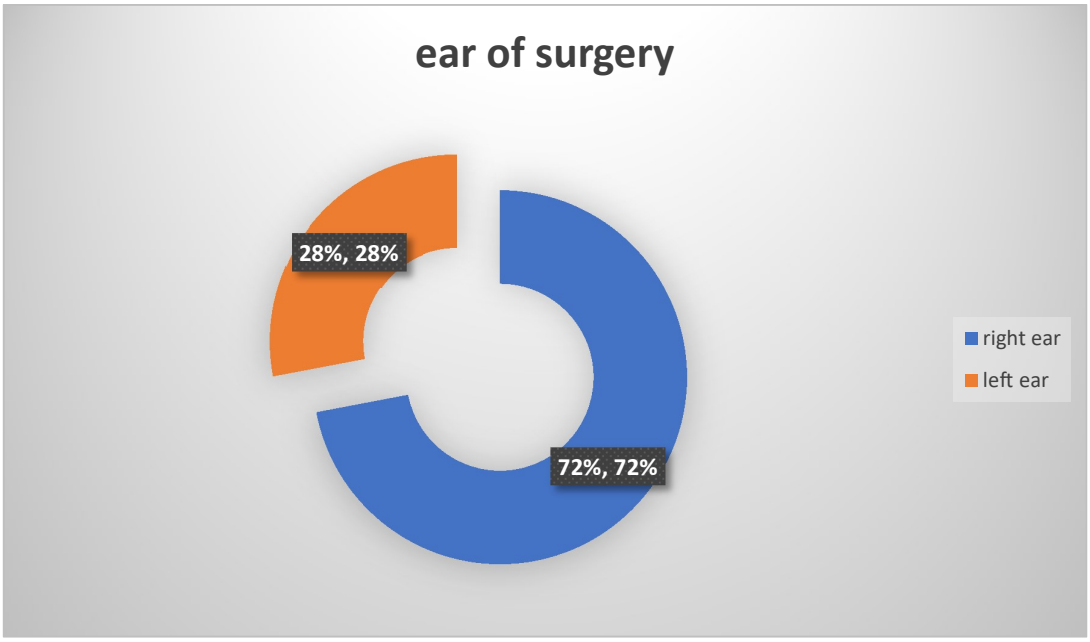
Ear of surgery

Table 6. frequency distribution of ear of surgery

S.no	**Ear of surgery**	Frequency (50)	Percent (%)
1.	Right ear	36	72
2.	Left ear	14	28

Among the study populations, more than 70% of the patients had surgery in right ear.

Chart 6. frequency distribution of ear of surgery.



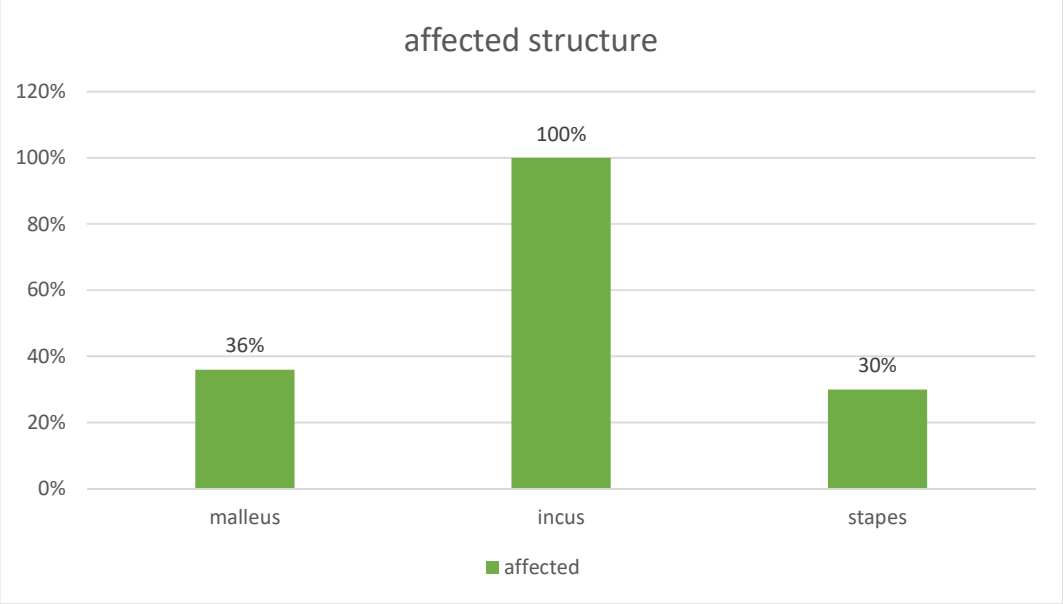
OSSICULAR CHAIN STATUS

Table 7. frequency distribution of ossicular chain status in COM cases

S.no	**Variables**	Frequency (50)	Percent (%)
1.	**Malleus**		
	Handle eroded	8	16
	Head eroded	7	14
	Head and handle eroded	3	6
	Intact	32	64
2.	**Incus**		
	Long process eroded	42	84
	Completely eroded	8	16
3.	**Stapes**		
	Intact	35	70
	Supra structure eroded	15	30

Among the study populations, more than 60% of the patients had intact malleus. more than 80% of the patients had long process incus eroded. 30% of the patients had eroded stapes suprastructure.

Chart 7. frequency distribution of malleus, incus, stapes erosion.



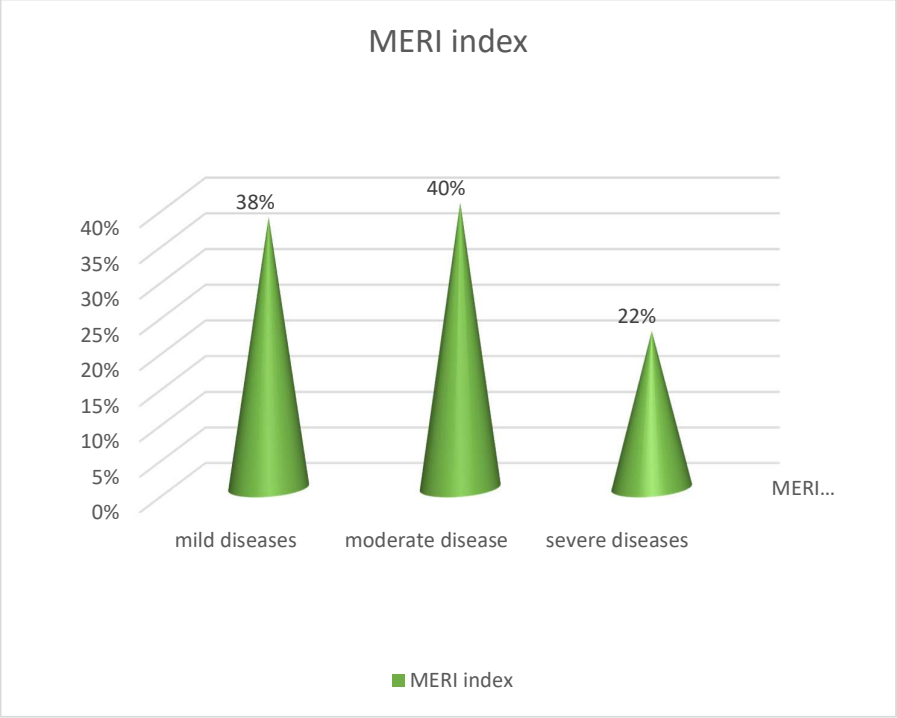
Middle ear risk index

Table 8. frequency distribution of middle ear risk index

S.no	**Middle ear risk index**	Frequency (50)	Percent (%)
1.	Mild diseases (1 to 3)	19	38
2.	Moderate diseases (4 to 6)	20	40
3.	Severe diseases (7 to 12)	11	22

Among the study populations, 40 percent of the patients had moderate diseases according to MERI index.

Chart 8. frequency distribution of MERI indices



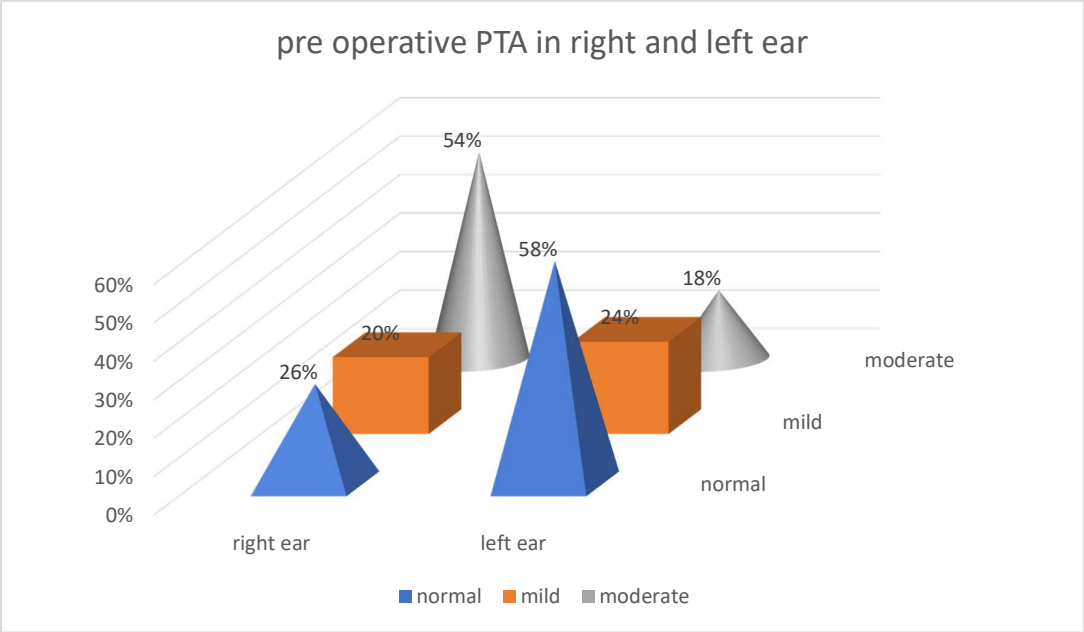
Preoperative PTA in left and right ear

Table 9.frequency distribution of preoperative PTA in left and right ear

S.no	**Pre operative PTA**	Frequency (50)	Percent (%)
1.	**Right ear**		
	Normal (<26 dB)	13	26
	Mild hearing loss (26-40 dB)	10	20
	Moderate hearing loss (41-55 dB)	27	54
2.	**Left ear**		
	Normal (<26 dB)	29	58
	Mild hearing loss (26-40 dB)	12	24
	Moderate hearing loss (41-55 dB)	9	18

Among the study populations, more than 50% of the patients had moderate hearing loss in right ear pre operatively, nearly 20% of the patients had moderate hearing loss in left ear pre operatively.

Chart 9. frequency distribution of pre operative PTA in right and left ear



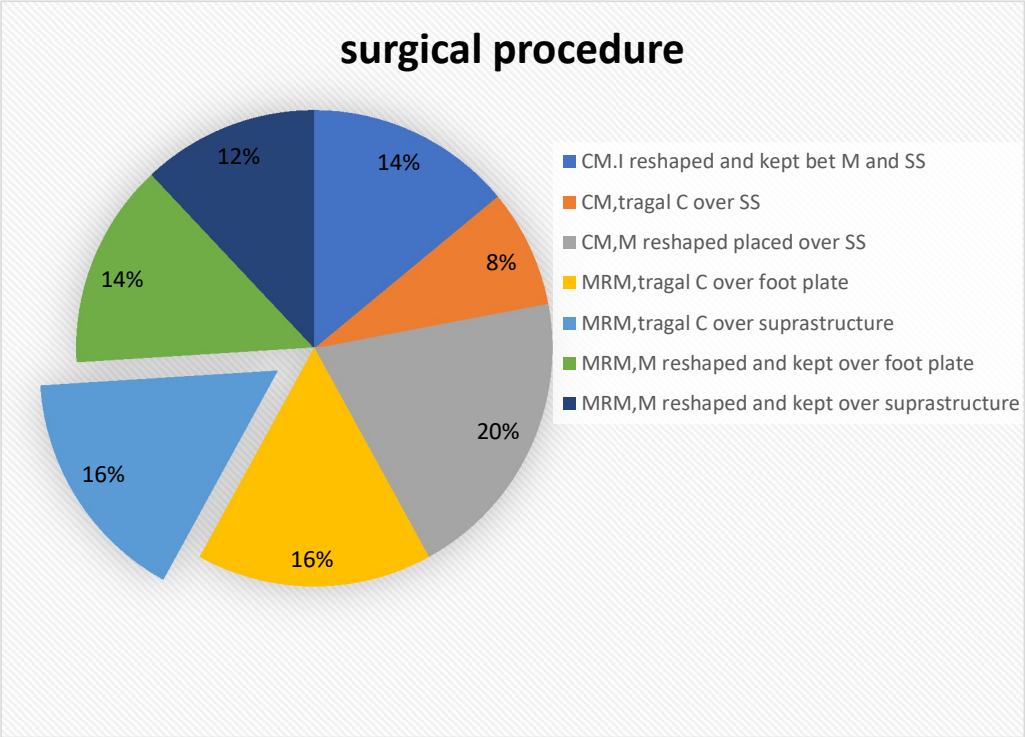
Surgical procedure

Table 10.frequency distribution of surgical procedure

S.no	**Surgical procedure**	Frequency (50)	Percent (%)
1.	CM, I reshaped and kept between M and SS	7	14
2.	CM, tragal cartilage over SS	4	8
3.	CM, M reshaped placed over SS	10	20
4.	MRM, tragal cartilage over foot plate	8	16
5.	MRM, tragal cartilage over suprastructure	8	16
6.	MRM, M reshaped and kept over foot plate	7	14
7.	MRM, M reshaped and kept over suprastructure	6	12

Among the study populations , twenty percent of the patients had CM,M reshaped placed over SS, next to it were 16 % of the patients had MRM, tragal cartilage over foot plate, MRM, tragal cartilage over supra structure .

Chart 10. frequency distribution of surgical procedure



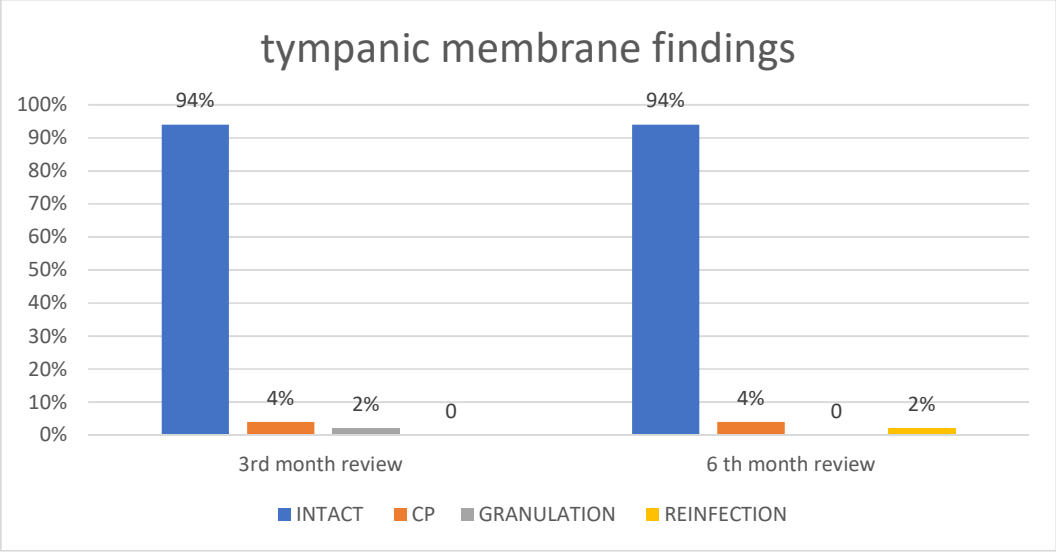
Tympanic membrane findings after surgical procedure

Table 11. frequency distribution of post operative tympanic membrane finding

S.no	**Tympanic membrane findings**	Frequency (50)	Percent (%)
1.	**TM findings on 3rd month review**		
	CP	2	4
	Granulation	1	2
	Intact	47	94
2.	**TM findings on 6 th month review**		
	CP	2	4
	Reinfection	1	2
	Intact	47	94

Among the study populations, nearly 95% of the patients had intact tympanic membrane on 3rd and 6th month review.

Chart 11. frequency distribution of tympanic membrane findings



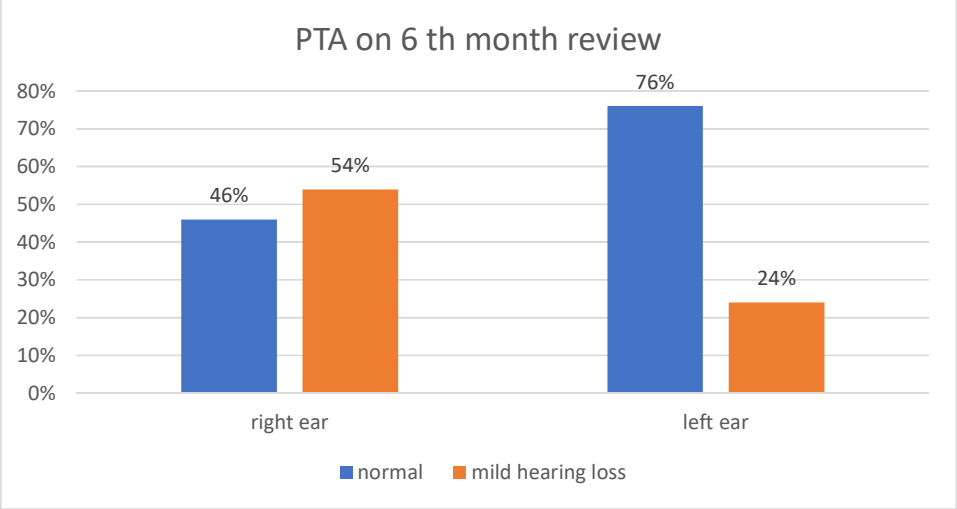
Pure tone audiometry after surgical procedure

Table 12. frequency distribution of pure tone audiometry

S.no	Variables	Frequency,		percent	
	PTA findings on 3rd month review				
1.		**Right ear**		**Left ear**	
	Normal (<26dB)	20,	40%	35,	70%
	Mild hearing loss(26-40 dB)	30,	60%	15,	30%
2	**PTA findings on 6th month review**				
	Normal (<26dB)	23,	46%	38,	76%
	Mild hearing loss(26-40 dB)	27,	54%	12,	24%

Among the study populations ,70% of the patients had normal hearing in left ear compared to right ear 40%. At the end of the 6th month more than 75% of the patients had normal hearing in left ear.

Chart 12. frequency distribution of pure tone audiometry

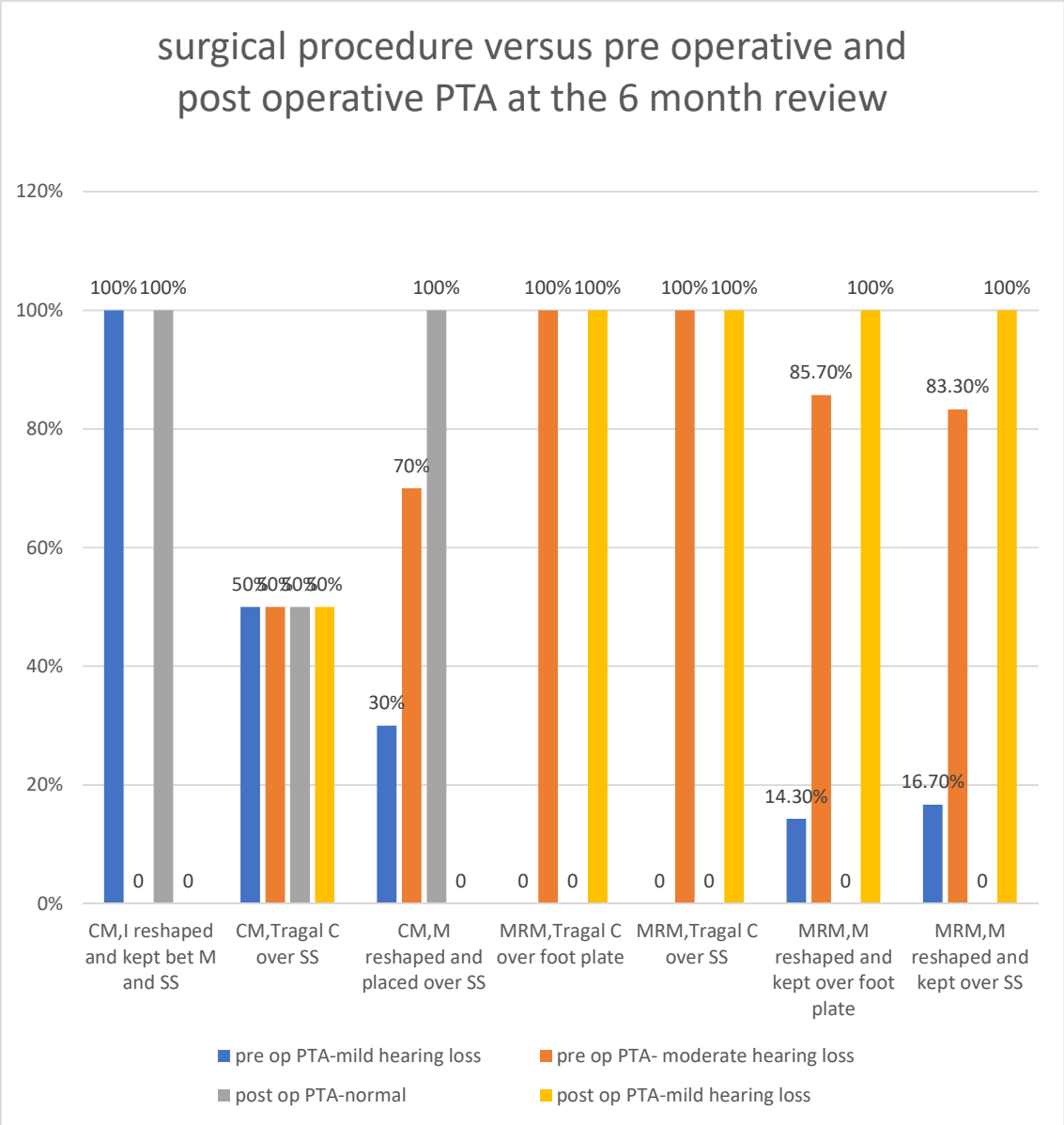


Inferential statistics using chi square test and fisher exact test Surgical procedure versus pre operative and post operative PTA at the 6 month review

Table 13. frequency distribution of surgical procedure versus pre operative and post operative PTA at the 6 month review

S.no	Surgical procedure	Pre operative PTA		Post operative PTA at 6 months		P value
		Mild Hearing loss	Moderate Hearing Loss	Normal hearing	Mild hearing loss	
1	CM,I reshaped and kept bet M and SS	7, 100%	0	7, 100%	0	0.0001
2.	CM,tragal C over SS	2, 50%	2, 50%	2, 50%	2, 50%	0.0001
3.	CM,M reshaped and placed over SS	3, 30%	7, 70%	10, 100%	0	0.0001
4.	MRM,tragal C over foot plate	0	8, 100%	0	8, 100%	0.0001
5.	MRM, tragal C over suprastructure	0	8, 100%	0	8, 100%	0.0001
6.	MRM,M reshaped and kept over foot plate	1, 14.3%	6, 85.7%	0	7, 100%	0.0001
7.	MRM,M reshaped and kept over suprastructure	1, 16.7%	5, 83.3%	0	6, 100%	0.0001

Chart 13. Frequency distribution of surgical procedure versus pre operative and post operative PTA at the 6 month review



DISCUSSION

- Among the study population, most common age group is between 16-24 years accounting to 54% of total cases.
- There is an almost equal distribution of cases among both male and female.
- Right COM is more common than left COM among the study population.
- Among the cases in our study squamosal type is more common than mucosal disease.
- In mucosal type of COM, the TM finding is of the following decreasing order central> subtotal> posterior quadrant> anterior quadrant perforation.
- In squamosal type of COM, most common TM finding is postero superior retraction pocket> attic perforation.
- More than 80% of cases had erosion of long process of incus and 30% of cases had erosion of stapes suprastructure in both squamosal and mucosal type of COM.
- About 60% of cases had intact malleus and found to be the most resistant among the ossicles for erosion in COM.
- According to Middle Ear Risk Index (MERI) in the study cases, 40% of cases presented with moderate disease with a score of 4-6, followed by mild disease (38%) and severe disease (22%).

- Various surgical procedures followed in the above study with post op PTA in 6^{th} month follow up shows 100% improvement in cortical mastoidectomy , incus reshaped and kept between malleus and stapes suprastructure, followed by cortical mastoidecomy with malleus reshaped and kept over stapes suprastructure.

CONCLUSION

Cartilage ossiculoplasty have an advantage of easy availability and carving compared to reshaping ossicles, minimise the recurrence of disease and provides acceptable hearing improvement. Autologous ossicles holds good result in ossiculoplasty which provides hearing improvement upto normal limits. Experience and patience of the surgeon is very important in ossiculoplasty for achieving excellent results.

ANNEXURE

BIBILIOGRAPHY

1. A study of use of autologous cartilage in ossicular reconstruction by Prakash Nagenahili Siddappa and colleagues. In this study 50 patients are included, tragal and conchal cartilage are used for ossicular reconstruction. Post-operative hearing improvement is seen in all patient with mean ABG closure of 7.4 dB, which is statistically significant.
2. A study conducted by Sougata Mahanty and colleagues in west Bengal entitle a comparative study of outcome of ossiculoplasty using cartilage, bone and different alloplasts in Chronic otitis media. Totally 50 cases were included in that 15 patients underwent cartilage ossiculoplasty, 19 patients with autologous incus, 16 patients with polyethylene PORP. Hearing improvement after 6 months of follow-up with <20 dB ABG in presence of stapes suprastructure was 60%, 73.68%, 56.25% respectively**.**
3. A study was conducted by Dr. Pratheesh entitled "ossicular erosion in CSOM, Reconstructive procedure and outcomes" In this study of 164 patients were included. Most common ossicle to erode in COM cases is long process of incus (24.4%). Malleus and stapes have a comparable result in case of erosion and they were found to be more resistant in erosion during the pathogenesis of csom. 114 cases - cortical

mastoidectomy (CM) with type 1 tympanoplasty, with hearing improvement of 11.30%

15 cases - CM with reshaped incus between malleus and stapes suprastructure done with hearing improvement of 9.70%

2 cases - CM, TYPE 3 Tympanoplasty, Conchal cartilage over Suprastructure done with hearing improvement of 5.15%

1 case -CM, Malleus reshaped between stapes suprastructure and neo-TM with hearing improvement of 18.35%

MERI score and OOPSI was used in this study. Results are showing that cases with high MERI Score and OOPSI have greater chances of ossicular erosion and thus requiring some form of ossiculoplasty as management

4. A study about ossiculoplasty was done by Austin-Kartush.

They compared improvement in hearing in patients for whom ossiculoplasty was done with another group for whom only myringoplasty was done. 181 patients were included in ossiculoplasty group and 204 patients in myringoplasty group. Their study decided a post op hearing of 10db as success. with such a criterion, success rate was 81% in cases with myringoplasty. But only 55% cases improved after ossiculoplasty. When they reduced the criteria from 10 dB to 20 dB as success, their results

improved. 97% was the success rate in group of myringoplasty. Group of ossiculoplasty showed a result of 85%. In group of ossiculoplasty, Austin classification was done. group A contains 60% cases. Group B with 23%. 8% each in group C and group D. 1% percent does not fall in this classification

Study about erosion of ossicles in COM cases was done in Himalayan Institute of Medical Sciences, Dehradun. They include a total of 150 patients in their study. Patients aged more than 16 who were prepared for mastoidectomy was included in this study. In their study, 64%cases were mucosal type where as 36% cases were squamous. 29.78 was the mean age of presentation in this study. 48% were male patients where as 52% were females. In 80.63 percent cases, malleus was found to be intact. On further classifying 97.78% cases of mucosal type of COM cases had intact malleus. whereas malleus was intact only in 55% cases of unsafe-COM. Malleus was completely intact in 10% cases. Head alone was eroded in 6.67% cases of squamous type of COM. Handle of malleus was eroded in 2.22% cases of mucosal type of COM where as in squamosal type of COM 26.67% cases had handle eroded.

Incus was eroded in 7.77% cases of mucosal type of COM. It was totally intact only in 15% cases of squamosal type of COM. In squamosal type, 40% cases had totally absent incus and 35% cases had erosion of

long process and lenticular process. Corresponding erosion in mucosal type was only 17.33% and 15.33% respectively.

Out of 150 patients, 118(78.67%) cases had intact stapes. 1.11% mucosal type of COM had eroded stapes where as 51.67% cases of COM squamous type had eroded stapes.

In his study, he included the status of malleo-incudal joint and incudo-stapedial joint. 26% cases had malleo-incudal joint discontinuation. It was more in squamosal type of COM. As far as incudo stapedial joint is evaluated, 38.67% cases had discontinuity, more common in squamosal type.

5. In another study about ossicular erosion , conducted by Mehrnoosh Mousaviagdas, He included166 cases for evaluation. In his study he concluded that 30.7% erosion of incus partially and 55.4% erosion of incus completely. He concluded that incus is the most common bone eroded in csom cases. In his study, the incidence of erosion of other ossicles were much lower compared to that of incus.
6. Austin DF. Ossicular reconstruction. Otolaryngol Clin North Am 1972;5:145–60. Kartush JM . Ossicular chain reconstruction. Capitulum to malleus.
7. Otolaryngol Clin North Am 1994;27:689–7 Kos MI, Castrillon R, Montandon P, Guyot JP. Anatomic functional longterm results of canal

wall-down mastoidectomy.

8. Ann Otol Rhinol Laryngol. 2004;113(11):872-876. Ajalloueyan M. Experience with surgical management of cholesteatoma.
9. Arch Otolaryngol Head Neck Surg. 2006;132(9):931-9 Zenner HP, Stegmaier A, Lehner R, Baumann I, Zimmermann R,Open Tubingentitanium prostheses for ossiculoplasty: a prospective clinical trial.
10. Aristides Sismanis, MD. Tympanoplasty. In: Glasscock- Shambaugh SURGERY of the EAR. Ed; Micheal E Glasscock III, MD, Aina Julianna Gulya, MD.5th Ed; Elsevier publishers.2007, pg:463-485.
11. J Laryngol Otol. 2002;116(2):97-102. Goldenberg RA, Emmet JR. Current use of implants in middle ear surgery.
12. Otol Neurotol. 2001;22(2):145-152. Chang CC, Chen MK. Canal-wall-down tympanoplasty with mastoidectomy for advanced cholestatoma.
13. J Otolaryngol. 2000;29(5):270- 273 Karmarkar S, Bhatia S, Saleh E, et al. Cholesteatoma surgery: the individualized technique.
14. Ann Otol Rhinol Laryngol. 1995;104(8):591- 595. Rizer, FM. Overlay versus underlay tympanoplasty.
15. Acta Otolaryngol 1963; Suppl 188:82-91 Shea CM. Tympanoplasty: The undersurface graft technique-transcanal approach.
16. Scott Brown 4th edition-descriptive and applied anatomy of ear ,John Ballantyne.

17. Mahadevaiah text book of otorhinolaryngology Saunders; 2001:106-112 Sheehy JL, Anderson RG. Myringoplasty: a review of 472 cases.
18. Ann Otol Rhinol Laryngol 1980;89:331-4 Sheehy JL, Glasscock ME. Tympanic membrane grafting with temporalis fascia.
19. Arch Otolaryngol 1967;6:391 Sheehy JL. Tympanoplasty: The outer surface grafting technique. In: Brackman DE, Shelton C, Arriaga MA, eds. Otologic Surgery 2nd ed. Philadelphia, Pa: W.B. Saunders; 2001:96-103 Smyth GDL.
20. Scott Brown 8th edition, chronic otitis media chapter 83, George Browning, Justin Weir, Gerard Kelly and Lain R.C. Swan.
21. J Laryngol Otol. 1992;106:591- 596. Tos M and Lau T. Stability of Tympanoplasty in Children. Otolaryngol Clinics N Am1989;22(1):15-28.Vrabec JT, Steirman K, Grady JJ. Hydroxyapetite prosthesis extrusion.
22. Otology and Neurotology 2002;23(5):653-6 Vrabec JT, Deskin RW, Grady JJ. Meta-analysis of pediatric tympanoplasty.

Arch Otolaryngol 1999;125(5):530-534 Wullstein H. Theory and practice of tympanoplasty.

CASE SHEET PROFORMA

NAME :

AGE/SEX :

IP.NO :

OCCUPATION :

ADDRESS :

DOA :

COMPLAINTS:-

- Ear discharge
- Hard of hearing
- Ear blocking sensation
- Ear ache, tinnitus, giddiness
- Associated nasal discharge/nasal obstruction / throat pain
- Fever / headache/ vomiting
- Any other symptoms

PAST HISTORY:

- Previous H/O ear discharge/ any ENT surgeries

- Any co-morbidities

PERSONAL HISTORY: socio-economic status

GENERAL EXAMINATION:

VITALS:

SYSTEMIC EXAMINATION:

ENT EXAMINATION:

EXAMINATION OF EAR:

	RIGHT	**LEFT**
Preauricular region	-	
Pinna	-	
Post auricular region	-	
External auditory canal	-	
Tympanic membrane	- site and size of perforation	
Mastoid region	-	
Facial nerve	-	

AUDIOLOGICAL TEST (tuning fork test): using 512Hz

Rinne's test, Weber's test, Absolute Bone Conduction test

VESTIBULAR FUNCTION TEST:

EXAMINATION OF NOSE AND PNS:

EXAMINATION OF THROAT:

INVESTIGATIONS:

- All basic investigation for surgery
- Diagnostic nasal endoscopy
- Examination under microscopy
- Pure tone audiogram
- HRCT Temporal bone
- Assessment of Eustachian tube function
- Aural swab for C/S

DIAGNOSIS:

PROCEDURE DONE:

OPERATIVE NOTES:

POST OPERATIVE COURSE: post operative follow-up and post-op PTA analysis, at 3rd and 6th month

PARTICIPANT'S CONSENT FORM

Participant's namel:

Address:

Title of the study: "**OSSICULAR PATHOLOGY IN CHRONIC SUPPURATIVE OTITIS MEDIA AND COMPARISON BETWEEN RECONSTRUCTION WITH RESHAPED OSSICLES AND CARTILAGE"**

The details of the study have been provided to me in writing and explained to me in my own language. I confirm that I have understood the above study and had the opportunity to ask questions. I understand that my participation in the study is voluntary and that I am free to withdraw at any time, without giving any reason, without the medical care that will normally be provided by the hospital being affected. I agree not to restrict the use of any data or results that arise from this study provided such a use is only for scientific purpose(s). I have been given an information sheet giving details of the study. I fully consent to participate in the above study.

(I also consent / do not consent to use my stored biological samples for future scientific purposes) – if applicable

Signature of the participant: _____ Date: _____

Signature of the witness: _____ Date: _____

Signature of the investigator: _____Date: _____

MASTER CHART

S.NO	NAME	AGE	SEX	IP. NO	SIDE	Rt Ear	Lt Ear	Ear Of Surgery	Malleus	Incus	Stapes	MERI	Preop Rt Ear PTA	Preop Lt Ear PTA	Surgical Process	TM finding on 3rd month review	TM finding on 6th month review	Rt Ear PTA 3rd month	Lt Ear PTA 3rd month	Rt Ear PTA 6th month	Lt Ear PTA 6th month
1	RAGAVI	18	F	55441	R	PSR	INTACT	R	Handle erode	Long process eroded	intact	6	50	18	MRM, conchal c over suprastructure	INTACT	INTACT	36	17	34	17
2	VASANTHA JAYA	30	F	57345	R	ST	INTACT	R	Intact	Long process eroded	Intact	2	47	22	CM,M reshaped and placed over SS	INTACT	INTACT	25	22	22	21
3	ATSAYA	18	F	66091	B/L	PSR	posterior	R	Intact	Long process eroded	Suprastructure eroded	4	40	36	MRM,M reshaped and kept over footplate	INTACT	INTACT	34	36	32	36
4	JOTHI	17	F	69314	R	Attic P	INTACT	R	Head eroded	Completely eroded	Intact	6	40	16	MRM,M reshaped and kept over suprastructure	INTACT	INTACT	35	17	33	16
5	LINCY	28	F	70546	L	INTACT	ST	L	Intact	Long process eroded	Intact	4	16	39	CM,M reshaped and placed over SS	INTACT	REINFECTION	17	26	17	21
6	RAJKUMAR	20	M	72144	R	PSR	INTACT	R	Handle erode	Long process eroded	Suprastructure eroded	7	45	13	MRM, conchal c over footplate	INTACT	INTACT	38	14	34	14
7	SANJAY	17	M	75617	R	PSR	INTACT	R	Intact	Long process eroded	Suprastructure eroded	4	43	17	MRM,M reshaped and kept over footplate	INTACT	INTACT	37	17	32	16
8	LAKSHMI	42	F	76999	L	INTACT	AURAL P	L	Handle erode	Long process eroded	Suprastructure eroded	8	17	54	MRM, conchal c over footplate	INTACT	INTACT	17	37	17	34
9	MARIYAMMAL	24	F	483	R	PSR	INTACT	R	Intact	Completely eroded	intact	4	43	18	MRM,M reshaped and kept over suprastructure	INTACT	INTACT	38	18	33	18
10	JAYALAKSHMI	35	F	8491	B/L	ST	ST	L	Intact	Long process eroded	Intact	2	30	42	CM,M reshaped and placed over SS	INTACT	INTACT	30	27	30	25
11	TAMIL PANI	25	F	10143	L	INTACT	PSR	L	Intact	Long process eroded	intact	4	16	45	MRM, conchal c over suprastructure	INTACT	INTACT	16	37	17	33
12	UMARANI	45	F	11721	R	ATTic P	INTACT	R	head eroded	Long process eroded	Suprastructure eroded	7	42	19	MRM, conchal c over footplate	INTACT	INTACT	34	17	31	17
13	MAHENDRA MANI	55	F	68292	R	Attic P	INTACT	R	head eroded	Completely eroded	Suprastructure eroded	8	52	16	MRM,M reshaped and kept over footplate	GRANULATION	INTACT	38	16	37	16
14	TAMILSELVI	39	F	69790	B/L	posterior	anterior	L	Intact	Long process eroded	Intact	3	23	43	CM,Conchal c over SS	INTACT	INTACT	23	30	23	28
15	JANANI	17	F	73846	R	PSR	INTACT	R	Intact	Long process eroded	Suprastructure eroded	4	49	16	MRM,M reshaped and kept over footplate	INTACT	INTACT	39	17	34	17
16	JEEVANRAJ	21	M	5831	B/L	PSR	posterior	R	Head and handl	Completely eroded	intact	6	45	37	MRM, conchal c over suprastructure	INTACT	INTACT	39	36	34	36

17	THARIKA	16	F	5824	B/L	CP	CP	R	Intact	Long process eroded	Intact	1	51	36	CM,M reshaped and placed over SS	INTACT	INTACT	30	35	25	36
18	NISHANTHI	23	F	10057	R	PSR	INTACT	R	Intact	Long process eroded	Intact	5	55	18	MRM,M reshaped and kept over suprastructure	INTACT	INTACT	38	17	33	17
19	DHIVYA	22	F	11296	L	INTACT	CP	L	Intact	Long process eroded	Intact	1	25	49	CM,M reshaped and placed over SS	INTACT	INTACT	26	24	28	23
20	MANIMEGALAI	40	F	20920	B/L	PSR	posterior	R	Intact	Long process eroded	Intact	4	44	37	MRM, conchal c over suprastructure	INTACT	INTACT	38	38	34	37
21	RUKMANI	39	F	21492	R	CP	INTACT	R	Intact	Long process eroded	Intact	1	42	19	CM,Conchal c over SS	INTACT	INTACT	28	18	26	19
22	RENUGA	33	F	22292	L	INTACT	anterior	L	Intact	Long process eroded	Intact	1	20	47	CM,M reshaped and placed over SS	INTACT	INTACT	19	22	18	20
23	PAIROSE	43	F	24304	R	ST	INTACT	R	Intact	Long process eroded	Intact	3	37	15	CM,M reshaped and placed over SS	INTACT	INTACT	23	15	21	16
24	JAYAMALINI	20	F	52263	R	Attic P	INTACT	R	head eroded	Completely eroded	Intact	6	52	18	MRM,M reshaped and kept over suprastructure	CP	CP	39	18	35	20
25	KEERTHANA	27	F	77799	R	PSR	INTACT	R	Handle erode	Long process eroded	Suprastructure eroded	7	49	16	MRM, conchal c over footplate	INTACT	INTACT	38	16	32	17
26	SYAMALADEVI	30	F	78533	R	CP	INTACT	R	Intact	Long process eroded	Intact	3	36	16	CM, I reshaped and kept bet M and SS	INTACT	INTACT	25	16	22	16
27	SASIKALA	27	F	79698	L	INTACT	CP	L	Intact	Long process eroded	Intact	2	15	35	CM,Conchal c over SS	INTACT	INTACT	17	29	16	27
28	TAMILSELVAM	57	M	58692	R	PSR	INTACT	R	Intact	Long process eroded	Suprastructure eroded	4	47	17	MRM,M reshaped and kept over footplate	INTACT	INTACT	36	16	34	16
29	BALAJI	22	M	61049	R	anterior	INTACT	R	Intact	Long process eroded	Intact	1	37	18	CM,M reshaped and placed over SS	INTACT	INTACT	25	18	21	17
30	BHARATH	18	M	68708	L	INTACT	posterior	L	Intact	Long process eroded	Intact	1	16	34	CM, I reshaped and kept bet M and SS	INTACT	INTACT	18	26	18	24
31	ROBINHOOD	21	M	77743	L	INTACT	CP	L	Intact	Long process eroded	Intact	3	21	35	CM, I reshaped and kept bet M and SS	INTACT	INTACT	20	28	20	26
32	NEELAKANDAN	31	M	82366	L	INTACT	posterior	L	Intact	Long process eroded	Intact	3	15	38	CM, I reshaped and kept bet M and SS	INTACT	INTACT	18	20	18	18
33	KAPILDEV	26	M	10754	R	CP	INTACT	R	Intact	Long process eroded	Intact	6	46	17	CM,M reshaped and placed over SS	INTACT	INTACT	27	18	26	17

34	UDHAYAKUMAR	23	M	11030	R	CP	INTACT	R	Intact	Long process eroded	Intact	1	36	14	CM, I reshaped and kept bet M and SS	INTACT	INTACT	25	16	23	14
35	AZHAGESAN	38	M	13486	R	PSR	INTACT	R	Head and handl	Completely eroded	Suprastructure eroded	7	43	18	MRM, conchal c over footplate	INTACT	INTACT	36	18	32	16
36	MUTHAMILSELVA	18	M	16649	L	INTACT	PSR	L	Intact	Long process eroded	intact	4	16	43	MRM, conchal c over suprastructure	INTACT	INTACT	17	35	18	34
37	SIVARAJ	17	M	17329	R	Attic P	INTACT	R	head eroded	Completely eroded	Intact	6	46	19	MRM,M reshaped and kept over suprastructure	INTACT	INTACT	38	19	36	17
38	ANBARASAN	24	M	58163	R	Attic P	INTACT	R	head eroded	Long process eroded	Suprastructure eroded	7	44	16	MRM, conchal c over footplate	INTACT	INTACT	36	16	32	16
39	BALAMURUGAN	20	M	76749	R	PSR	INTACT	R	Intact	Long process eroded	Suprastructure eroded	4	46	16	MRM,M reshaped and kept over footplate	INTACT	INTACT	37	16	35	17
40	HARIHARAN	19	M	80900	B/L	PSR	posterior	R	Head and handl	Completely eroded	intact	6	48	40	MRM, conchal c over suprastructure	INTACT	INTACT	39	40	36	39
41	KANNAN	52	M	85180	R	ST	INTACT	R	Intact	Long process eroded	Intact	2	37	18	CM,Conchal c over SS	INTACT	INTACT	31	17	25	18
42	ELANGO	42	M	86547	B/L	ST	ST	R	Intact	Long process eroded	Intact	3	39	38	CM, I reshaped and kept bet M and SS	INTACT	INTACT	22	15	19	15
43	VETRIVEERAN	58	M	65947	R	PSR	INTACT	R	Handle erode	Long process eroded	Suprastructure eroded	7	50	18	MRM, conchal c over footplate	INTACT	INTACT	40	19	34	18
44	RAJAPRABHU	34	M	68525	B/L	PSR	posterior	R	Intact	Long process eroded	Intact	4	46	36	MRM, conchal c over suprastructure	INTACT	INTACT	38	34	36	37
45	RAJKUMAR	21	M	68554	R	Attic P	INTACT	R	Head eroded	Completely eroded	Intact	6	44	16	MRM,M reshaped and kept over suprastructure	INTACT	INTACT	36	18	33	16
46	SAKTHIVEL	35	M	73691	R	PSR	INTACT	R	Handle erode	Long process eroded	Suprastructure eroded	7	45	13	MRM, conchal c over footplate	CP	CP	38	18	36	16
47	VENKATESH	24	M	10305	L	INTACT	anterior	L	Intact	Long process eroded	Intact	3	16	43	CM,M reshaped and placed over SS	INTACT	INTACT	18	28	17	25
48	GOPALAKRISHNAN	21	M	13855	R	PSR	INTACT	R	Handle erode	Long process eroded	Suprastructure eroded	7	52	17	MRM,M reshaped and kept over footplate	INTACT	INTACT	37	18	35	17
49	ARIYAN	16	M	23336	R	posterior	INTACT	R	Intact	Long process eroded	Intact	1	32	17	CM, I reshaped and kept bet M and SS	INTACT	INTACT	24	16	22	16
50	GOWTHAM	17	M	60104	L	INTACT	AURAL P	L	Handle erode	Long process eroded	intact	7	17	54	MRM, conchal c over suprastructure	INTACT	INTACT	18	39	18	37

ABBREVATIONS USED

L	Left
R	Right
B/L	Bilateral
CP	Small all quadrant central perforation
ST	Subtotal perforation
Attic P	Attic perforation
Tragal C	Tragal cartilage
PSR	PosteroSuperior Retraction pocket
CM	Cortical Mastoidectomy
MRM	Modified Radical Mastoidectomy
SS	Suprastructure of Stapes
TM	Tympanic membrane
Tym	Tympanoplasty