

AIMS AND OBJECTIVES

To study

- ❖ The structural anatomy of the mesotympanum , retrotympanum including the ponticulus , subiculum , sinus tympani and epitympanic ventilatory pathways,
- ❖ The status of the epitympanic diaphragm including the type of tensor tympani fold , patency of anterior and posterior isthmi, using angled endoscope in permanent perforation syndrome during type 1 tympanoplasty.

INTRODUCTION

- Myringoplasty or type 1 tympanoplasty is one of the most common otologic surgical procedures done.
- A case of chronic suppurative otitis media-permanent perforation syndrome (inactive mucosal disease - >6 months) wherein a simple closure of the tympanic membrane perforation done does produce hearing improvement but tympanoplasty has to be done taking into consideration the various functional aspects of the middle ear cleft .

This includes

- Status of the epitympanum-including the epitympanic diaphragm, tympanic isthmi, and the various mucosal folds contributing to the middle ear ventilation pathways which gives the benefits of the functional endoscopic ear surgery.
- Apart from eustachian tube dysfunction, the major cause of middle ear disease is the dysventilation of the middle ear cleft that occurs due to mucosal fold adhesions , tympanic isthmi blockage .
- The epitympanic diaphragm partitions the middle ear cleft into the anteroinferior compartment under the diaphragm which includes the protympanum, mesotympanum and hypotympanum. The part above the diaphragm is the posterosuperior compartment

containing epitympanum,retrotympanum,aditus ad antrum,antrum and mastoid gas cell system.

- In permanent perforation syndrome, even with patent eustachian tube, there could be isthmi blockage , negative pressure in mastoid gas system .
- Ventilation patency along with a proper myringoplasty will help in reducing the recurrence of tympanic membrane retractions, hearing deficits and reperforations.

MIDDLE EAR MUCOSAL FOLDS ANATOMY AND EMBRYOLOGY

Middle ear compartments

The middle ear cavity is conceptually divided into five compartments namely

- Protympanum
- Mesotympanum
- Retrotympanum
- Epitympanum
- Hypotympanum

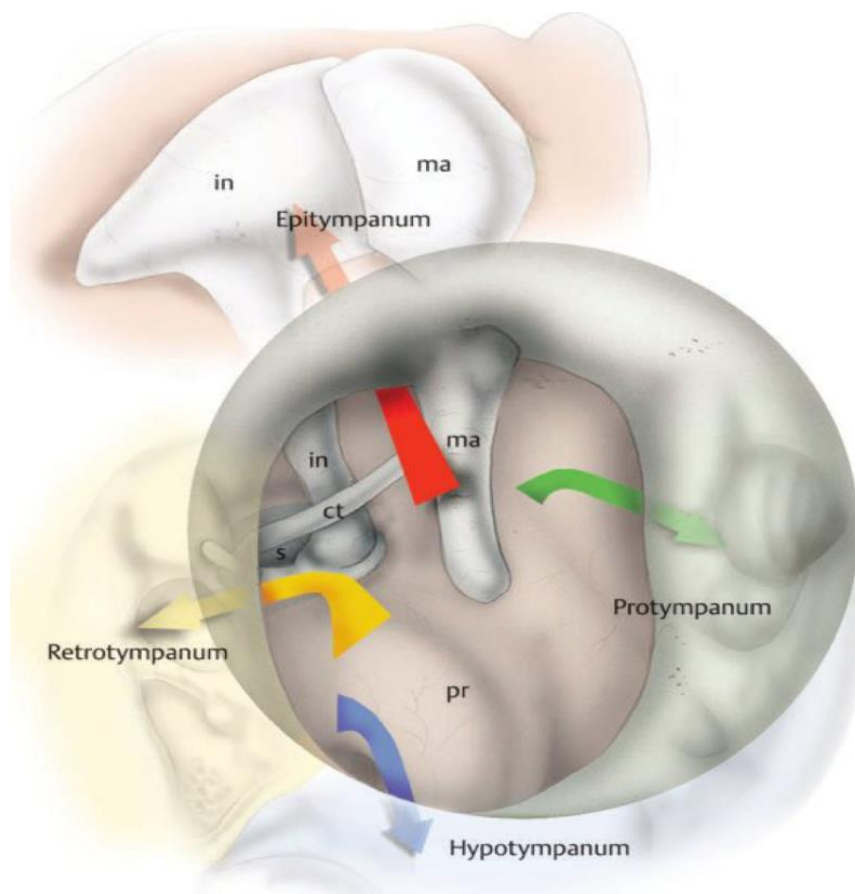


Fig-1: Compartments of Middle Ear

Middle Ear Mucosal Folds Development:

- Between the 3rd and 7th months, gelatinous tissue in the middle ear is gradually absorbed.
- Also the middle ear anatomy is formed by the growth of endothelium- lined fluid pouches developing from the orifice of the eustachian tube, extending towards the middle ear cleft .
- Between the mucosal layers of the folds there are remnants of the primitive mesoderm such as the blood vessels nourishing the “viscera” of the middle ear .
- Four main sacs are formed namely,
 - 1) Saccus anticus
 - 2) Saccus medius
 - 3) Saccus superior
 - 4) Saccus posticus

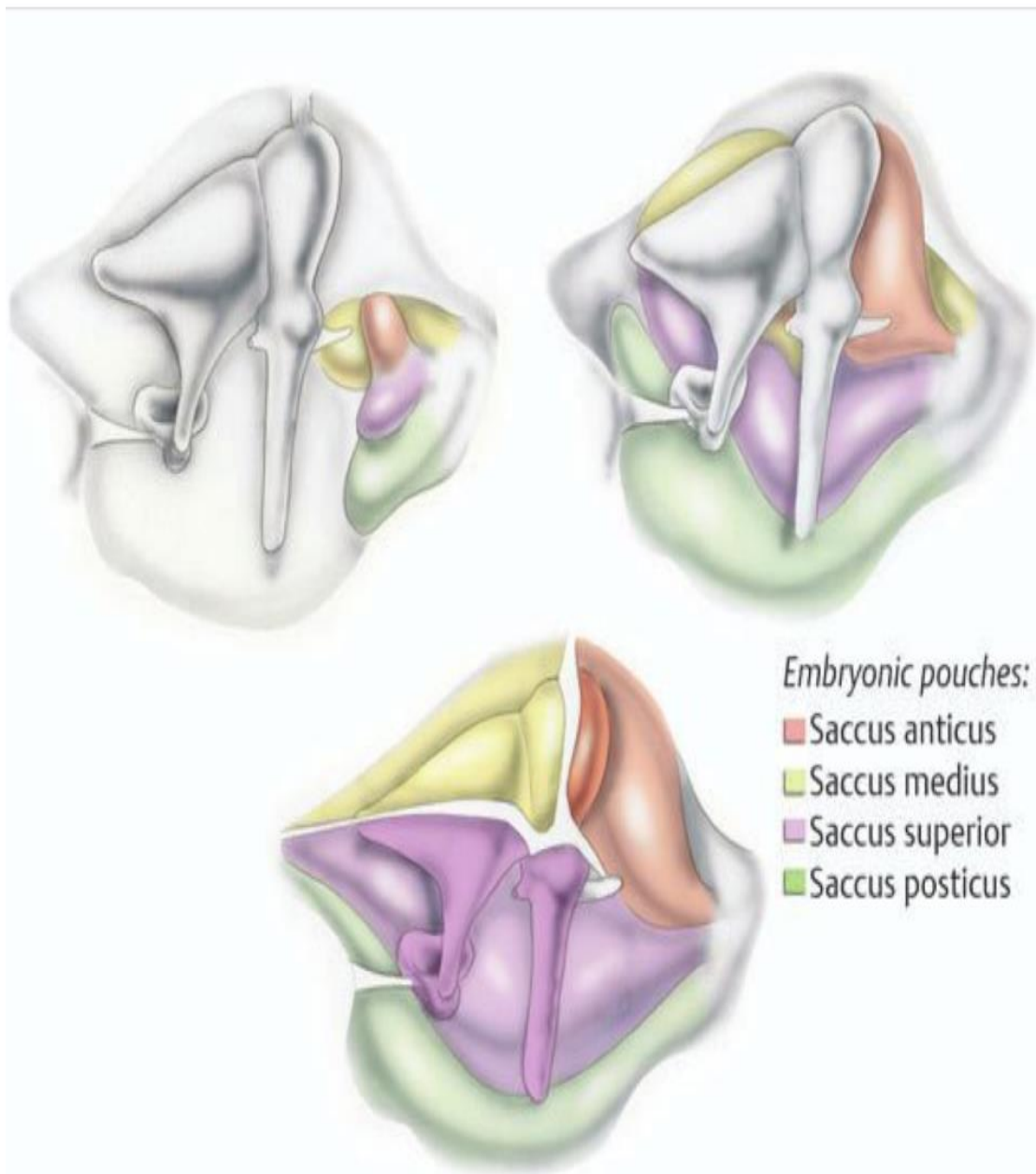


Fig-2: Embryonic Pouches of Middle Ear

Saccus Anticus:

- Saccus anticus: The smallest of the sacci.
- It extends from anterior to posterior in a cranial direction and lies anteriorly to the tensor tympani tendon.
- It forms the anterior pouch of von Tröltsch.
- It also forms the inferior aspect of the tensor fold by contacting the developing saccus medius.
- The relationships between saccus anticus and saccus medius hence influence the inclination of the tensor tympani fold and the volumes of the anterior epitympanic space and supratubal recess .

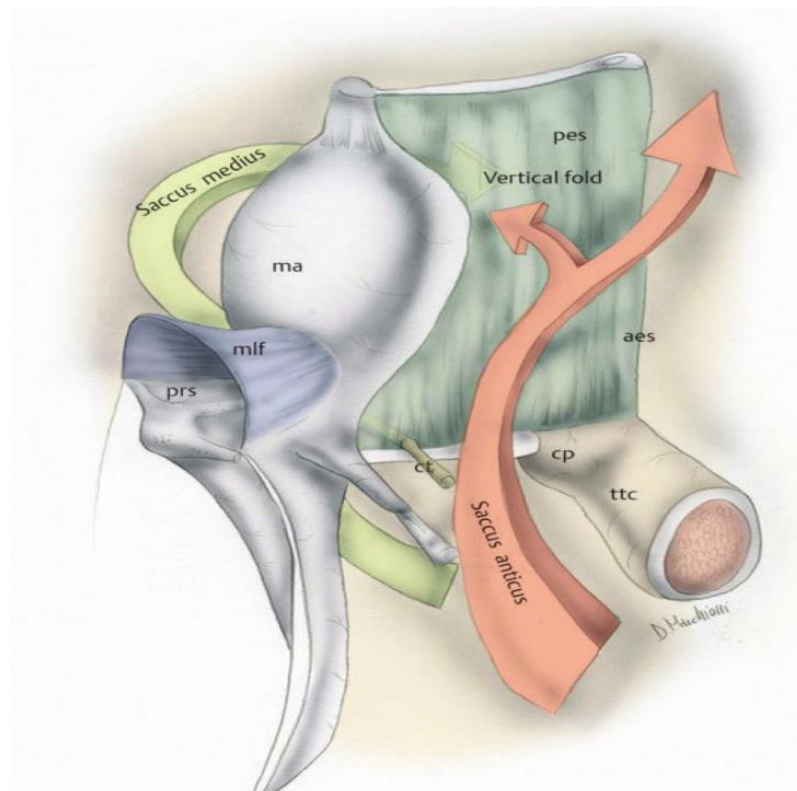


Fig-3: Saccus Anticus Development

- If the saccus anticus extends more cranially it may form the larger part of the anterior epitympanic space thus contacting the saccus medius in a more posterior position leading to the formation of a vertical fold lying in a coronal plane between anterior and posterior epitympanic spaces.

Saccus Medius:

- Saccus medius: The saccus medius forms the attic.
- It extends upward towards the isthmus and usually breaks into three sacci.
- The anterior saccus tends to form the anterior compartment of the attic, and the superior aspect of the tensor tympani fold when it contacts the saccus anticus.
- The medial saccus extends posteriorly, forming the posterior attic, medial and lateral; passing above the body of the incus and the head of the malleus and merging with the saccus superior it forms the superior aspect of the incudomalleolar lateral fold and the malleolar lateral fold.
- The saccus posterior extends posteriorly, forming the mesotympanic spaces lying medial to the ossicles, heading towards the antrum, and eventually pneumatizing the portion of mastoid cells derived from the pars petrosa of the temporal bone.

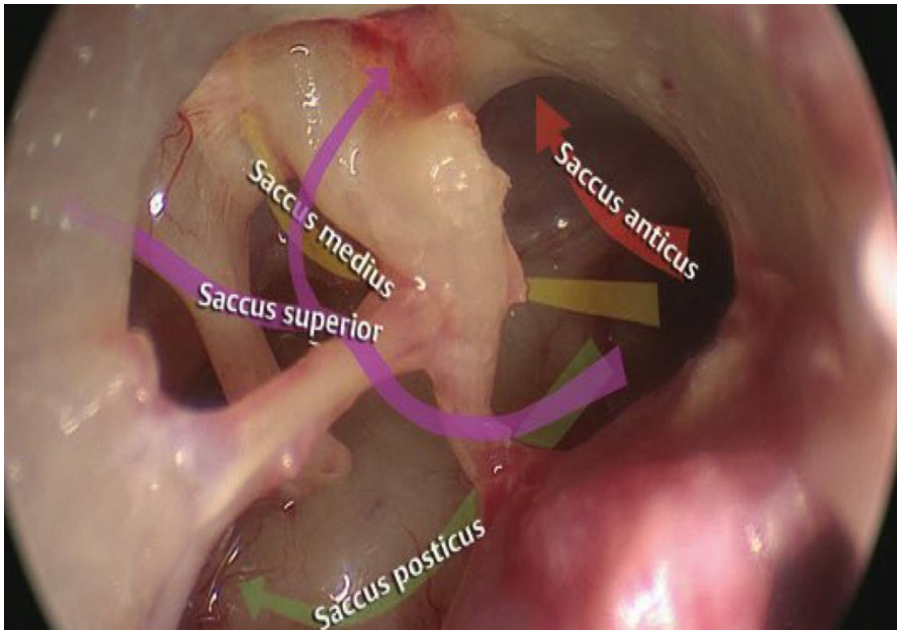


Fig-4: All Sacci Development

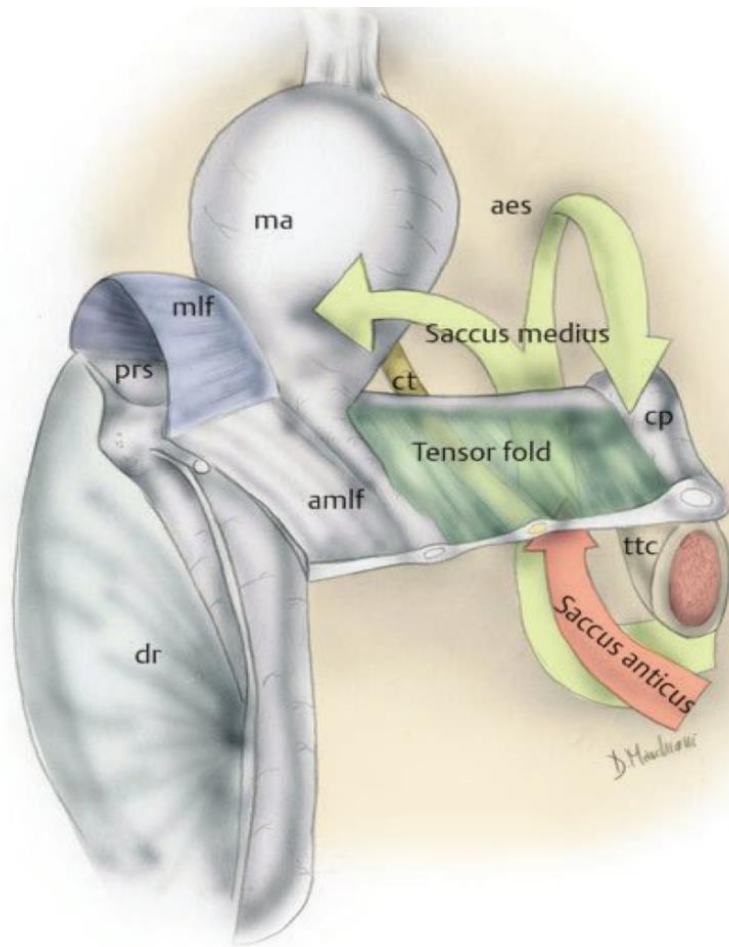


Fig-5: Saccus Medius Development

Saccus Superior:

- Saccus superior: The saccus superior initially extends posteriorly and laterally, passing through the handle of the malleus, which lies laterally to it, and the long process of the incus, lying medially.
- Then it turns cranially, forming the posterior pouch of von Tröltsch and then the Prussak space.
- Merging superiorly with the saccus medius, it forms the inferior aspect of the lateral malleolar fold and the lateral incudomalleolar fold .
- It extends further posteriorly, passing over the pyramidal eminence forming part of the antrum, with the saccus medius, and eventually pneumatizes the portion of mastoid cells derived from the pars squamosa of the temporal bone.
- Persistence and further development of the fold between the saccus medius and saccus superior in the antrum results in a bony partition called the Koerner's septum.

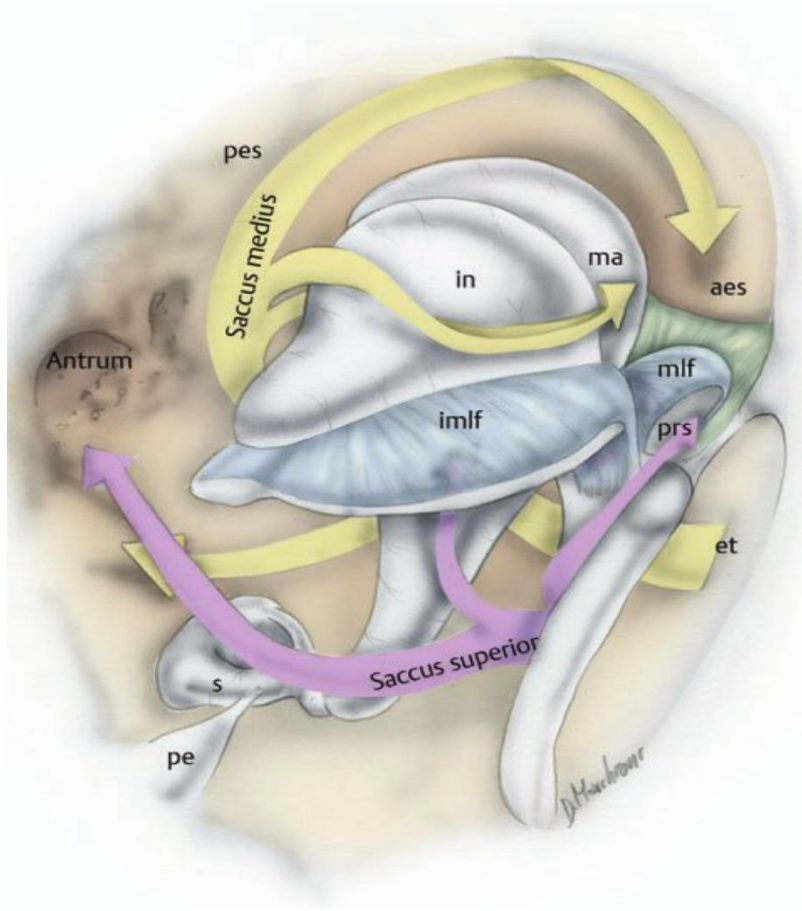
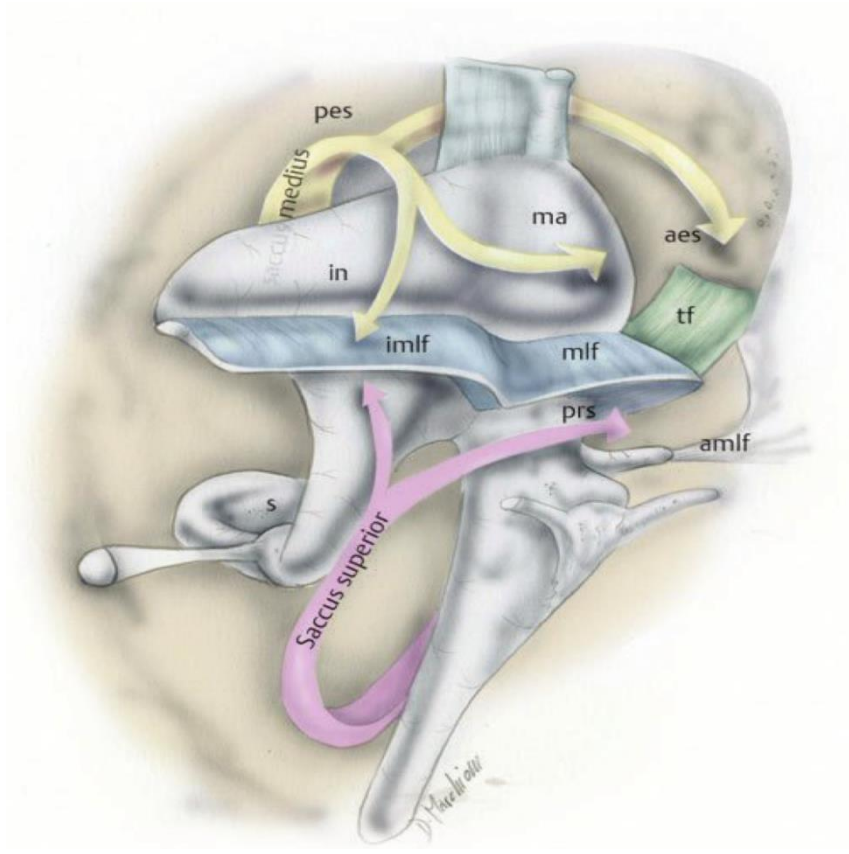


Fig-6: Saccus Superior Development

Saccus posticus:

- Saccus posticus: The saccus posticus extends inferiorly to the middle ear, forming the hypotympanum, subtympanic sinus, round window niche, sinus tympani, posterior tympanic sinus, and the larger portion of the oval window niche.

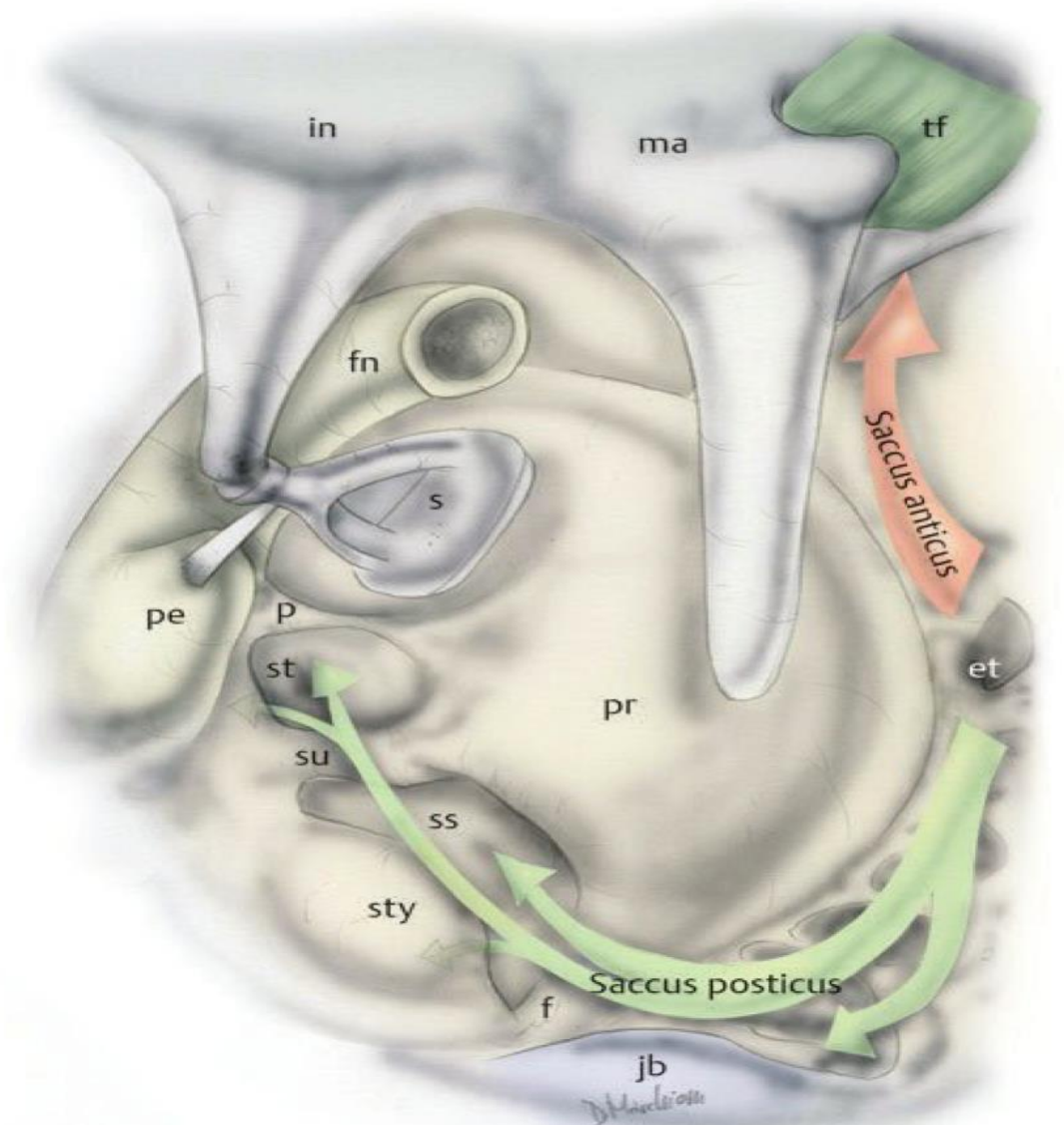


Fig-7: Saccus Posticus Development

Below picture shows the origin of various middle ear pouches, recesses and other structures.

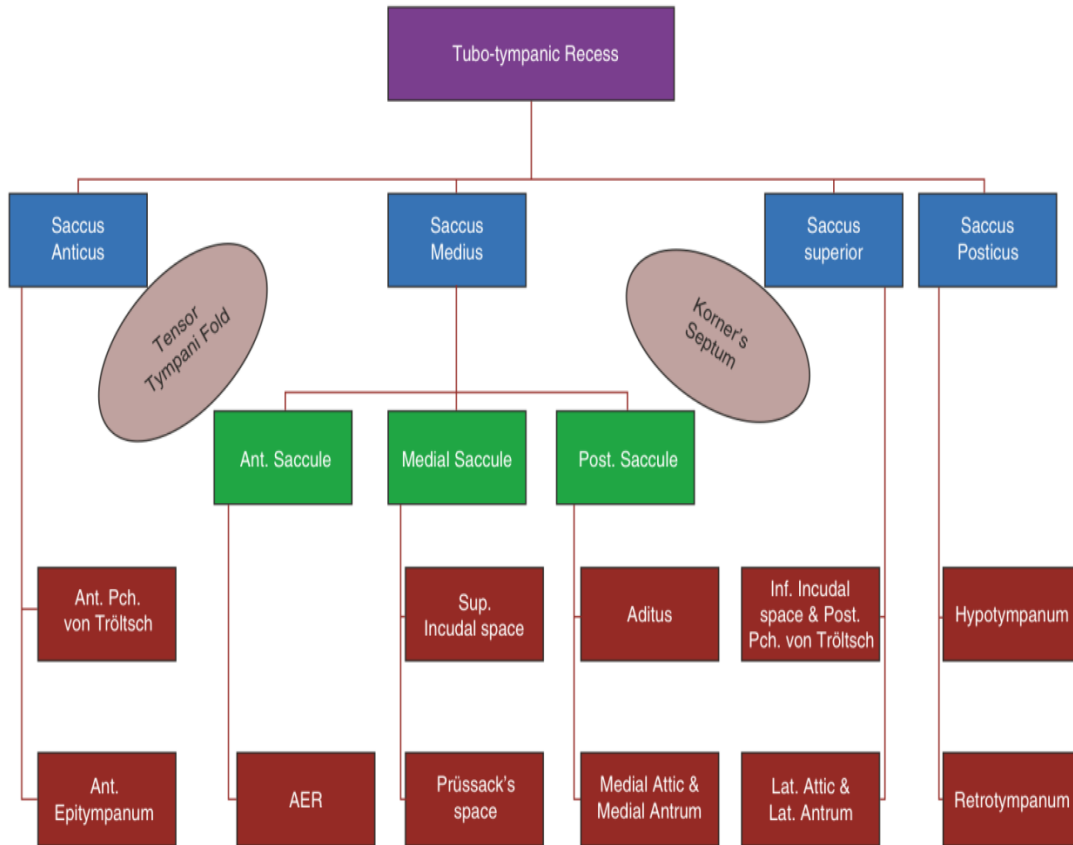


Fig-8: Middle Ear Development

Mucosal folds:

- Middle ear mucosal folds get attached from the walls of the middle ear to its contents thus carrying ligaments and blood vessels to the ossicles.
- There are two types of mucosal folds:
 - 1) Composite folds
 - 2) Duplicate folds

Composite fold:

- A combination of a ligament and lining mucosa, with a varying amount of mucosal extension over the ligaments and ending with free edges. They form when expanding air sacs meet the preexisting ligament, covering it with mucosal membrane.
- Composite folds include anterior and lateral malleal ligament fold, posterior incudal fold.

Duplicate fold:

- Arise from the fusion of two expanding air sacs in the absence of any interposing structure. Their position varies because the extent of the expansion of each air sac varies in each individual.
- This includes tensor tympani fold and lateral incudomalleal fold.

- The below picture shows the various folds in the middle ear .

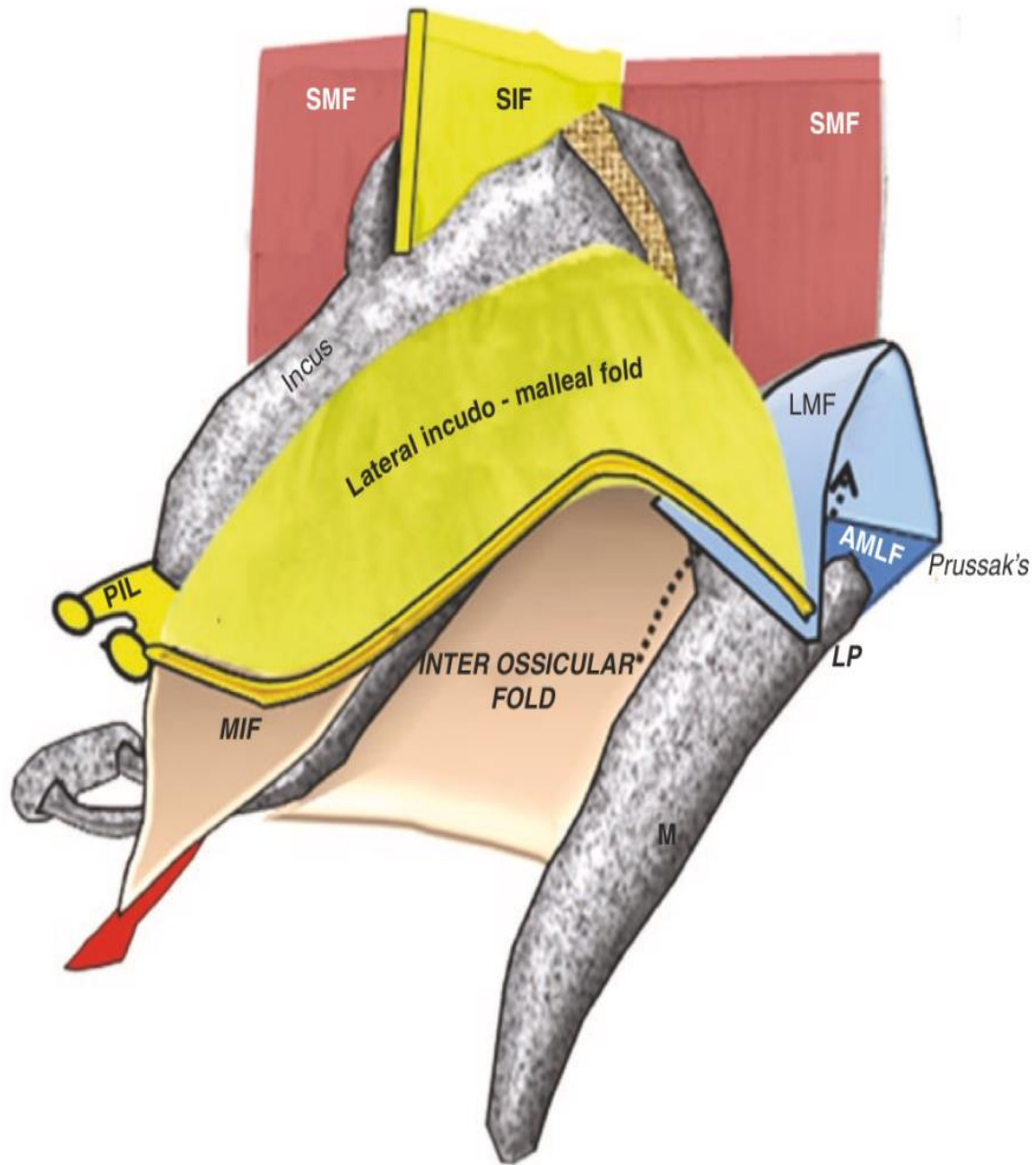


Fig-9: Folds of Middle Ear

Epitympanic diaphragm:

- Chatellier and Lemoine in 1946 formulated the concept of epitympanic diaphragm.
- Epitympanic Diaphragm The epitympanic diaphragm consists of **three malleal ligamental folds** (anterior, lateral, and posterior),
 - The posterior incudal ligamental fold, and **two membranous folds**
 - The tensor fold
 - The lateral incudomalleal fold ,together with the malleus and incus .
- Palva and colleagues described the anatomy of the epitympanic diaphragm when studying ventilation pathways of the epitympanum(1).
- They observed that the aeration from the eustachian tube leads directly to the mesotympanic and hypotympanic spaces, whereas the epitympanum is separated from the direct air pathway and is only aerated through the tympanic isthmi.
- The 0° and 45° endoscopes allow visualisation of the space between the incudostapedial joint and cochleariform process with the tensor tympani tendon (Proctor's anterior isthmus).

- The 45°endoscope allows magnification of the space between the pyramidal process and the short process of the incus (Proctor's posterior isthmus).

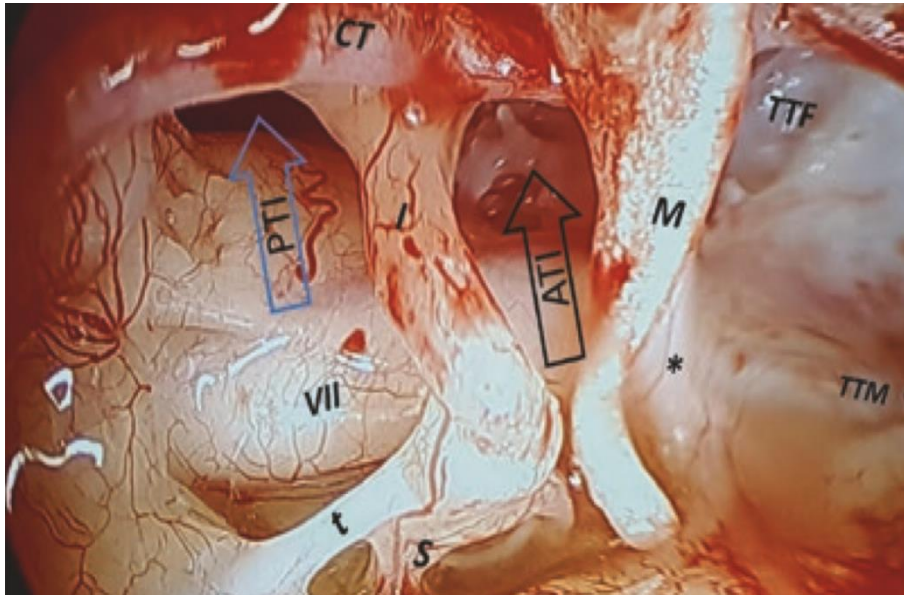


Fig-10: Endoscopic picture of Anterior & posterior isthmus

- The mesotympanic region ventilates the inferior lateral attic. In a more cranial position lies the superior lateral attic whose inferior limit is represented by the incudomalleolar fold.
- This anatomical area together with the medial attic is the superior attic or upper unit.
- The superior attic is in communication with the mesotympanum through the tympanic isthmus and posteriorly opens to the aditus ad antrum.

- The lower unit is a reduced compartment represented by the Prussak space.
- It is separated anatomically and physiologically from the upper unit by its vault, which is represented by the lateral malleal ligament fold.
- This inferior epitympanic portion is ventilated in most cases from the posterior pocket through the mesotympanum.
- The tensor tympani fold has a strategic position in the epitympanic diaphragm preventing communication between the supratubal recess, the region belonging to the protympanum, and the overlying anterior epitympanum.
- Below picture shows the epitympanic diaphragm, various folds and ligaments forming it. Also shows the anterior and posterior tympanic isthmi.

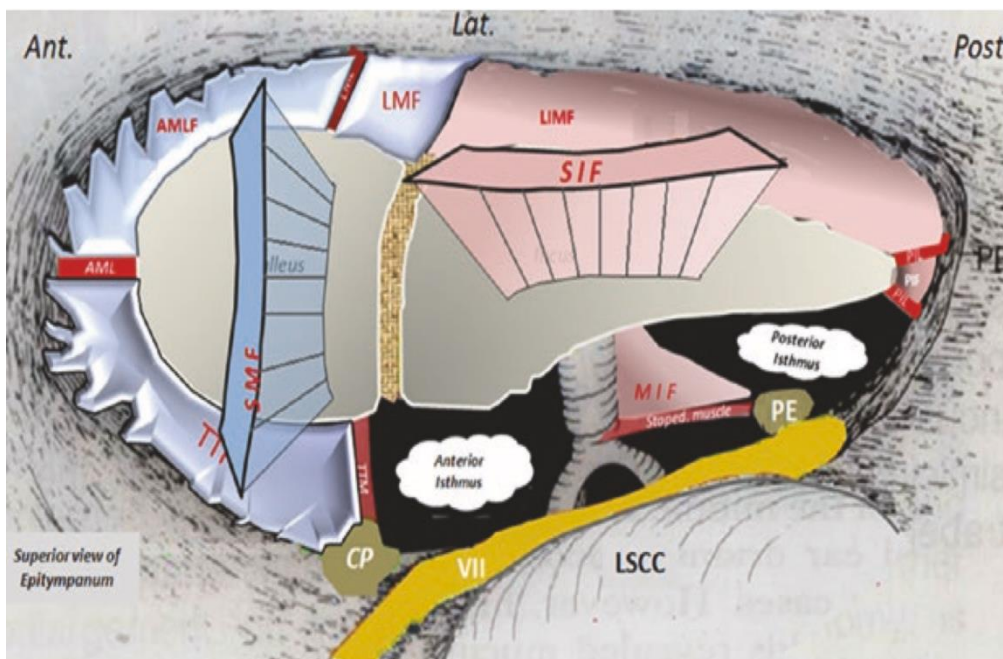


Fig-11: Epitympanic diaphragm

Tympanic isthmi

The tympanic isthmus is divided into two portions by the medial incudal fold.

Anterior isthmus

- The anterior isthmus if patent is present between tensor tympani tendon anteriorly and stapes posteroinferiorly.
- It measures between 1 and 3 mm.

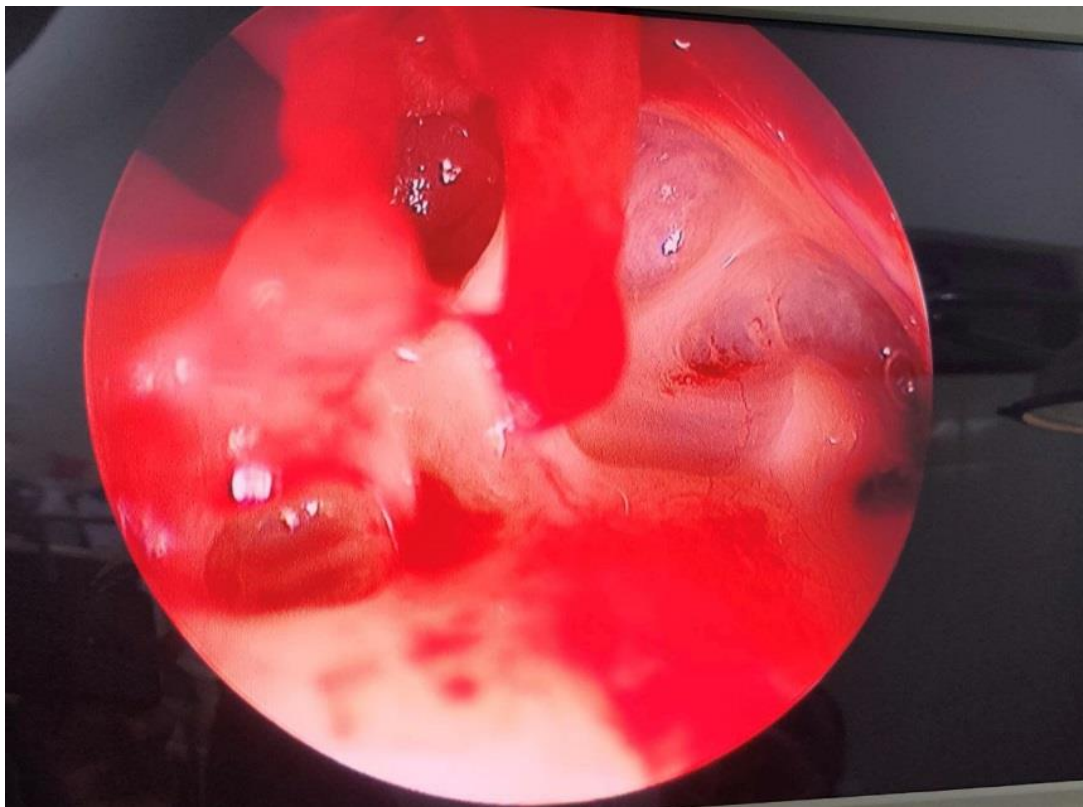


Fig-12: Endoscopic picture of patent anterior isthmus

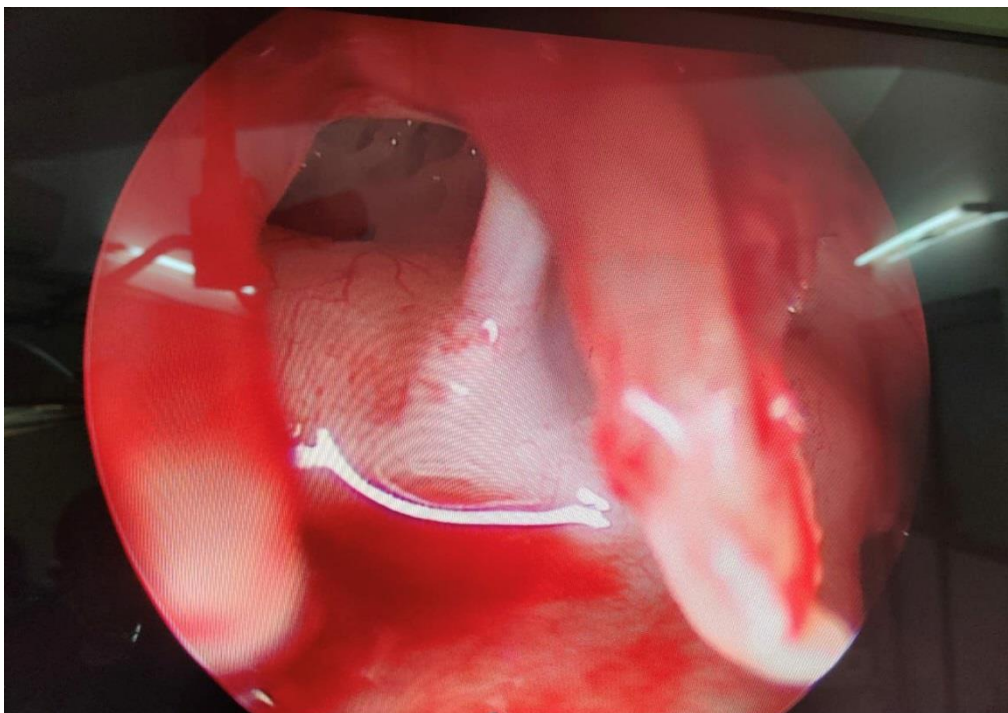
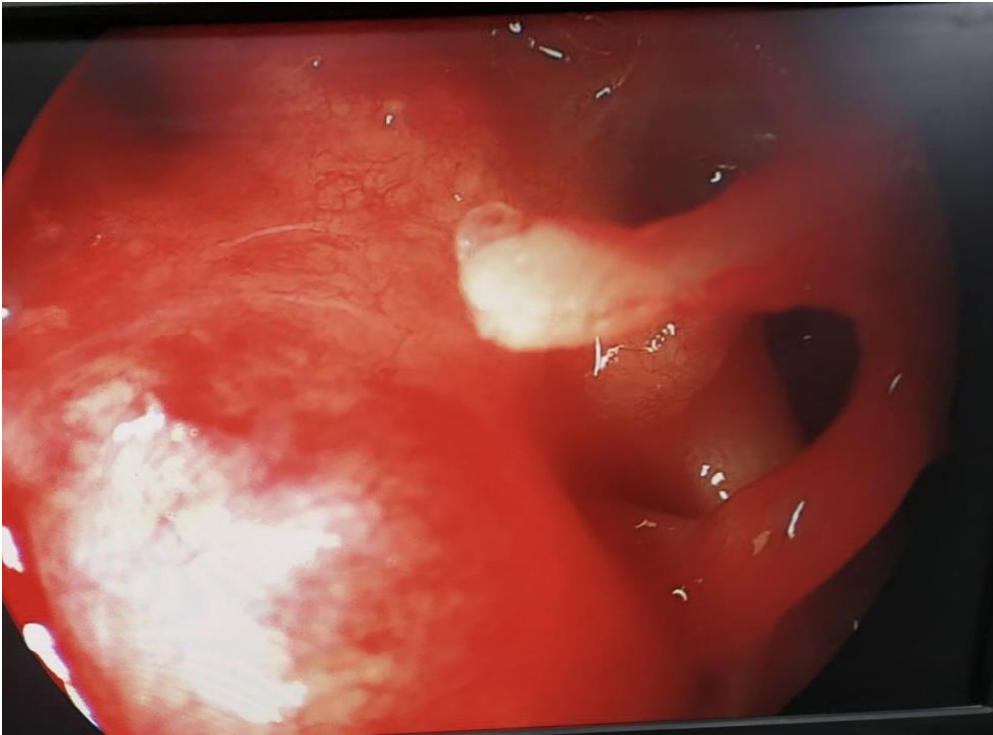


Fig-12: Endoscopic picture of patent anterior isthmus

Posterior isthmus :

- The posterior isthmus lies between the short process of incus and stapedial muscle.

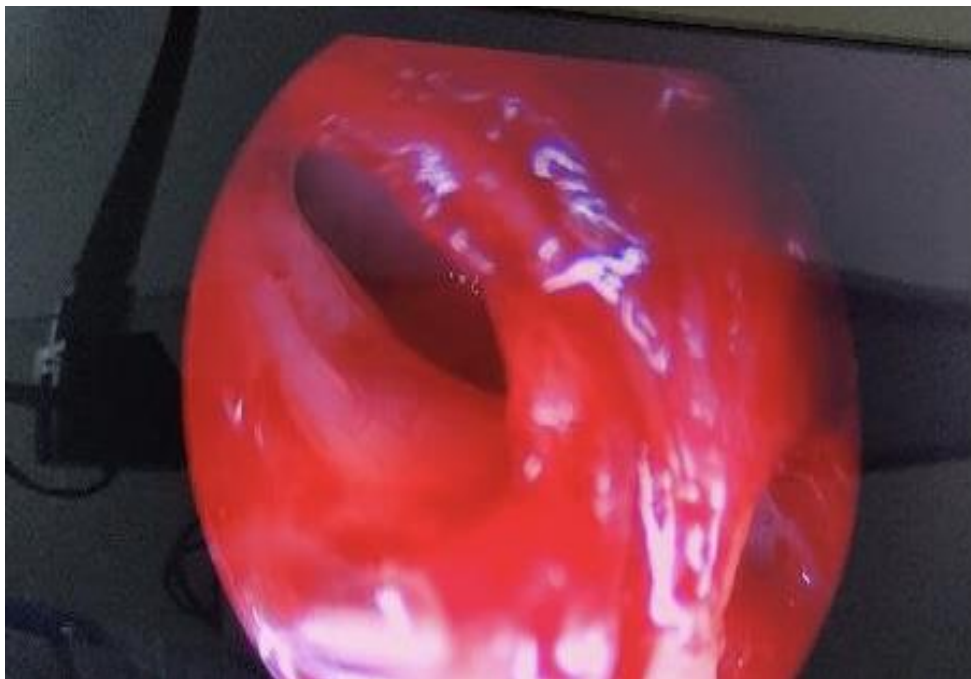
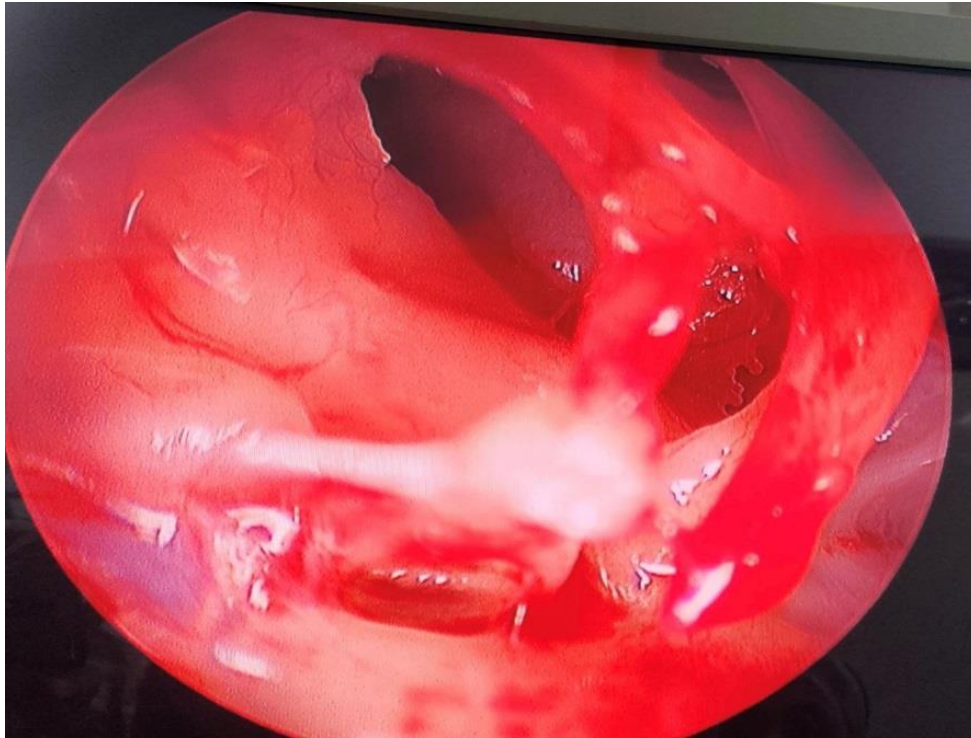


Fig-13: Endoscopic picture of patent posterior isthmus

Tensor tympani fold :

- The tensor fold has a variable anatomy. In most patients it shows a superior concavity, extending laterally from the canal of the tensor tympani muscle to the lateral aspect of the protympanum, posteriorly attaching to the cochleariform process and to the tensor tympani tendon, and extends anteriorly to the root of the zygomatic bone, forming the epitympanic floor.
- When it inserts on the transverse crest its direction is almost vertical and when it inserts on the tubaric tegmen its direction is horizontal.
- Usually it has a curvature of 45° and its most frequent point of insertion is at the central portion of the anterior supratubal epitympanic tegmen.
- The peripheral portion of the tensor tympani fold presents a thicker component, and the central portion is usually more thinner and transparent and can easily be cut.
- Depending on its angle, the underlying supratubal recess is wider or smaller.

Complete tensor tympani fold:

- When the tensor tympani fold is complete, the only ventilation pathway to the anterior epitympanum is through the isthmi.

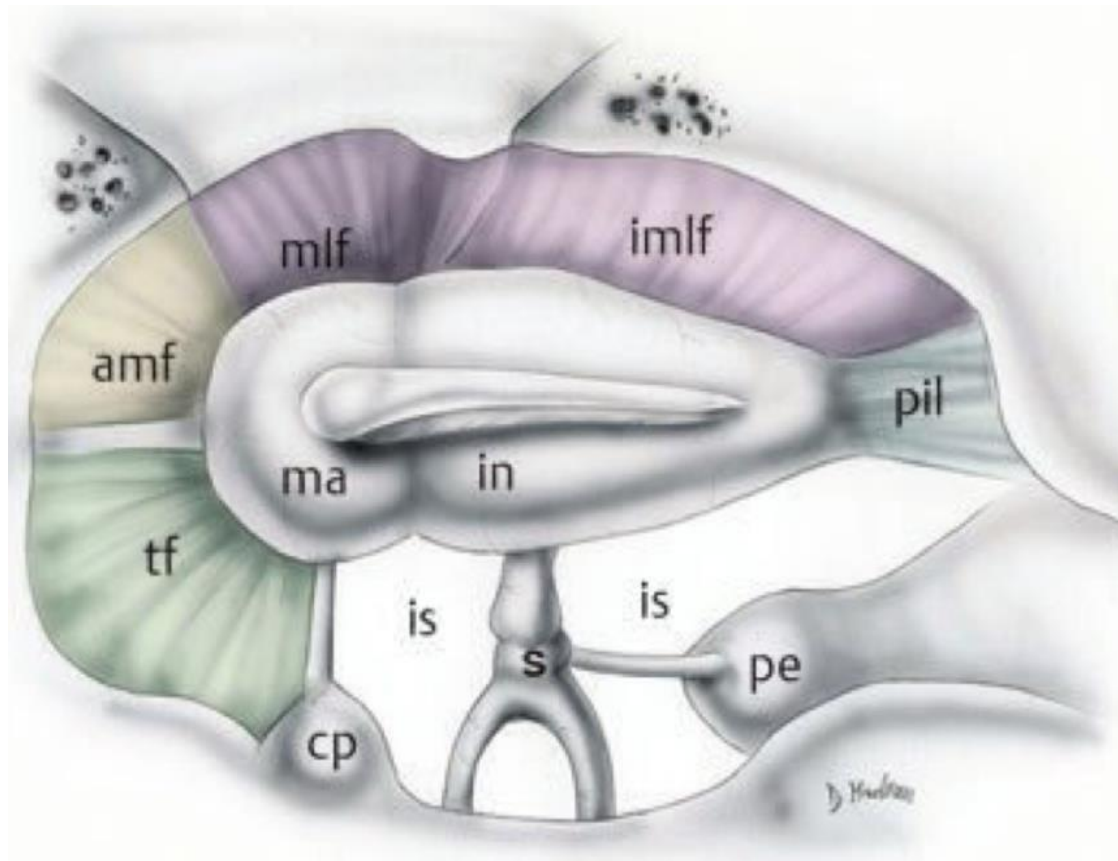


Fig-14: Complete tensor tympani fold

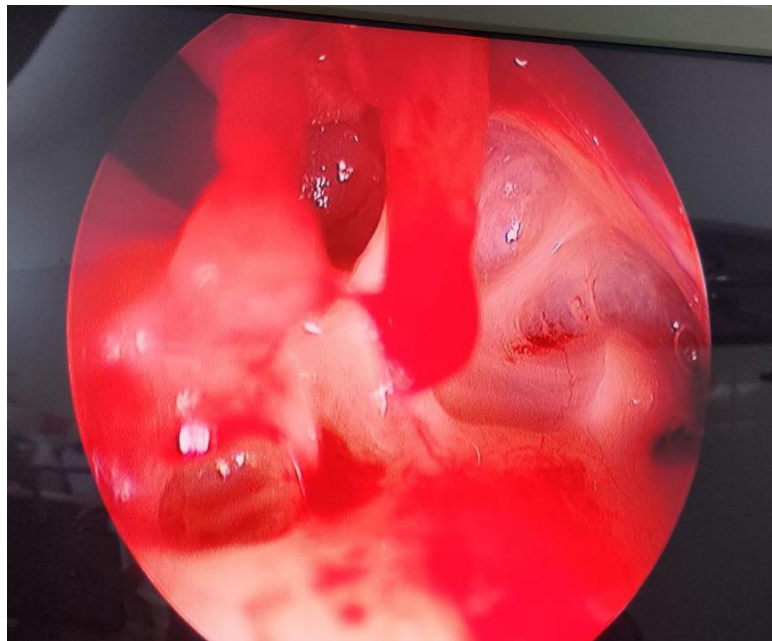
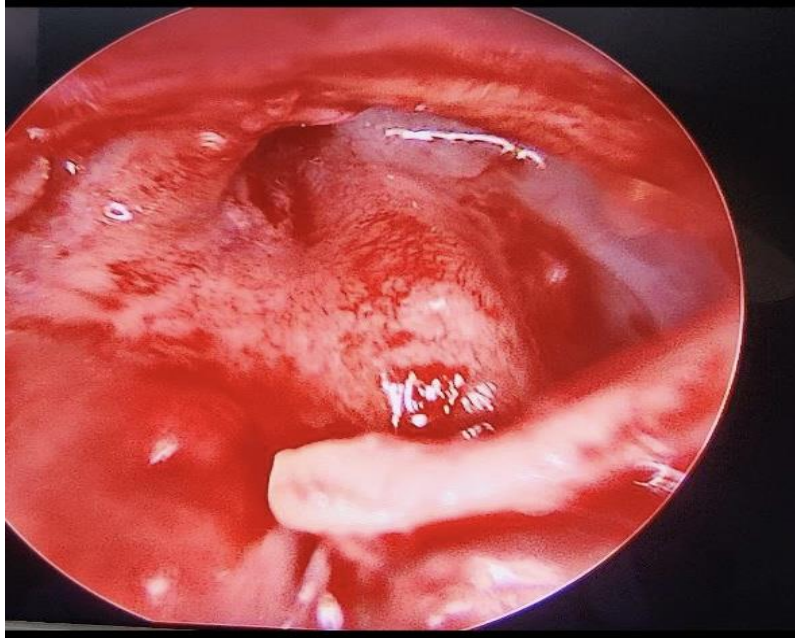


Fig-14: Endoscopic picture of Complete tensor tympani fold

When tensor tympani fold is complete, it appears as a mucosal fold extending from above the supratubal recess till the tensor tympani tendon separating the anterior epitympanum completely from the protympanum.

Incomplete tensor tympani fold:

- Palva and colleagues stated that only 25% of patients had incomplete tensor tympani fold(2).
- This permits a direct communication between the eustachian tube, supratubal recess and the anterior epitympanic recess.
- When tensor tympani fold is incomplete and visualised endoscopically it arises above the supratubal recess but fails to extend till the tensor tympani tendon. In this case anterior epitympanum can be seen through the incomplete tensor tympani fold.

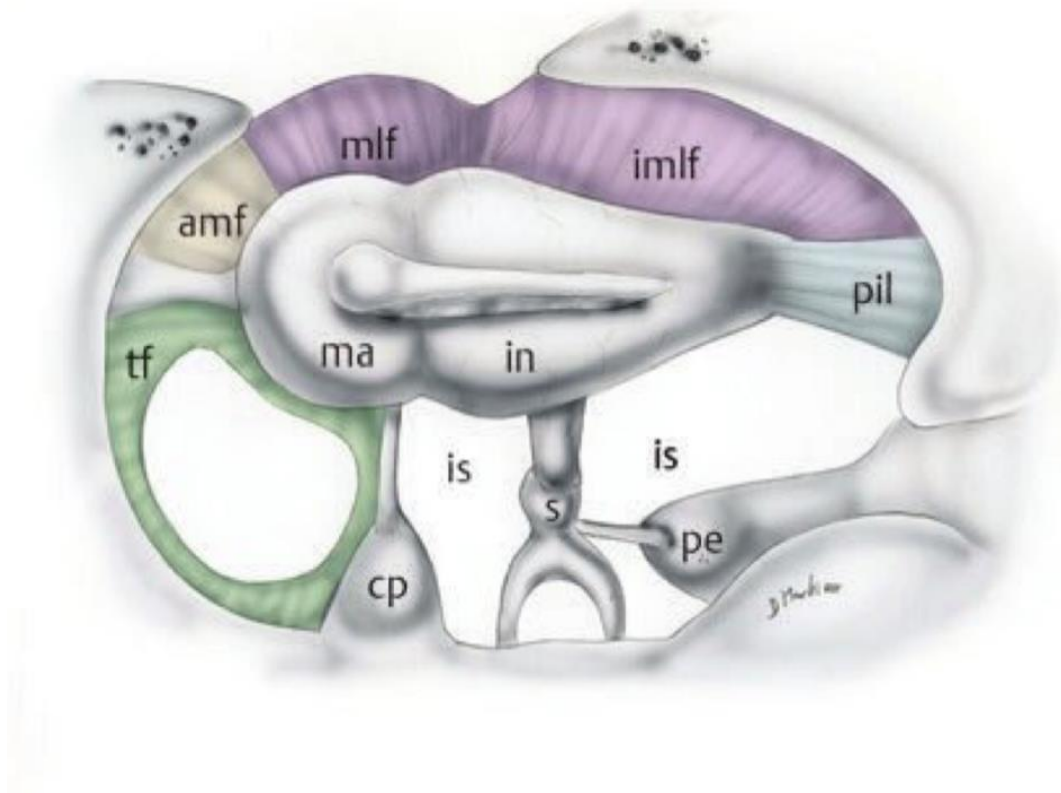


Fig-15: Incomplete tensor tympani fold

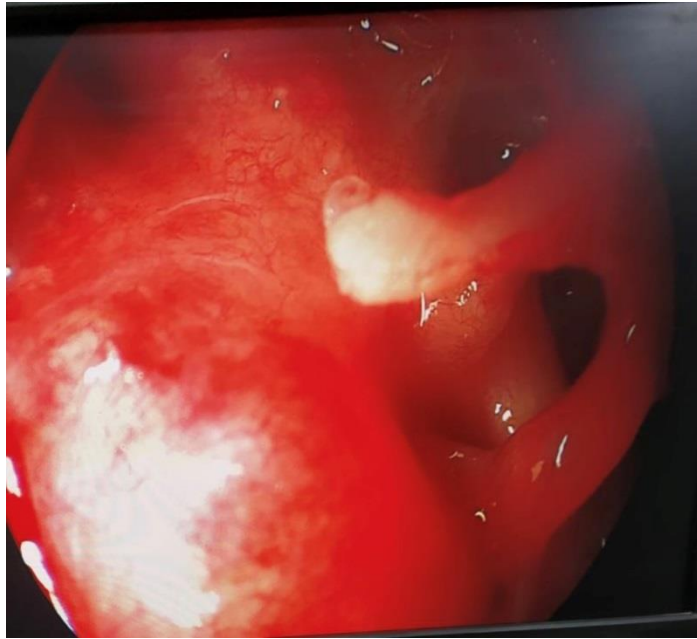
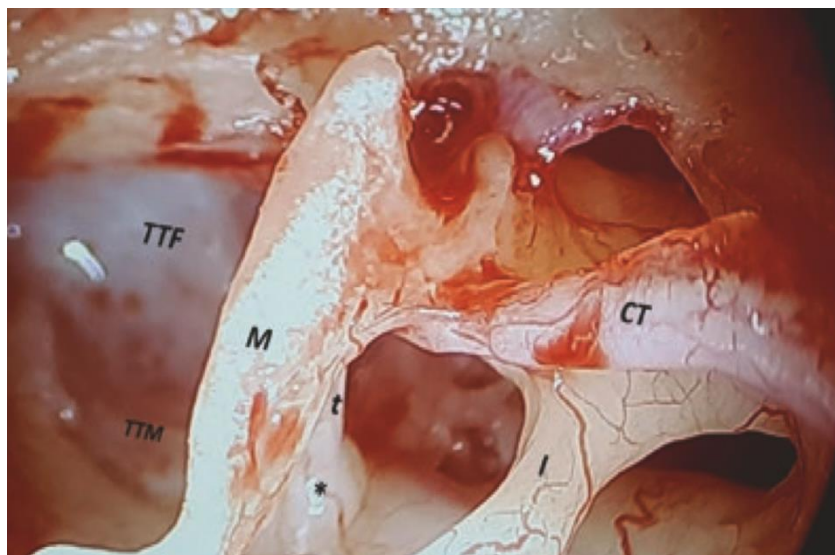


Fig-16: Endoscopic picture of incomplete tensor tympani fold

- Because of its anatomical characteristics, the tensor tympani fold region is extremely important in middle ear physiology, leading to a clear separation between anterior epitympanum and protympanum in terms of ventilation.



- Above picture shows the tensor tympani fold and the middle ear ossicles visualised using angled endoscope.

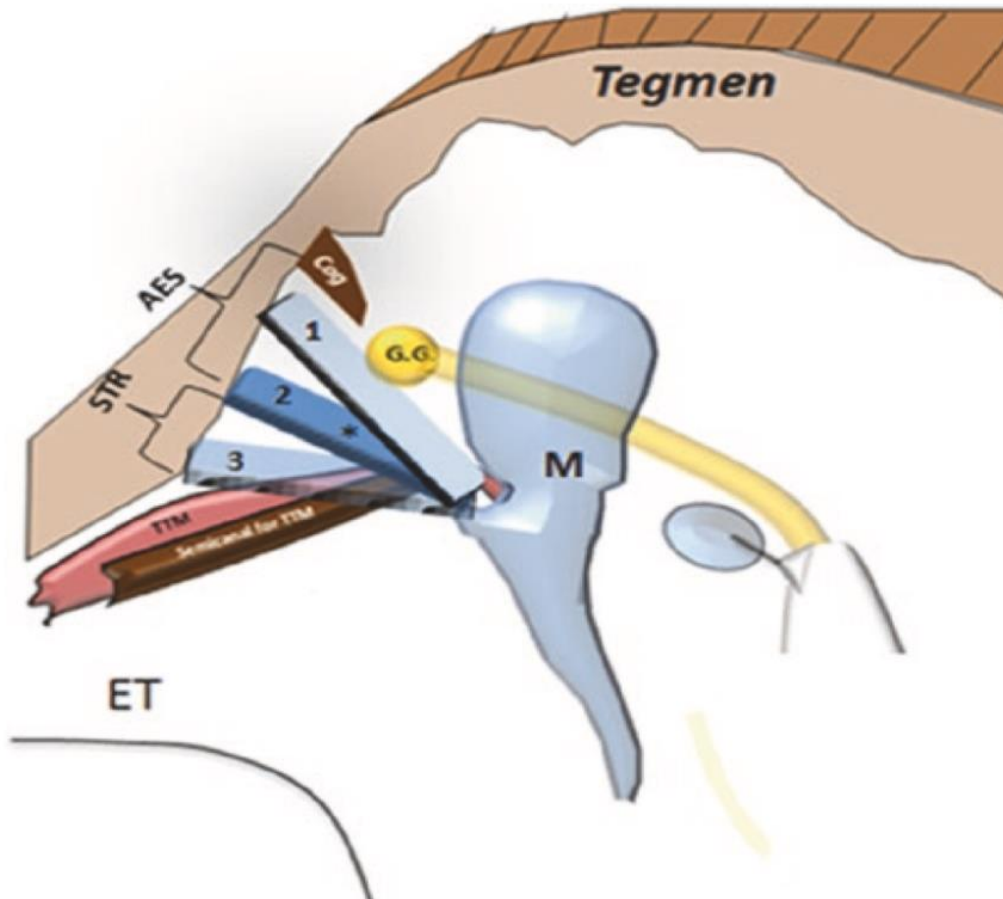


Fig-17: Tensor tympani fold types

- Above image shows the variable anterior attachments of the tensor tympani fold, 1-high attachment 2- intermediate attachment 3- low attachment.

Retrotyimpanum

The retro tympanum consists of superior and inferior compartments. It contains important sinuses namely the facial recess , posterior tympanic sinus , sinus tympani and lateral tympanic sinus. Various bony ridges and structures such as the ponticulus , subiculum , pyramidal eminence are a part of retrotyimpanum.

The below figure shows the various retro tympanic structures.

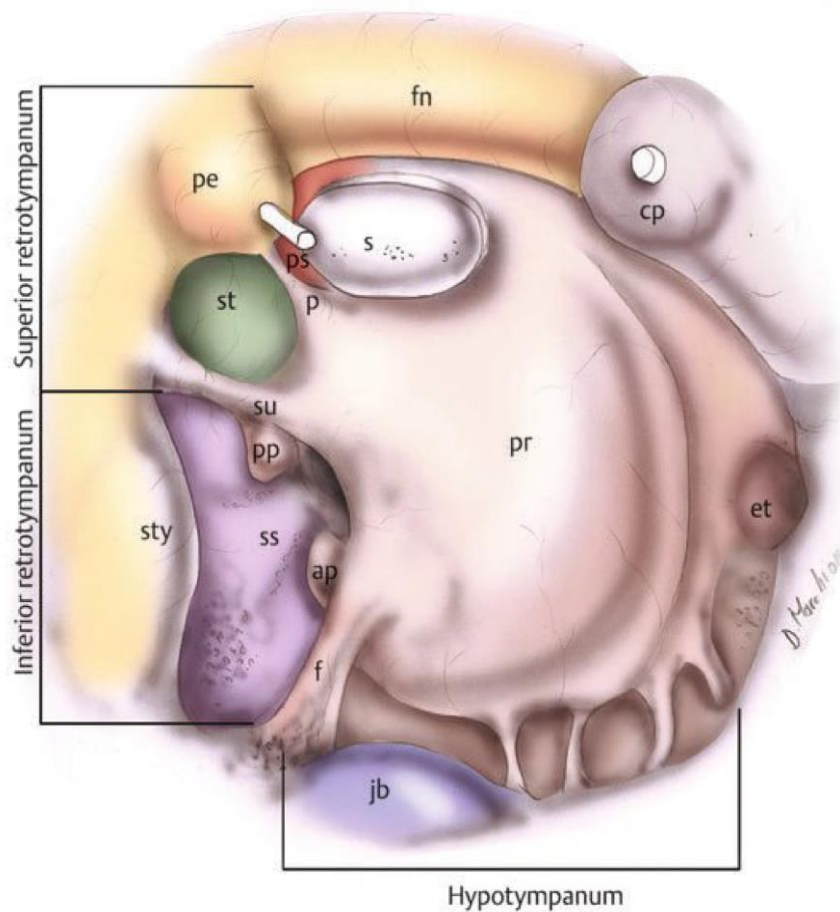


Fig-18: Retrotyimpanum

Ponticulus:

Ponticulus is a bony ridge extending from pyramidal process till the promontory.

Classical complete ponticulus – bony ridge separating sinus tympani from posterior sinus.

Communicating ponticulus – bridge like ponticulus with confluent sinus tympani.

Incomplete ponticulus – fails to extend till pyramidal process causing confluent sinus tympani.



Fig-19: Endoscopic picture of Retrotypanum

Subiculum:

Subiculum is a bony projection extending from posterior lip of round window niche to styloid eminence.

Complete subiculum – is seen as bony ridge separating sinus tympani from inferior retrotympaanum

Bridge subiculum – bridge type of subiculum resulting in sinus tympani communicating with inferior retrotympaanum.

Incomplete subiculum - subiculum fails to extend till the styloid eminence.

Absent subiculum – Subiculum not present.

Sinus tympani:

Sinus tympani is a recess lying medial to the pyramidal eminence and facial nerve, between ponticulus superiorly and subiculum inferiorly; lateral to posterior semicircular canal and vestibule.

Classical sinus tympani- sinus seen between ponticulus and subiculum medial to facial nerve.

Confluent sinus tympani- Sinus tympani seen communicating with posterior sinus with incomplete ponticulus.

Partitioned sinus tympani – bony ridge separating sinus tympani into superior and inferior sinus tympani.

Restricted sinus tympani- Due to high jugular bulb ,inferior extent of sinus tympani reduced.

Middle ear ventilation pathways:

- The mesotympanum and hypotympanum are directly aerated through the eustachian tube .
- There are two main ventilatory pathways to the epitympanum:
- Anterior route – Air stream passing from the eustachian tube to the protympanum, supratubal recess, to the anterior attic through the incomplete tensor tympani fold.Occurs in 25-40% of population.
- Posterior route- Main ventilatory pathway to the upper attic through the anterior and posterior isthmus.
- Additionally, through the posterior pouch of von Trötsch the prussak space is ventilated .

Eustachian tube patency:



Fig-20: Endoscopic picture of patent Eustachian tube

When the eustachian tube is patent, it is visualised endoscopically as intact orifice with no edematous mucosa blocking it .

THE MUCOSA OF THE TYMPANIC CAVITY

- The middle ear mucosa is mucus secreting respiratory mucosa with cilia on its surface. The degree of the mucociliary epithelium varies in normal middle ears, being more in the young individuals.

- Three distinct mucociliary pathways can be identified
 - Epitympanic,
 - Promontorial and
 - Hypotympanic, the latter being the largest.

- All these pathways coalesce at the tympanic end of the Eustachian tube.

- The mucous membrane lines the bony walls of the tympanic cavity, and it extends to cover the ossicles and their supporting ligaments in much the same way as the peritoneum covers the viscera in the abdomen.

- The mucosal folds also cover the tendons of the two middle ear muscles and carry the blood supply to and from the contents of the tympanic cavity thus separating the middle ear space into compartments.

Permanent perforation syndrome

In 1965 Thornburn described the lillie type 2 - chronic inflammation of the middle ear cleft. He termed it permanent perforation syndrome.

He described it as consisting of

- Permanent perforation of the pars tensa,
- Without discharge for prolonged periods or intermittently discharging ear,
- Margins of perforation covered completely with healed epithelium.

When not discharging the middle ear mucosa remains pale and no granulation or debris are seen.

The hearing loss depends on the size, site of perforation, ossicular status and other factors.

Due to the margins of perforation being epithelialised the perforation fails to heal.

The ear can remain inactive for prolonged periods or can become infected by ascending infections or by entry of water into ears becoming active and discharging.

The permanent perforation syndrome is treated medically to retain the inactive stage and tympanoplasty is done for tympanic membrane perforation closure and hearing restoration.

Tympanic isthmi blockage:

Endoscopically tympanic isthmi blockage was seen as isthmi covered with edematous mucosa and non visualisation of attic through the isthmi.



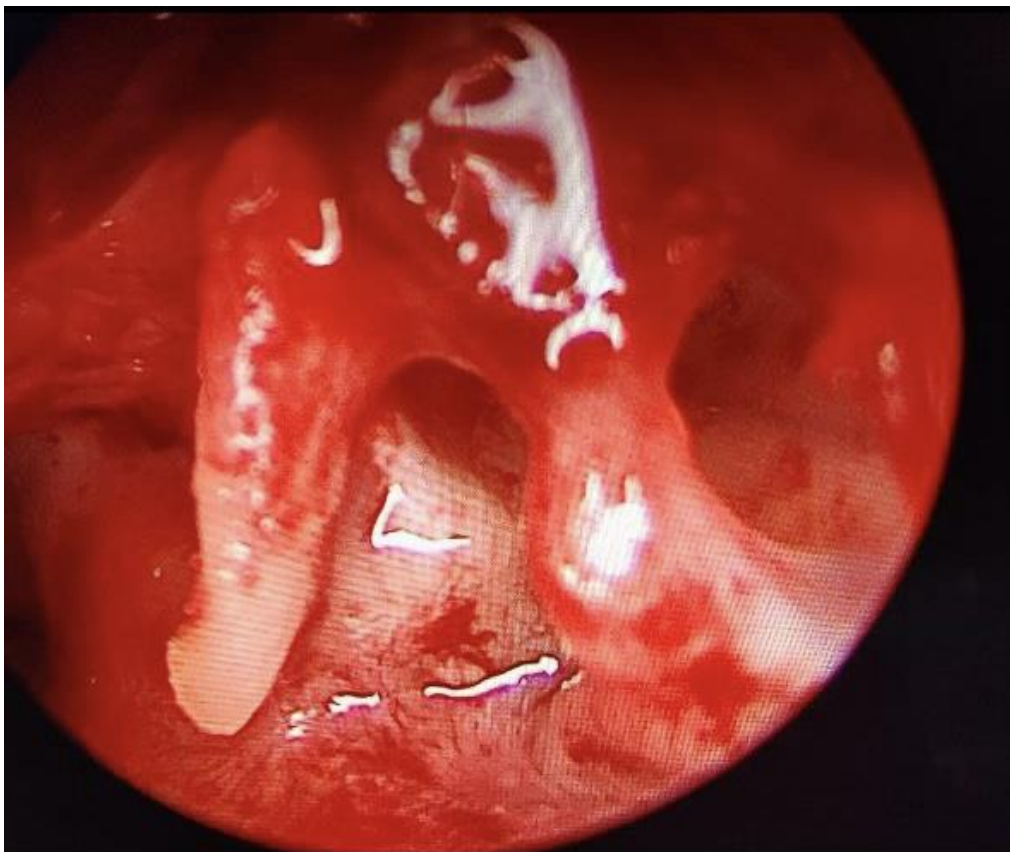
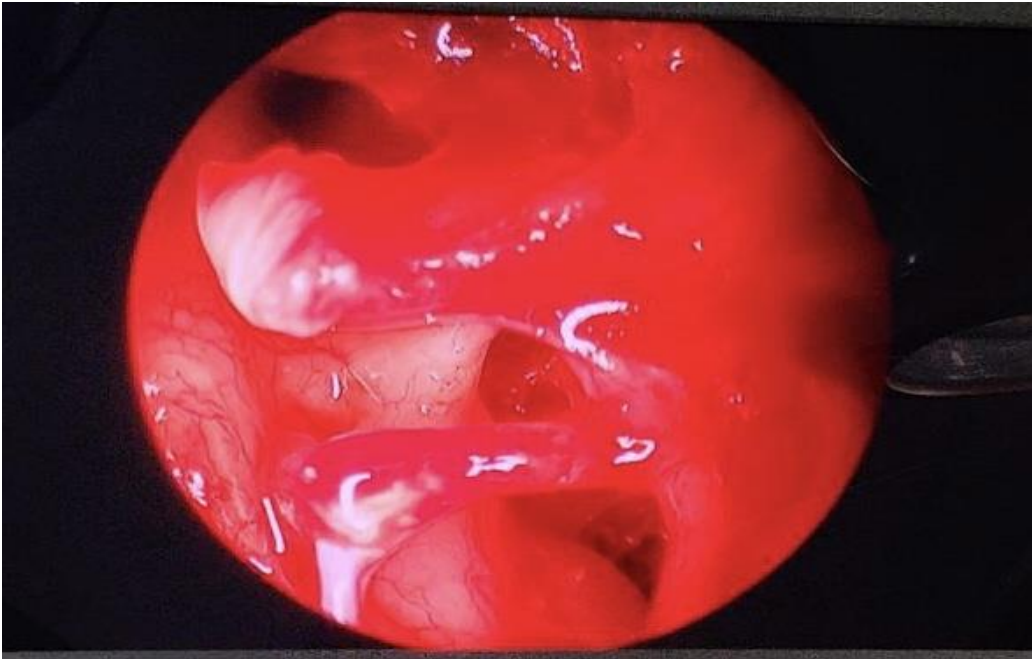


Fig-21: Endoscopic picture of blockage of tympanic isthmi

Endoscopic tympanoplasty

In 1967 Mer and colleagues introduced the use of middle ear endoscopes.

Since then various endoscopes are being utilised for ear surgeries from myringoplasty, ossiculoplasty, grommet insertion, mastoid explorations no skull base surgery.

Endoscopic tympanoplasty has changed the perspective of tympanic membrane and ossicular chain reconstruction

With the use of 0 degree and various angled endoscopes tympanoplasty has become more functional than just anatomical

Functional endoscopic ear surgery like the endoscopic tympanoplasty aims to not only reconstruct the anatomical defects but restores the physiological mechanisms of middle ear

Endoscopic tympanoplasty is thus utilised for evaluating the hidden areas of the middle ear not routinely visualised by microscopic techniques and re ventilating the middle ear compartments

Trans canal endoscopic tympanoplasty circumvents the need of a post auricular incision used routinely in the microscopic technique and helps in preserving most of the functional middle ear mucosa

REVIEW OF LITERATURE

T Palva et al published “tensor fold and anterior epitympanum”-1997 (2).The aim of this study was to evaluate the anatomy and pathology of anterior epitympanum and tensor tympani fold.51 temporal bones were dissected and the results were that only 27% of them had an incomplete tensor tympani fold.

James J. Holt published “The Ponticulus: An Anatomic Study”-2005 (3).In this study,50 cadaveric temporal bones were studied to examine the structural anatomy and variations of the ponticulus. Results concluded that 33 of the specimens had complete ponticulus ,7 had incomplete ponticulus and 10 of the specimens had absence of ponticulus.

Daniele Marchioni et al published “Selective Epitympanic Dysventilation Syndrome”-2010(4).The prevalence of isthmi blockage and complete tensor tympani fold was assessed in cases of attic cholesteatoma with normal eustacian tube function who underwent surgery.They hypothesised the selective epitympanic dysventilation syndrome and further concluded that not only a patent Eustachian tube is essential for complete ventilation of middle ear but also a patent tympanic isthmi and incomplete tensor tympani fold.

A. C. Cheiță et al published “The recesses of the retro-tympanum”-2010 (5).The objective of the study was to examine the posterior tympanic wall and the four recesses.37 cadaveric temporal bones were studied.The study concluded that all four recesses may or may not be present with each of the recess having a unique internal configuration and that it is important to identify the positive bony projections.

Daniele Marchioni et al published “Endoscopic Anatomy of the Middle Ear”-2011 (6).

-The authors based on their experience suggest that in vivo endoscopy of tympanic cavity is the best way to evaluate the ventilation routes which they believe are the most important pathogenetic causes in chronic middle ear disease.

Daniele Marchioni et al published that “The contribution of selective dysventilation to attical middle ear pathology”-2011 (7).This article concluded that even with normal Eustachian tube and normal middle ear pressure, with complete or incomplete tensor tympani fold and isthmi blockage there was selective negative pressure in the epitympanum.Hence it concluded that selective epitympanic dysventilation arising from isthmi blockage can cause attical pathology.

Karan Sharma et al published “Middle Ear Cleft in Chronic Otitis Media: A Clinicohistopathological Study”-2011 (8).The aim of this study was to evaluate the changes in middle ear cleft in chronic otitis media including clinical, intraoperative and histopathological aspects.100 patients with chronic otitis media who underwent surgery were studied and they concluded that 11.11% were unsafe otitis media in clinically safe cases.They also stated that the pathological changes and middle ear mucosa involvement are not always predictable.

Muaaz Tarabichi et al published “Endoscopic Management of Chronic Otitis Media and Tympanoplasty”-2013 (9).

-The authors suggest that endoscope is better for poor anterior ventilation of mesotympanum and for selective poor epitympanic ventilation.

-Also endoscope gives better visualisation for anterior tympanic membrane perforations.

João Flávio Nogueira et al published “Endoscopic Anatomy of the Retrotympanum”-2013 (10).This study described the various types of retro tympanic structures like the sinus tympani,ponticulus and subiculum.

Daniele Marchioni et al published “Prevalence of ventilation blockages in patients affected by attic pathology: a case-control study”-2013 (11).The objective of this study was to evaluate the anatomical and pathological findings using retrospective video analysis in patients with attic disease and without attic disease.The study concluded that selective epitympanic dysventilation occurred with obstruction of tympanic isthmi causing,attic disease in patients with normal Eustachian tube function.

Takatoshi Furukawa et al published “Feasibility and Advantages of Transcanal Endoscopic Myringoplasty” -2014 (12).The objective of this study was to examine the feasibility and advantages of transcanal endoscopic myringoplasty procedure.Endoscopic myringoplasty was performed in 21 patients (25 ears) and the study concluded that endoscopic views during myringoplasty were superior to microscopic view.They also stated that endoscopic myringoplasty can be done for any perforation size and narrow external auditory canal.

Kyoko Shirai et al published “Volume of the epitympanum and blockage of the tympanic isthmus in chronic otitis media: a human temporal bone study”-2015 (13).

-The objective of the study was to compare the volume of epitympanum and the area of tympanic isthmus.

-The study concluded that congenital tympanic isthmus stenosis is not likely a cause of COM, but obstruction of tympanic isthmus with soft exudate may be associated with COM with epitympanic pathology.

Bin Li et al published “Endoscopic Anatomy of the Tensor Fold and Anterior Attic”- 2017 (14).The aim of the study was to evaluate the variants of tensor tympani fold , it’s relations and endoscopic approaches.Three types tensor tympani fold were identified- vertical, oblique(majority)and horizontal.

M Bonali et al published “The variants of the retro- and hypotympanum: an endoscopic anatomical study”-2017(15).The objective of the study was to describe the anatomical variations of the hypo- and retrotympanum using endoscopes.The study revealed 38% ridge ponticulus , 35% bridge ponticulus and 27% incomplete ponticulus.

Sreerama Murty Boddepalli et al published “Epitympanic Diaphragm: Endoscopic Functional Tympanoplasty”-2018 (16).

-In this study,100 patients with large tympanic membrane perforation underwent endoscopic tympanoplasty and tympanic isthmi were evaluated endoscopically.

-Conclusion of the study was that using endoscopic ventilatory pathway clearance and tympanoplasty ,94% positive results were obtained.

B. Y. Praveen Kumar et al published “Dimensions and morphology of the sinus tympani: an anatomical study”-2018 (17).The objective was to study the morphology and dimensions of sinus tympani.The results concluded that out of twenty wet temporal bones studied 13 specimens had classical sinus tympani,6 bones had confluent type , 1 was restricted type and there were no partitioned type.

Bayram ,Sahin et al published “Endoscopic evaluation of middle ear anatomic variations in autopsy series: analyses of 204 ears”-2018 (18).The aim of this study was to evaluate the anatomical variations of the middle ear in an autopsy series.One hundred and two cadaveric temporal bones were studied and results were -out of 204 ears studied,3 of them had agenesis of pyramidal eminence and stapedial tendon,76.4% had complete ponticulus ,12.3% had bridge shaped ponticulus,in 11.3% specimens ponticulus was absent.Subiculum was complete in 66.7%,was absent in 23% and incomplete in 10.3% of specimens.

Yasser Shewel et al published “Endoscopic Assessment of the Isthmus Tympanicum and Tensor Tympani Fold and their Relationship with Mastoid Pneumatization in Chronic Otitis Media”-2020 (1).

-The aim of the study was to evaluate the tympanic isthmus and tensor tympani fold in relation with the mastoid pneumatization in cases of COM.

-Sixty patients were studied in two groups;group A – patients with tympanic membrane perforation and group B- patients with limited attic disease.

-The study concluded that limited attic disease was significantly correlated to obstruction of tympanic isthmus,incomplete tensor tympani fold was associated with well pneumatized mastoid.

MATERIALS AND METHODS

Study Design: Observational cross sectional study

Study Setting: The study was conducted at Upgraded Institute of Otorhinolaryngology, Rajiv Gandhi Government General Hospital, Chennai – 600003.

Study Sample: 30

Ethical Committee Clearance: Obtained from the Institutional ethical committee.

Study Period: December 2020 – December 2021

TECHNIQUE:

Tympanoplasty -type 1 is performed in the selected cases of permanent perforation syndrome under study. During tympanoplasty, along with ossicular chain integrity the upper mesotympanum is inspected using 0 deg hopkins rigid rod lens endoscope. The mucosal folds along the malleus (posterior malleal ligament) are visualised. Using a 45 deg hopkins rigid rod lens endoscope tensor tympani fold along with Eustachian tube is visualised. Placing it anteriorly and superiorly to the handle of malleus the epitympanic diaphragm is visualised and tympanic isthmi (proctors anterior and posterior isthmus) are studied. Retrotympanum is endoscopically assessed

including the ponticulus, subiculum and sinus tympani. Hence the epitympanic diaphragm is endoscopically assessed along with neighbouring mucosal folds.

DATA COLLECTION:

- 1) Complete history and clinical examination
- 2) Pure tone audiogram
- 3) HRCT temporal bone
- 4) Endoscopic assessment

INCLUSION CRITERIA:

- 1) Age group: 18- 50 years
- 2) Both sex- male and female
- 3) Patients presenting to OPD with
 - a. Conductive hearing loss: <40 dbHL
 - b. No active discharge- inactive mucosal disease
 - c. Dry ear - 6 months
- 4) Normal middle ear mucosa
- 5) Preliminary plan -type 1 tympanoplasty

EXCLUSION CRITERIA:

- 1) Age group: extremes of age
- 2) Hearing loss- >40 dbHL
- 3) Wet ear
- 4) Thick, pink/reddish middle ear mucosa

METHODOLOGY:

- 1) ETHICAL COMMITTEE APPROVAL
- 2) SELECTION OF PATIENTS ACCORDING TO INCLUSION CRITERIA
- 3) INFORMED AND WRITTEN CONSENT
- 4) COMPLETE CLINICAL HISTORY AND ENT EXAMINATION
- 5) PURE TONE AUDIOMETRY
- 6) HRCT TEMPORAL BONE
- 7) PERFORMING TYPE I TYMPANOPLASTY
- 8) LOOKING FOR ENDOSCOPIC STRUCTURES
 - HANDLE OF MALLEUS
 - EUSTACHIAN TUBE
 - MIDDLE EAR MUCOSA
 - TENSOR TYMPANI FOLD

- ANTERIOR ISTHMUS
- POSTERIOR ISTHMUS
- PONTICULUS
- SUBICULUM
- SINUS TYMPANI
- TYPE OF ISTHMUS BLOCK ON SYRINGING

- 9) DATA COMPILATION
- 10) STATISTICAL ANALYSIS
- 11) CONCLUSION

RESULTS AND ANALYSIS

In our study on endoscopic evaluation of tympanic isthmi, 30 cases of permanent perforation syndrome who underwent type 1 tympanoplasty were included. Thorough clinical history and examination was done for all the patients. They were evaluated with PTA and HRCT temporal bone. Endoscopic evaluation of middle ear mucosal folds, tympanic isthmi were done.

Data entry has been done in Microsoft Excel. Statistical analysis using Descriptive and Analytical Statistics with Chi Square carried out using SPSS Version 20 Software.

Table-1: Distribution study of Age group

Age group	Number of patients
18-30 years	13
31- 40 years	5
41- 50 years	12

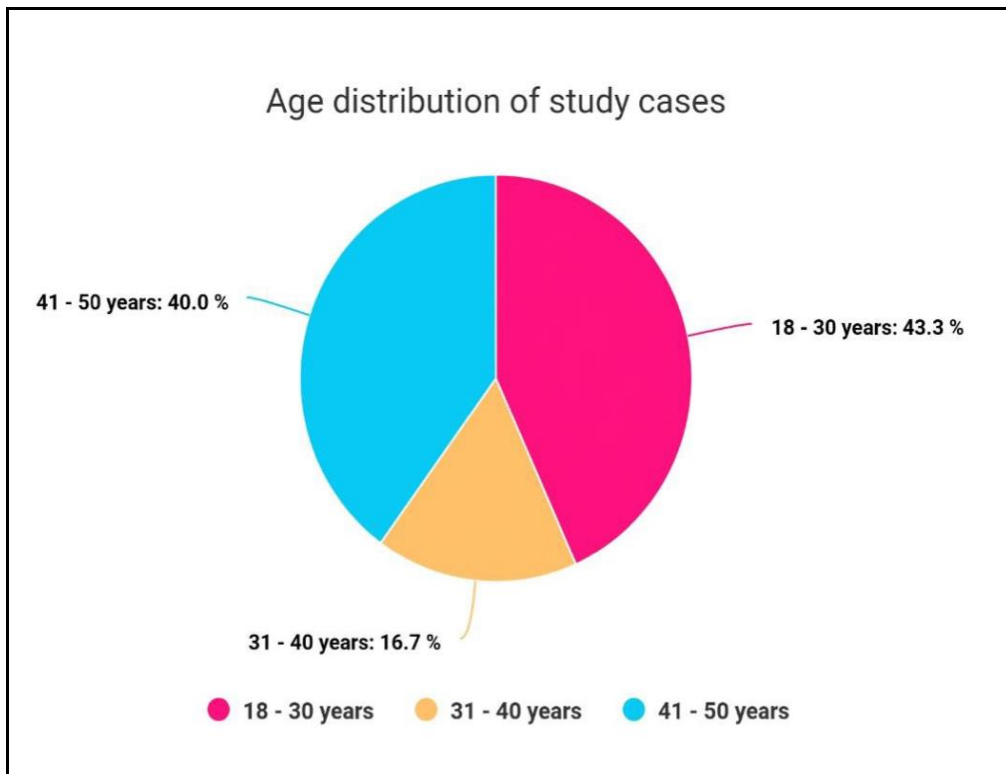
In our study out of total study population of 30 patients

13 patients were in the age group 18- 30 years

5 patients were in the age group 31- 40 years

12 patients were in the age group 41- 50 years

Mean age of our study was 34.4 years.



In our study the age of patients under study ranged from 18 to 50 years.

43.3% of patients were between 18 and 30 years of age;

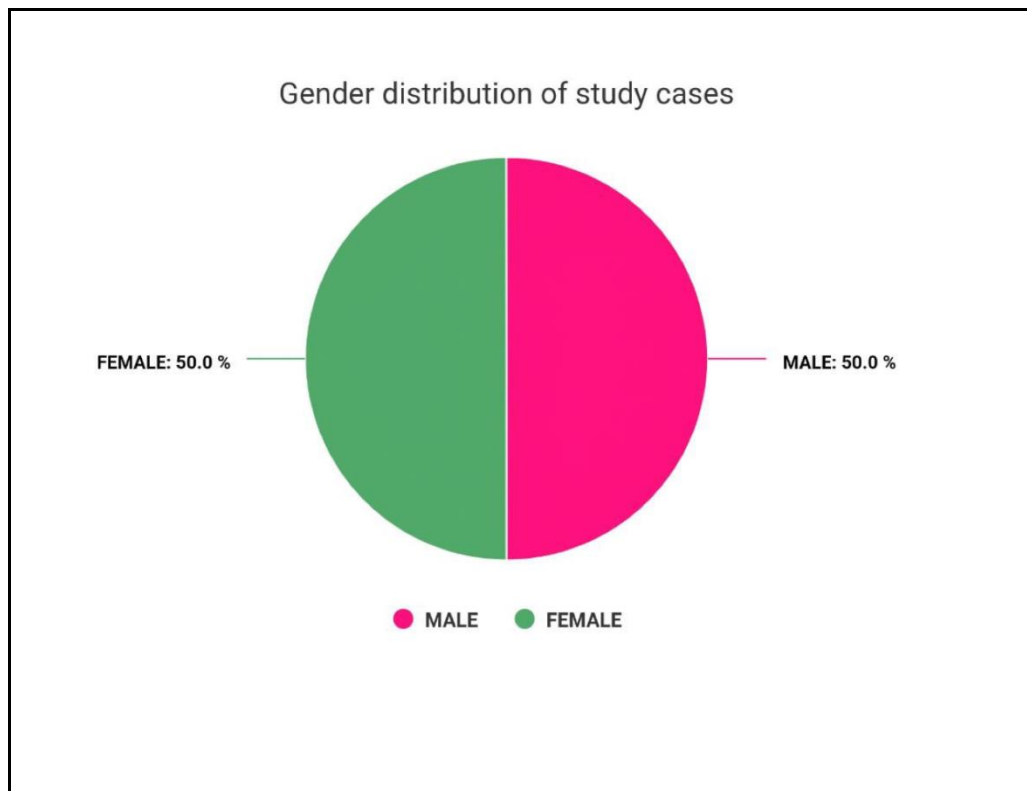
40 % of patients were between 41 and 50 years of age;

16.7% of patients were between 31 and 40 years of age.

Majority of our patients under study were in the age group 18 to 30 years.

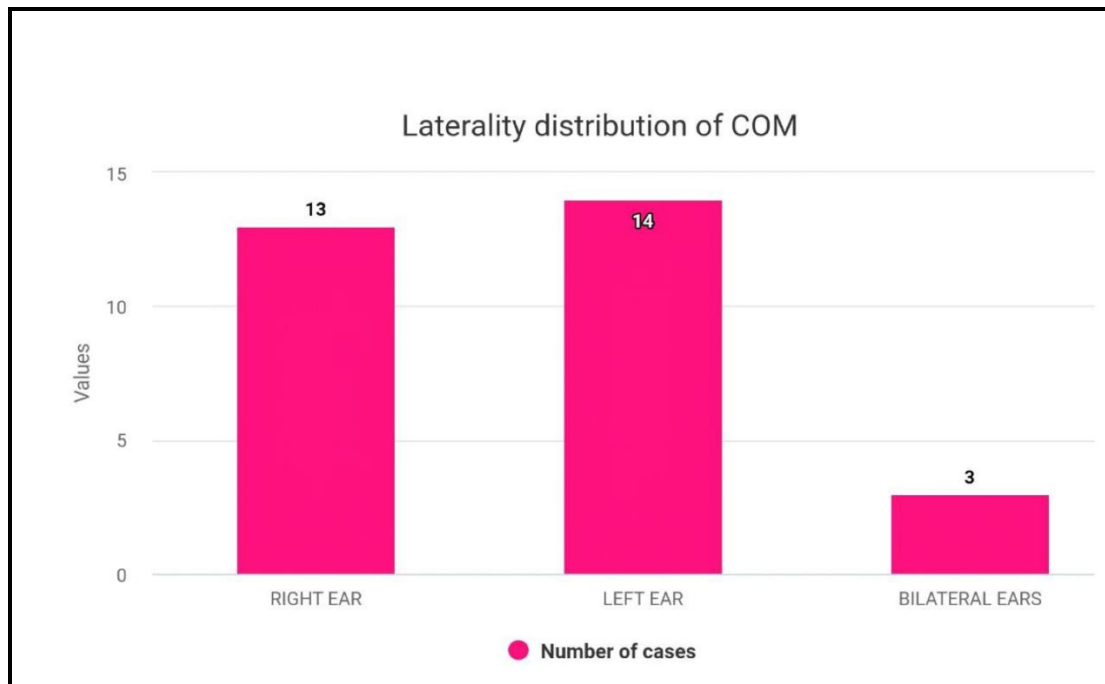
Table-2: Distribution study of Gender

Gender	Number of patients
Male	15
Female	15



In our study of 30 patients, 15 patients were males and 15 patients were females.

Thus 50% of our study population were males and 50 % of our study population were females.



In our study out of 30 patients,14 patients had left ear disease alone;

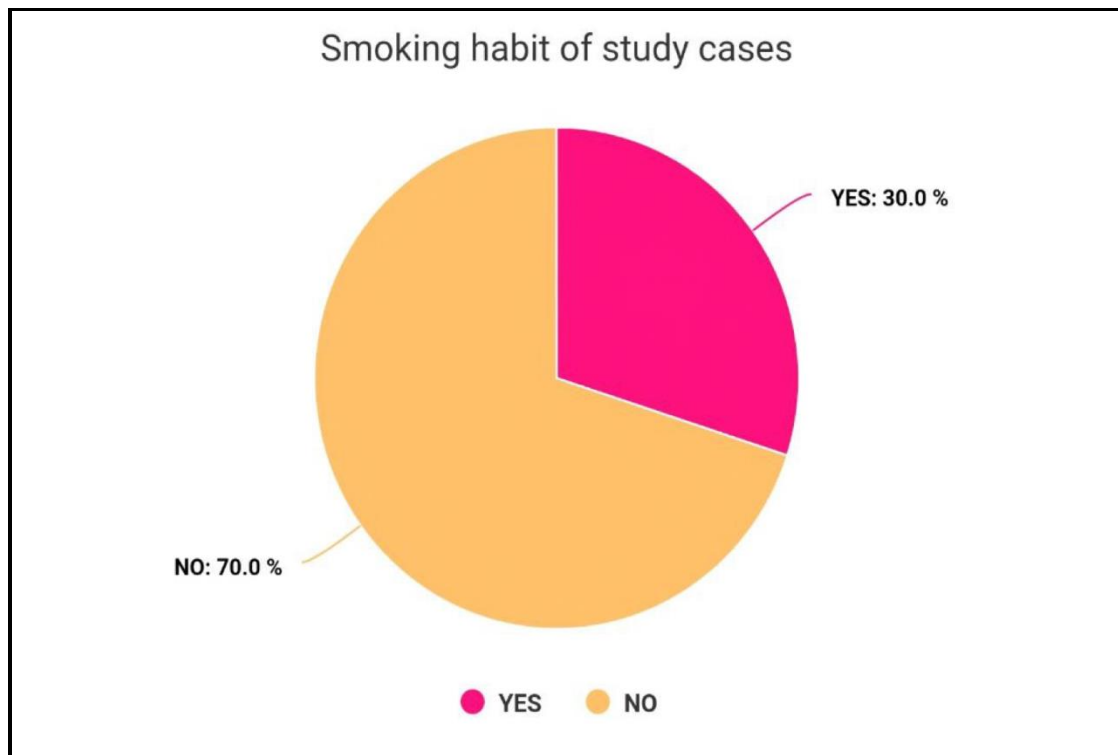
13 patients had right ear disease alone; 3 patients had bilateral ear disease.

Out of the 3 bilateral cases,2 patients underwent Right type 1 tympanoplasty and 1 patient underwent left type 1 tympanoplasty.

Thus 15 patients underwent Right type 1 tympanoplasty and 15 patients underwent left type 1 tympanoplasty.

Table-3: Distribution study of Smoking Habit

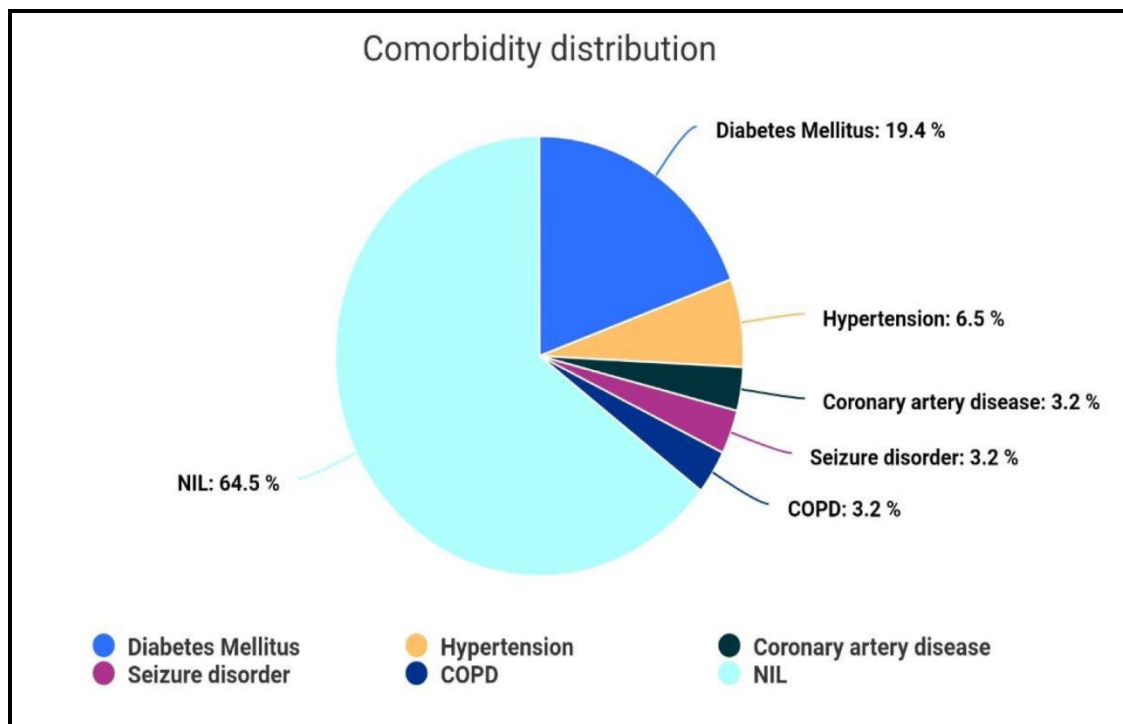
Smoker	Number of patients
Yes	9
No	21



In our study, out of 30 patients – 9 patients were smokers and 21 patients were non smokers. Thus 30% of our study population were smokers and 70% were non smokers.

Table-4: Distribution study of Comorbidity

Comorbidity	Number of patients
Diabetes Mellitus	6
Hypertension	2
Coronary artery disease	1
Seizure disorder	1
COPD	1
NIL	20



In our study, out of 30 patients

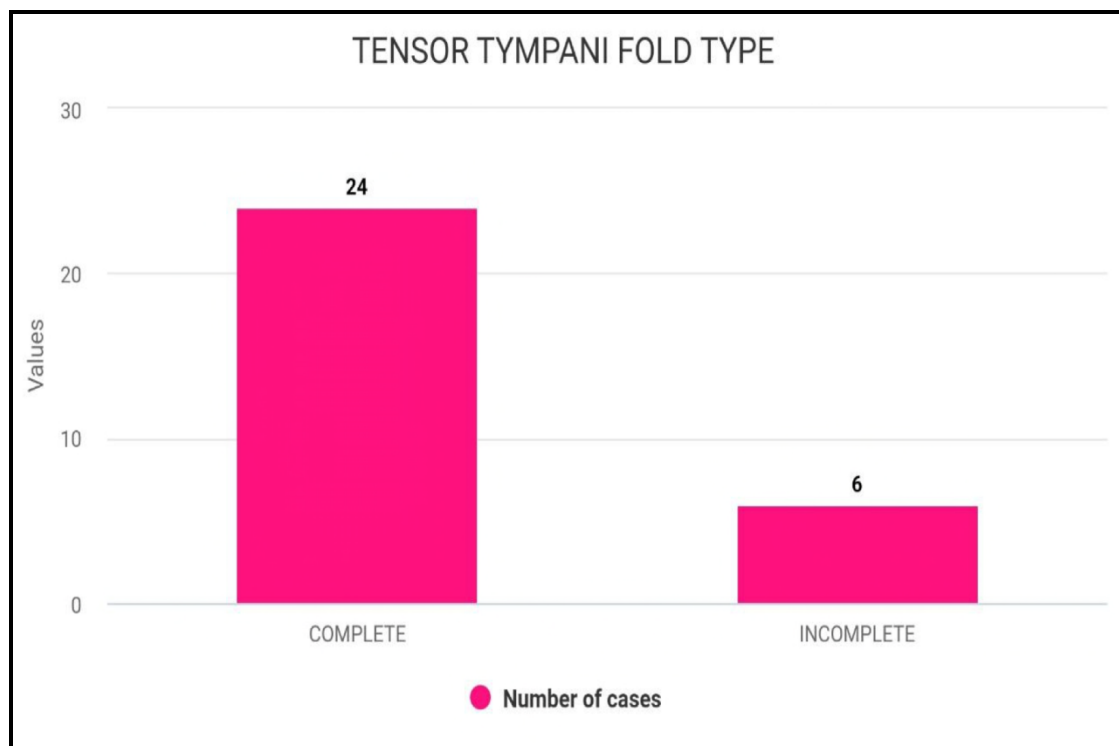
64.5% patients had no comorbidities, 19.4% patients were diabetic, 6.5% patients were hypertensive, 3.2% patients had coronary artery disease, 3.2% patients had seizure disorder and 3.2% patients had COPD.

Eustacian tube status

27 cases in our study had a patent eustachian tube, 3 cases had edematous eustachian tube.

Tensor tympani fold

Out of 30 patients studied, 24 patients had complete tensor tympani fold and 6 patients had incomplete tensor tympani fold.



80% of our study population had complete tensor tympani fold and 20% had incomplete tensor tympani fold.

TENSOR TYMPANI FOLD TYPE PERCENTAGE

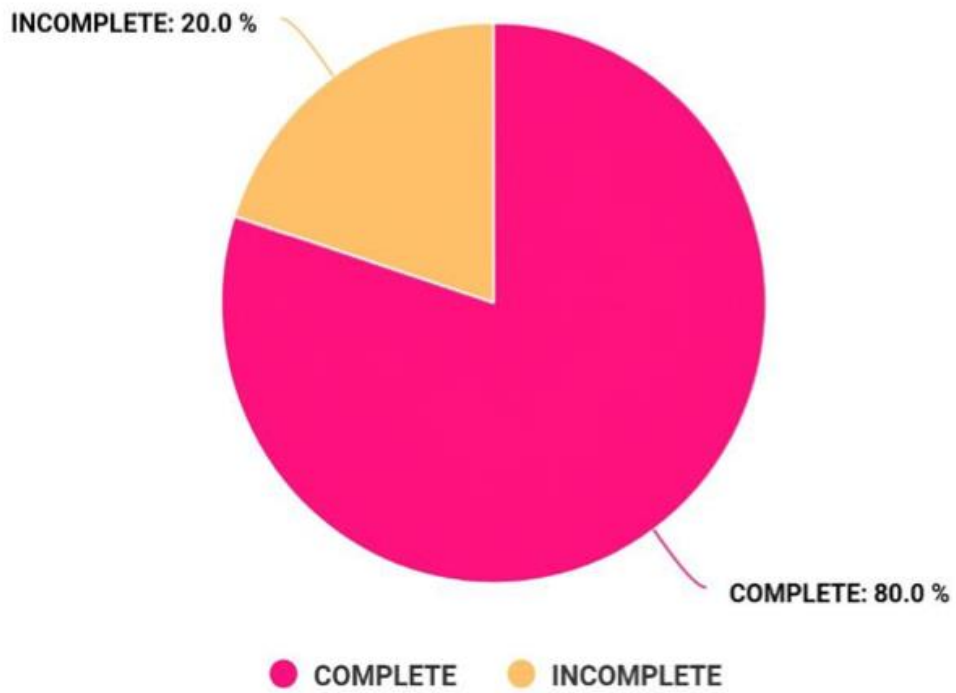
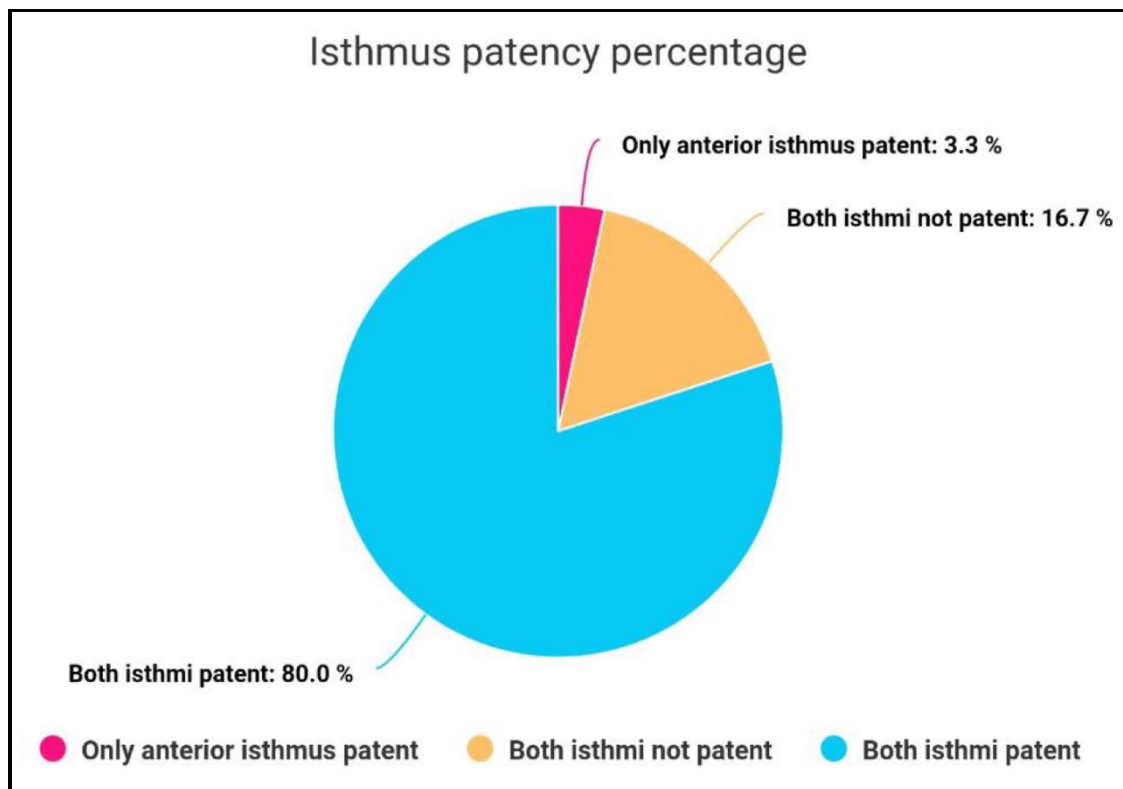


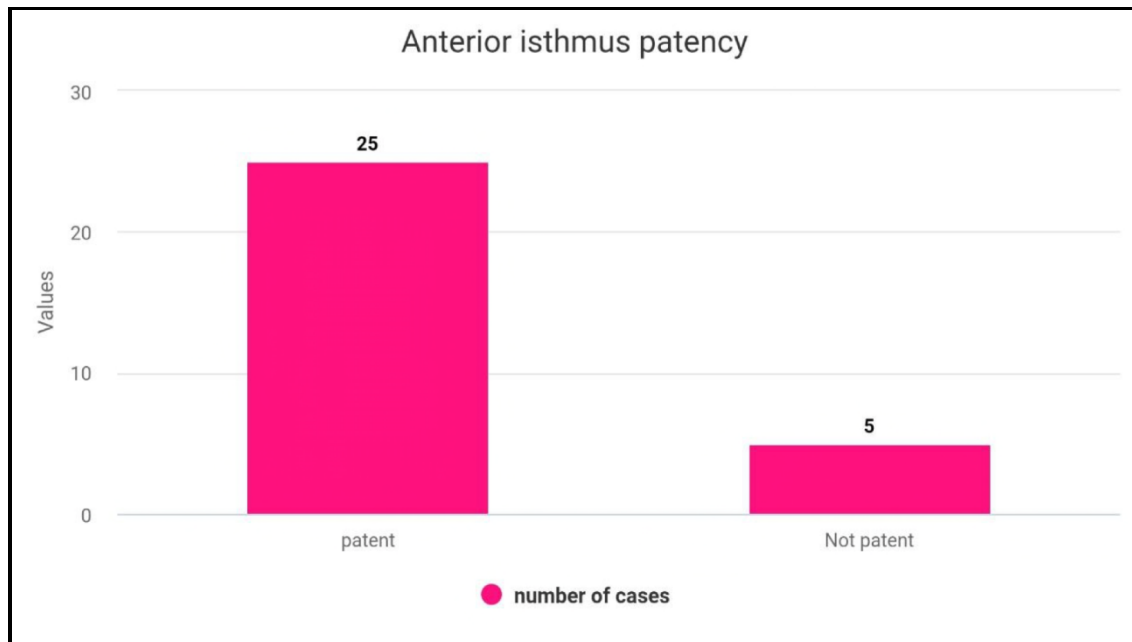
Table-5: Distribution study of Isthmus patency

Isthmus patency	Number of patients
Both isthmi patent	24
Both isthmi not patent	5
Only anterior isthmi patent	1

Out of 30 patients, 24 patients had both isthmi patent, 5 patients had both isthmi blocked, 1 patient had patent anterior isthmus but blocked posterior isthmus.



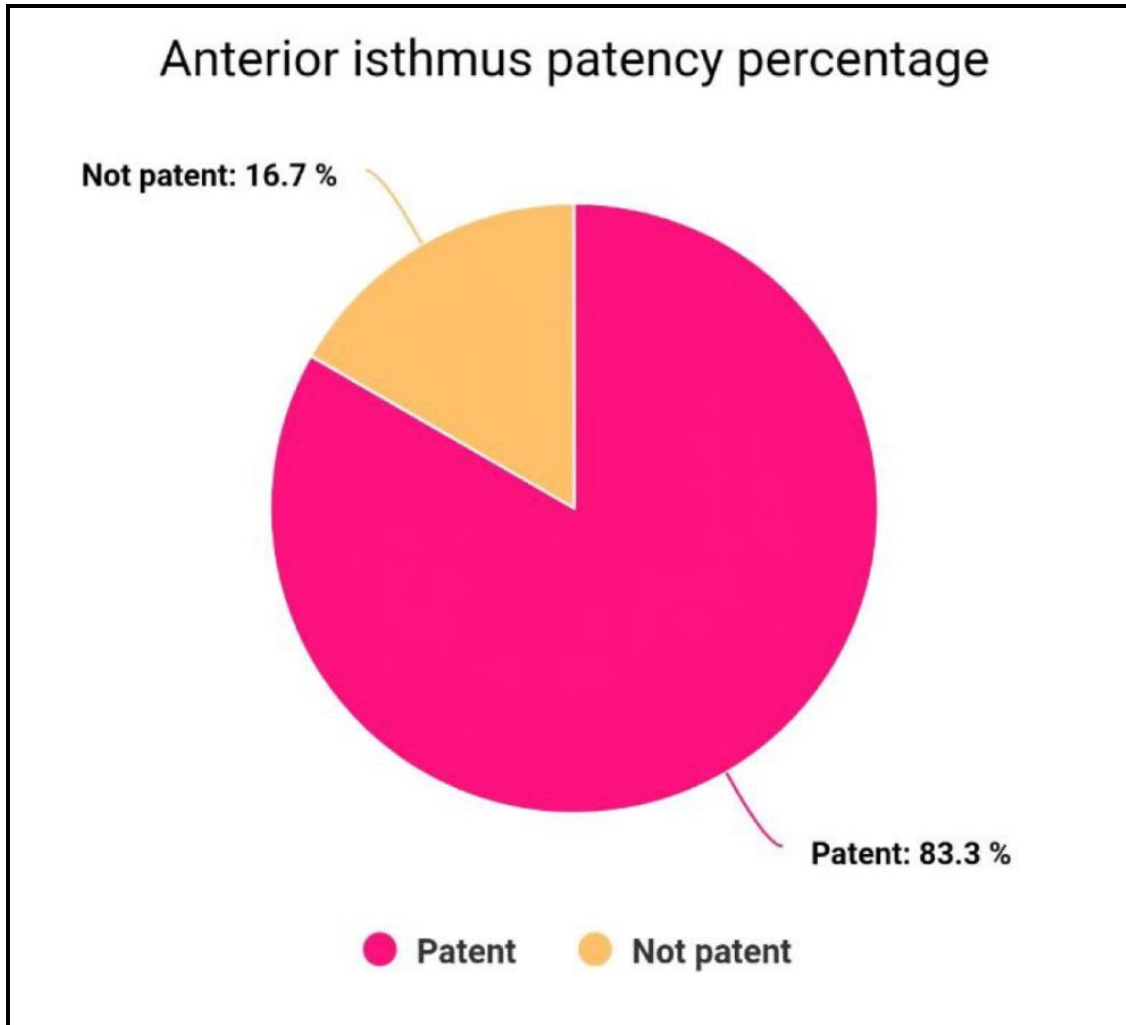
Of our study population, 80% patients had both isthmi patent, 16.7% patients had both isthmi blocked, 3.3% patients had only anterior isthmus patency.



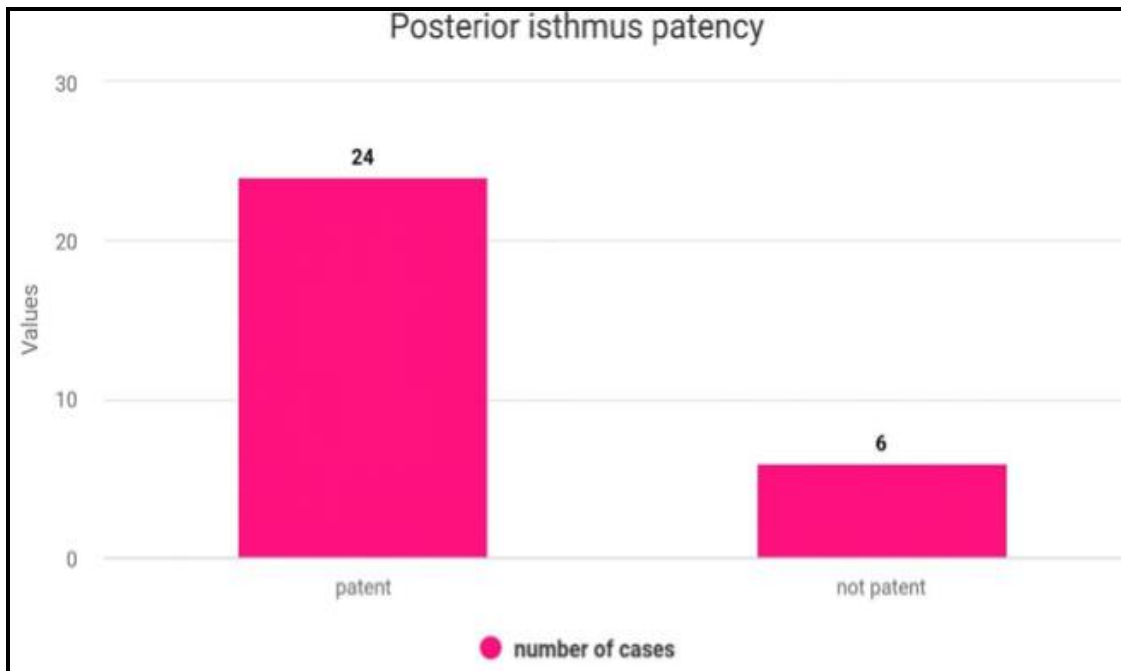
In our study, 25 patients had patent anterior isthmus and 5 patients had blocked anterior isthmus (edematous).

In patients with isthmus blockage syringing was done to relieve and identify the type of block.

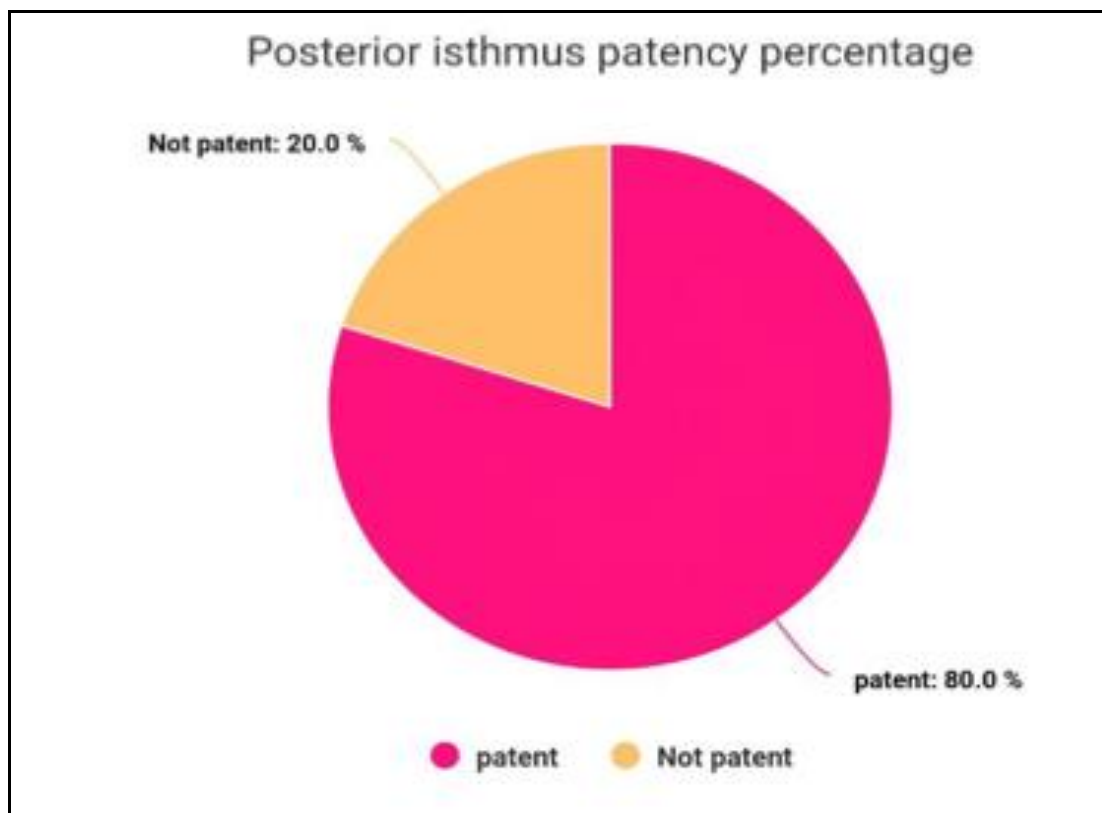
The blocks were identified as soft in all edematous isthmi.



83.3% of our study population had patent anterior isthmus and 16.7% had blocked anterior isthmus.



Out of 30 patients, 24 patients had patent posterior isthmus and 6 patients had blocked posterior isthmus.



In our study, 80% of the study population had patent posterior isthmus and 20% patients had blocked posterior isthmus.

Retrotyimpanum:

In our study of 30 patients,

10 patients had edematous retrotyimpanum (33.3%),

20 patients had normal retrotyimpanum (66.6%).

Out of 20 patients 18 had complete ponticulus(bony ridge) ,2 had incomplete ponticulus and no absence of ponticulus observed.

All 20 patients had complete subiculum

18 patients had classical sinus tympani and 2 patients had confluent sinus tympani type.

The below table shows the correlation of age and anterior isthmus patency and as the p value is above 0.05 it is not statistically significant.

		Anterior isthmus		Total		
		Patent	Not patent		Chi square value	P value
Age	18-30	11	2	13		
	31-40	4	2	6	1.670	0.434
	41-50	10	1	11		
Total		25	5	30		

The below table shows the correlation between age and posterior isthmus patency and is statistically insignificant.

		Posterior isthmus		Total		
		Patent	Not patent		Chi square value	P value
Age	18-30	10	3	13		
	31-40	4	2	6	1.562	0.458
	41-50	10	1	11		
Total		24	6	30		

The below table shows the correlation between sex and anterior isthmus patency and is statistically insignificant.

		Anterior isthmus		Total		
		Patent	Not patent		Chi square value	P value
Sex	Male	12	3	15		
	Female	13	2	15	0.240	0.624
Total		25	5	30		

The below table shows the correlation between sex and posterior isthmus patency and is statistically insignificant.

		Posterior isthmus		Total		
		Patent	Not patent		Chi square value	P value
Sex	Male	11	4	15	0.833	0.361
	Female	13	2	15		
Total		24	6	30		

The below table shows the correlation between smoking habit and anterior isthmus patency and is statistically insignificant.

		Anterior isthmus		Total		
		Patent	Not patent		Chi square value	P value
Smoker	Yes	7	2	9		
	No	18	3	21	0.286	0.593
Total		25	5	30		

The below table shows the correlation between smoking habit and posterior isthmus patency and is statistically insignificant.

		Posterior isthmus		Total		
		Patent	Not patent		Chi square value	P value
Smoker	Yes	7	2	9		
	No	17	4	21	0.040	0.842
Total		24	6	30		

The below table shows the correlation between smoking habit and status of tensor tympani fold and is statistically insignificant.

		Tensor tympani fold		Total		
		Complete	Incomplete		Chi square value	P value
Smoker	Yes	7	2	9		
	No	17	4	21	0.040	0.842
Total		24	6	30		

The below table shows the correlation between sex and status of tensor tympani fold and is statistically insignificant.

		Tensor tympani fold		Total		
		Complete	Incomplete		Chi square value	P value
Sex	Male	13	2	15		
	Female	11	4	15	0.833	0.361
Total		24	6	30		

The below table shows the correlation between age and status of tensor tympani fold and is statistically insignificant.

		Tensor tympani fold		Total		
		Complete	Incomplete		Chi square value	P value
Age	18-30	11	2	13		
	31-40	5	1	6	0.578	0.749
	41-50	8	3	11		
Total		24	6	30		

OBSERVATION

Intra operative findings:

Findings noted out of total study population of 30 cases.

Finding	Number of patients	Percentage
Eustachian tube patent	27	90%
Handle of malleus medialized	5	16.7%
Edematous middle ear mucosa	10	33.3%
Incomplete tensor tympani fold	6	20%
Complete tensor tympani fold	24	80%
Patent anterior isthmus	25	83.3%
Patent posterior isthmus	24	80%
Complete ponticulus bony ridge type	18	60%
Incomplete ponticulus	2	6.7%
Absent ponticulus	-	-
Classical sinus tympani	18	60%
Confluent sinus tympani	2	6.7%
Restricted sinus tympani	-	-
Partitioned sinus tympani	-	-

Finding	Number of patients	Percentage
Complete subiculum	20	66.7%
Incomplete subiculum	-	-
Absent subiculum	-	-
Pyramidal eminence and stapedial tendon present	30	100%
Ossicular chain intact	30	100%

DISCUSSION

30 patients were studied to evaluate the structural anatomy of the compartments of middle ear and the patency of ventilatory pathways. Data was collected with regards to age ,sex, chief complaints, laterality, duration of disease, comorbidities, smoking habit, previous ear surgery, PTA , HRCT temporal bone, Otoendoscopic findings, surgery done ,intra operative findings which included- edges of perforation, handle of malleus, middle ear mucosa, eustachian tube, tensor tympani fold, anterior isthmus, posterior isthmus, retrotympanum (ponticulus, subiculum, sinus tympani, pyramidal eminence) , isthmi blockage syringing and identification.

AGE:

In the study by Yasser Shewel et al ,group A comprising of patients with tympanic membrane perforation, the average age was 26.0 years.

In the study by Karan Sharma et al ,the mean age was 26.08 years with age range of 10-50 years.

In our study, the mean age is 34.4 years with a minimum age of 18 years and maximum age of 50 years.

SEX:

In the study by Yasser Shewel et al, study population comprised of 63.33% of females and 36.67% of males.

In the study by Karan Sharma et al, male :female was 1:1.2 .

In our study male : female ratio is 1:1 .

INTRA OPERATIVE FINDINGS

TENSOR TYMPANI FOLD:

In the study by Yasser Shewel et al, group A comprising of patients with tympanic membrane perforation showed that 22.2% of patients had incomplete tensor tympani fold and 77.8% had complete tensor tympani fold .

In the study by T Palva et al, they observed incomplete tensor tympani fold in 25% of cases.

In the study by Li B et al, 8 out of 28 (28.6%) temporal bone specimens had incomplete tensor tympani fold.

In our study, out of the 30 patients evaluated 20% of patients had incomplete tensor tympani fold which is consistent with the above studies.

ISTHMUS:

In the study by Yasser Shewel et al , group A comprising of patients with tympanic membrane perforation showed that 83.3% of patients had patent isthmus and 16.7% had isthmus blockage due to mucosal edema, granulation tissue or medialized malleus.

In the study by Sreerama Murty Boddepalli et al, out of 100 patients 78 had tympanic isthmi blockage.

In our study 16.7% of patients had anterior isthmus blockage and 20% of patients had posterior isthmus blockage which is consistent with Yasser Shewel et al study.

PONTICULUS:

In the study by Holt , out of 50 cadaveric temporal bones studied 33 specimens had complete ponticulus(66%) , incomplete ponticulus was observed in 7 (14%) specimens and 10 (20%) specimens had no ponticulus.

In the study by Bayram Sahin et al , out of 204 ears studied 76.4% had complete bony ridge type ponticulus , in 12.3% specimens bridge shaped ponticulus observed and was absent in 11.3% specimens.

In the study by Chei ta et al , out of 31 temporal bones evaluated 16(51%) had complete bony ridge shaped ponticulus, 3(9.7%)

specimens had incomplete ponticulus and 12 (38.7%) specimens had bridge shaped ponticulus.

In the study by Bonali et al , 73% of complete ponticulus was observed(bony ridge-38% and bridge shaped-35%) and incomplete ponticulus was seen in 27% cases.

In our study out of 30 cases, 18 (60%) patients had complete ponticulus , 2(6.7%) patients had incomplete ponticulus, no ponticulus was absent and 10 patients had edematous retrotypanum .These findings are consistent with the above studies.

SUBICULUM:

In the study by Bayram Sahin et al, out of 204 ears studied 66.7% had complete subiculum, 10.3% had incomplete subiculum and subiculum was absent in 23%.

In the study by Chei ta et al , complete subiculum absence was observed in 24.32% cases.

In the study by Bonali et al , 34% of complete subiculum absence was noted.

In our study with smaller study population and edematous retro tympanic cases there was no complete subiculum absence noted.

SINUS TYMPANI:

In the study by B. Y. Praveen Kumar et al , 65% of classical sinus tympani, 30% of confluent sinus tympani, 5% of restricted sinus tympani were noted with absence of partitioned sinus tympani.

In our study 60% of patients had classical sinus tympani, 6.67% patients had confluent sinus tympani and no cases of restricted or partitioned sinus tympani were seen.

PYRAMIDAL EMINENCE :

In the study by Bayram Sahin et al , 1.5% cases had agenesis of pyramidal eminence and absence of stapedial tendon.

In our study all 30 cases had normal pyramidal eminence and stapedial tendon.

MIDDLE EAR MUCOSA:

In the study by Karan Sharma et al , edematous middle ear mucosa was noted in 20% of patients .

In our study 33.3% patients had edematous middle ear mucosa.

OSSICULAR STATUS:

In the study by Karan Sharma et al , 23.8% cases had ossicular erosion in tubotympanic disease.

In our study all 30 cases had intact ossicular chain .

CONCLUSION

- Till now abundant literature is available regarding the epitympanum and isthmi status in atticoantral disease.
- Our study describes the various middle ear structures identified during endoscopic tympanoplasty that are vital in identifying the ventilatory mechanisms and which are not feasible with microscopic views.
- In our study eustachian tube patency was 90% , 80% had complete tensor tympani fold, 16.7% had anterior isthmus blockage, 20% had posterior isthmus blockage , 33.3% had edematous middle ear mucosa.
- We would like to propose that with patent eustachian tube , permanent perforation syndrome can be present with tympanic isthmi blockage which leads to persistence of disease.
- We also suggest that with usage of angled endoscopes we could alleviate the need of mastoidectomy in permanent perforation syndrome with identifying the ventilatory status and type of isthmus blockage.