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The Study On Frequencies Of Anatomical Variations Of The Structures In The Retrotympanum

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Abstract
The retrotympanum is a complex structure consisting of different spaces lying in the posterior wall of the tympanic cavity. The use of the endoscope for the removal of cholesteatoma matrix from the retrotympanum led to a decrease in cholesteatoma recidivism. Endoscopes were also used during second-look operations to detect residual cholesteatoma.
Aims: This study aims to dissect the cadaveric temporal bones and to study the frequencies of anatomical variations in the retrotympanum.
Methods: This is a descriptive anatomical study that was done in our hospital for 18 months between 1st November 2018 and 30th April 2020. 20 fresh cadaveric adult wet temporal bones were harvested, dissected and the frequencies of the structural components were noted.
Results: The pyramid was consistently present in 100%, subpyramidal space in 90%, posterior tympanic sinus in 100%, ponticulus in 85%, subiculum in 90% and Sinus tympani was present in 100% bones.
Discussion: The retrotympanum houses many significant structures with highly complex and variable anatomy due to which this region often cannot be completely visualized during microscopic ear surgery and has an important clinical significance.
Conclusion: Every ear surgeon must be aware of the endoscopic anatomy of the retrotympanum and its variations and should use endoscopes wherever required during ear surgery to clear disease from the retrotympanum.

Keywords: Retrotympanum, Endoscopy, Middle ear

Introduction

The retrotympanum is a complex structure consisting of different spaces lying in the posterior wall of the tympanic cavity. The retrotympanum is divided into the superior retrotympanum and the inferior retrotympanum by a bony crest termed the subiculum. We can identify four spaces in the superior retrotympanum: two spaces lying medial and anterior, and two spaces lying lateral and posterior to the third portion of the facial nerve and the pyramidal eminence. The pyramidal eminence is the fulcrum of the retrotympanum, separating the facial recess superiorly and the lateral tympanic sinus inferiorly. The ponticulus extending inward and transversally to the promontory region divides the space medial to pyramid into sinus tympani (ST) inferiorly and the posterior tympanic sinus (PTS) superiorly. (1)

The use of the endoscope for the removal of cholesteatoma matrix from the retrotympanum led to a decrease in cholesteatoma recidivism. Endoscopes were also used during second-look operations to detect residual cholesteatoma. (2)

Marchioni et al, in a landmark article described the endoscopic anatomy of the middle ear which was published in the Indian Journal of Otolaryngology and Head and Neck Surgery in 2011. They performed 40 transcanal otoendoscopic approaches to the sinus tympani in patients who were affected by cholesteatoma in this area. The otoendoscope was introduced into the middle ear in order to view and enable the removal of pathology from this area. (3) They described the sinus tympani and classified it into 4 types: Classical shape: When the sinus is located between the ponticulus and the subiculum lying medial to the facial nerve and the pyramidal process, Confluent shape: When an incomplete ponticulus is present and the sinus tympani is confluent with the posterior tympanic sinus, Partitioned shape: When a ridge of bone extends from the third portion of the facial nerve to the promontory is present, separating the sinus tympani into two portions a superior and an inferior, and Restricted shape: When a high jugular bulb is present thus reducing the inferior extension of the sinus tympani. (3)

A few other spaces in the retrotympanum were discussed by the authors. Pneumatization of the retrotympanum may extend to a variable degree into a recess under the pyramid. They named this space as the subpyramidal space (SS). This space is limited laterally by the medial aspect of the pyramidal process, medially by the lateral wall of the tympanum, inferiorly by the ponticulus and posteriorly and superiorly by the Fallopian canal, and it could be in direct anatomical continuity with the ST or with the PTS, depending on the position of the ponticulus. This description has helped surgeons to identify and define the anatomy of the retrotympanum. (4)

Aims: This study aims to dissect the cadaveric temporal bones and to study the frequencies of anatomical variations in the retrotympanum.

Materials and Methods

This is a descriptive anatomical study that was done in our hospital for 18 months between 1st November 2018 and 30th April 2020. Consent for this study was obtained by the Institutional Ethical Committee. 20 fresh cadaveric adult wet temporal bones were harvested. Each bone was mounted in a temporal bone holder in surgical position (Figure 1). Standard microsurgical instruments used in ear surgery, hand piece, micromotor, various burrs and zero degree rigid endoscope were arranged for dissection (Figure 2).

Figure 1: Right temporal bone mounted in Temporal bone holder

Figure 2: Instruments used in the study

The skin of the bony canal and tympanic membrane was completely excised. A wide canaloplasty done and incudo-stapedial joint was disarticulated. The chorda tympani nerve was sacrificed. The malleus and the incus were removed. This provides a good access to visualise and study the retrotympanum. Next a zero-degree rigid endoscope was introduced and the anatomy of the retrotympanum was studied in detail according to the structured proforma. The proforma included detailed examination of the structures in retrotympanum including pyramid, subpyramidal space,

posterior tympanic sinus, ponticulus, subiculum, sinus tympani, finiculus, and subtympanic sinus. The frequencies of abnormalities in these structures were recorded and tabulated.

Statistical technique

The anatomy of the retrotympanum, its various morphologies and its variations in twenty temporal bones were studied and described. The presence/absence of each structure and its morphology with respect to sample size (in percentage) were studied.

This study excluded Paediatric temporal bones, bones on which prior temporal bone surgery has been performed and bones with the temporal bone trauma were not harvested.

RESULTS

In the present study 20 fresh cadaveric temporal bones were dissected to study the endoscopic anatomy of the retrotympanum. Majority of the temporal bones in our study were from right side (70%). In the present study, the pyramid was consistently present in all the 20 bones (100%) (Figure 1). The presence of the subpyramidal space in 18 bones (90%). The presence of the posterior tympanic sinus in all the 20 bones (100%). In the present study, the ponticulus was present in 17 bones (85%). In the present study, subiculum was present in 18 bones (90%). Sinus tympani was present in all the 20 bones (100%) (Figure 2).

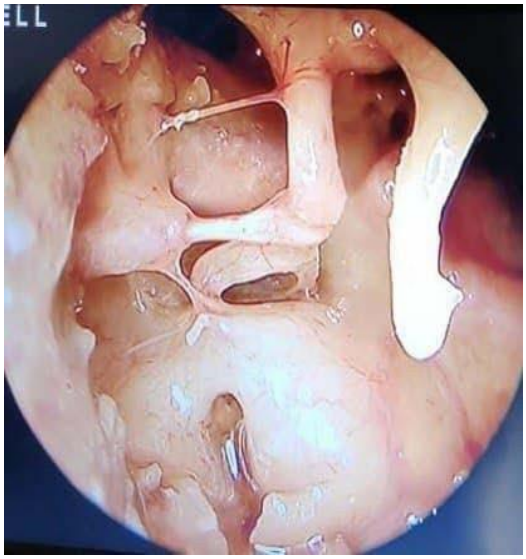


Figure 1: Pyramid

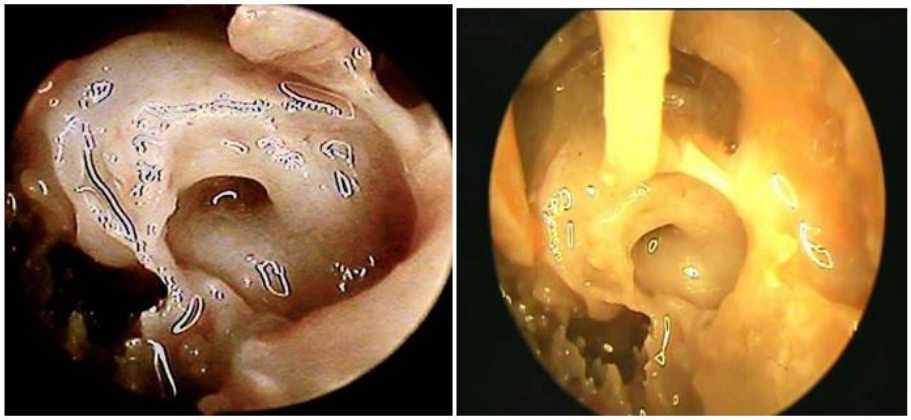
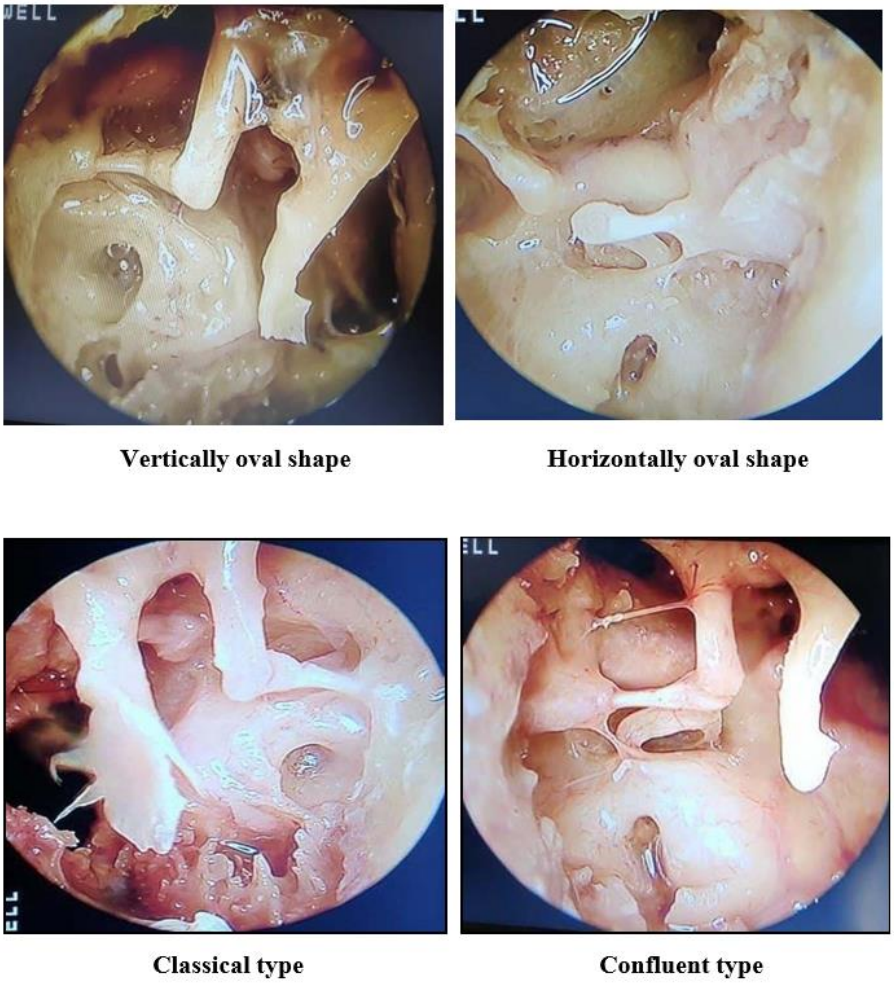


Figure 2 showing Subtympanic sinus in the cadaveric bone



Vertically oval shape | Horizontally oval shape

Classical type | Confluent type

Figure 3 showing shapes of Sinus tympani observed

Table 1: Shapes of the sinus tympani observed

Shape	Frequency	Valid percent
Vertically oval	17	85
Horizontally oval	3	15
Round	0	0
Polygonal	0	0

In the present study, the frequencies of shapes of sinus tympani were studied. Majority of the sinus tympani (17/20) were found to be vertically oval in shape (85%). Horizontally oval shape sinus tympani were found in 3 bones (15%). We did not find any sinus tympani with round and polygonal shapes (0%) (Figure 3).

Among 20 bones, finiculus was present in 19 bones (95%) in the present study. Among 20 bones, subtympanic sinus was present in 20 bones (100%) in the present study.

DISCUSSION

The posterior wall of the middle ear also called retrotympanum, contains many pockets of varying depths, dimensions and morphology which harbors diseased tissue like cholesteatoma and granulations in patients with chronic suppurative otitis media. (1)

The retrotympanum houses many significant structures with highly complex and variable anatomy due to which this region often cannot be completely visualized during microscopic ear surgery and has an important clinical significance with respect to the management of cholesteatoma in this

location. Inadequate clearance of disease from these areas by the surgeon because of the complex and variable anatomy and relative inaccessibility will lead to surgical failure and poor patient outcomes. (5)

Thorough knowledge of endoscopic anatomy is essential for complete clearance of disease from this area leading to good surgical results and to minimize the conditions like cholesteatoma recidivism or recurrence. Endoscopy gives wider and clearer view of the retrotympanic anatomy and also allows to understand middle ear physiology and ventilation pathways better. Hence this study is being performed to better understand the intricate, difficult and complex anatomy of the retrotympanum and to study the frequencies of variations in the various in the variations structures of the retrotympanum.(6)

The hub of retrotympanum is the pyramid which is an important anatomical structure, representing the fulcrum of the retrotympanum. In our study, the pyramid was present in all the 20 bones. This is in concordance with the study done by Cheita AC et al,(7) which showed the presence of pyramidal eminence in all the cases. The study done by Ciuchi V (8) and Parlier-Cuau C et al(9) also showed the presence of pyramidal eminence in 100% of their cases. In the study done by Marchioni D et al,(10) pyramid was visualised in all 15 subjects.

Marchioni D et al in their anatomical study first identified and defined subpyramidal space and showed its presence in 12/15 subjects. In the present study, subpyramidal space was present in 18/20 bones. (10)

In our study, posterior tympanic sinus was found in all the 20 bones (100%). The study done by Cheita AC et al(7), posterior tympanic sinus was found in 24/37 temporal bone specimens Holt JJ[10] noted the presence of posterior tympanic sinus in 47/51 cases (92%). The presence of the posterior tympanic sinus was reported by Parlier-Cuau C et al (9) in 38% cases in their study.

In our study, the ponticulus was present in 17 bones (85%). bones (24%). In case of Nitek et al's(11) study, the ponticulus was present in 66% of bones. Subiculum was visualized in 18/20 bones (90%) in our study. Cheita AC et al (7), in their study, found the presence of subiculum in 28/37 temporal bone specimens. Parlier-Cuau C et al (9) visualised subiculum in 57% of bones in their study. Subiculum was completely absent in 18% out of 50 cases observed by Maru N.(45)

Sinus tympani is known for its marked variation in its shape, size and its type. Meckel (13) was the first one to describe sinus tympani in 1820. Surgical significance of the sinus tympani was recognized by Steinbrugge in 1879 (14). In our study sinus tympani was present in all the temporal bones (100%). In our study, shape of sinus tympani was observed. 17/20 (85%) showed vertically oval and 3/20 (15%) showed horizontally oval sinus tympani. Round shaped and polygonal shaped sinus tympani was not observed in any of the cases in our study. Nitek S et al (11) dissected 30 temporal bones from adult cadavers and the morphological study of tympanic sinus was done. The study showed that the majority of the cases had vertically oval sinus tympani (47%). They found only one case of horizontally oval shape (3%). Frequency of round and polygonal shape was found in equal number of cases (23%). Sinus tympani was absent in 1 out of 30 cases. (11)

Finiculus represents the ideal limit between the inferior retrotympanum and hypotympanum and there is limited literature with respect to the study of finiculus. Marchioni D et al (15), in their study of Inferior retrotympanum revisited identified a ridge of bone connecting the basal helix of cochlea to the jugular wall of tympanum, in relation to the anterior pillar of the round window niche and renamed it as finiculus which was called by Proctor (16) as 'Sustentaculum promontory'. Finiculus was present in 14/25 subjects. In the present study, finiculus was present in 19 out of 20 bones (95%).

Marchioni D et al identified a well-delimited space between the subiculum superiorly and posteriorly and the finiculus inferiorly and anteriorly, limited posteriorly and laterally by the styloid eminence and posteriorly and medially by otic capsule, and open anteriorly and medially to the round window niche and called this space as the sinus subtympanicus. Subtympanic sinus was present in all the bones in our study (100%). In a study done by Marchioni D et al, well defined sub tympanic sinus was found in 46/65 cases (70%). (15)

The term Residual cholesteatoma is used when the ear surgeon deliberately or inadvertently leaves behind matrix in the middle ear or mastoid. Poor access and exposure is the major reason for residual disease due to complex and highly variable anatomy of the retrotympanum. Yung studied the use of the rigid endoscope in cholesteatoma surgery and concluded that the endoscope provided more control over the pathology in difficult to visualise areas like retrotympanum. (17)

CONCLUSION

A complete and detailed knowledge of anatomy of the middle ear is required to achieve good results in tympanoplasty. The retrotympanum houses various structures which are relatively inaccessible and not normally visualised under microscope, which when left behind (residual disease) leads to poor surgical results.

Every ear surgeon must be aware of the endoscopic anatomy of the retrotympanum and its variations and should use endoscopes wherever required during ear surgery to clear disease from the retrotympanum.

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