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RESEARCH ARTICLE
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THE MORPHOLOGICAL STUDY ON THE ENDOSCOPIC ANATOMY OF RETROTYMPANUM ON CADAVERIC BONES

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Abstract

The anatomy of the retrotympanum is highly complex and variable. Thorough knowledge of endoscopic anatomy is essential for complete clearance of disease from this area leading to good surgical results. The anatomical study with clinical implications aims to study the anatomy of retrotympanum in cadaveric temporal bones.

Aims: This study aims to analyse the surgical anatomy of the retrotympanum in human cadaveric temporal bones.

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: In the present study, 56% showed the confluence of the subpyramidal space with the posterior tympanic sinus and 6% showed its confluence with sinus tympani. 22% showed the subpyramidal space being confluent with both posterior tympanic sinus and sinus tympani. 50% had A type, 40% were of type B, 10% had type C sinus tympani.

Discussion: Endoscopic exploration of the middle ear might guarantee a very good exposure of these structures, allowing detailed anatomic descriptions of these hidden areas that cannot be completely visualized with a microscope

Conclusion: The thorough knowledge of the surgical anatomy of the retrotympanum is a basic prerequisite for complete eradication of disease from the retrotympanum and decrease the incidence of surgical failure or recidivism.

Keywords: Retrotympanum, anatomic variations, Endoscopy

Introduction

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. The anatomy of the retrotympanum is highly complex and variable. Thorough knowledge of endoscopic anatomy is essential for complete clearance of disease from this area leading to good surgical results. (1)

Chronic suppurative otitis media (CSOM) is a common disease seen in our country and other developing countries. This disease irreversibly damages the tympanic membrane, middle ear mucosa and ossicles resulting in hearing loss and troublesome otorrhea to the patient. Besides these symptoms, the infection may also spread to surrounding structures leading to extracranial and intracranial complications which may be life threatening. Hence it is essential for the ear surgeon to be able to manage this disease effectively through conservative and surgical means. (2)

CSOM is classified into 2 types, mucosal and squamous epithelial. In the mucosal variety, the disease is mainly limited to the mucoperiosteum of the middle ear cleft. The incidence of complications is less in the mucosal type, whereas in the squamous variant, the epithelium is found in the middle ear and mastoid which leads to the formation of cholesteatoma, which has bone eroding properties leading to a high incidence of extracranial and intracranial complications. (3)

Surgical treatment is the mainstay in the management of cholesteatoma. The cholesteatoma must be completely excised from the middle ear and mastoid to provide a dry ear to the patient which may not be possible in all patients because of difficult anatomical situations in the middle ear. (4)

This pathology mainly involves the spaces present in the posterior wall of the middle ear (retrotympanum), attic and mastoid. Surgery is the mainstay of treatment in these patients. Inadequate clearance of disease from these areas by the surgeon because of the complex and variable anatomy will lead to surgical failure and poor patient outcomes. (5)

Hence this study is being performed to understand the intricate, difficult and complex anatomy of the retrotympanum. It may be difficult to excise cholesteatoma matrix from deep and relatively inaccessible areas like the sinus tympani. Matrix tightly adherent to the stapes and facial nerve should also be left behind. These situations will lead to cholesteatoma recidivism and hence the surgical failure. The anatomical study with clinical implications aims to study the anatomy of retrotympanum in cadaveric temporal bones.

Aims: This study aims to analyse the surgical anatomy of the retrotympanum in human cadaveric temporal bones.

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. In our study, out of 20 bones, 14 (70%) of the bones were from the right side and the other 6 (30%) were from the left side. In the present study, 10 bones (56%) showed the confluence of the subpyramidal space with the posterior tympanic sinus and 1 bone (6%) showed its confluence with sinus tympani. 4 bones (22%) showed the subpyramidal space being confluent with both posterior tympanic sinus and sinus tympani. Subpyramidal space was not confluent with either posterior tympanic sinus nor sinus tympani in 3 bones (16%) (Table 1) (Figure 1).

Table 1: Morphology of the subpyramidal space in the retrotympanum

Subpyramidal space	Confluent with posterior tympanic sinus	Confluent with sinus tympani	Confluent with both posterior tympanic sinus and sinus tympani	Not confluent with either posterior tympanic sinus or sinus tympani
Frequency	10	1	4	3
Percentage	56	6	22	16

Table 2: Morphology of posterior tympanic sinus in the retrotympanum

Posterior tympanic sinus	Confluent with subpyramidal space	Confluent with sinus tympani	Confluent with both subpyramidal space and sinus tympani	Not confluent with either subpyramidal space or sinus tympani
Frequency	9	0	6	5
Percentage	45	0	30	25

Out of 20 bones, 9 bones (45%) showed the confluence of posterior tympanic sinus with subpyramidal space. 6 bones (30%) showed posterior tympanic sinus being confluent with both subpyramidal space and sinus tympani. 5 bones (25%) were not confluent with either subpyramidal space nor sinus tympani (Table 2) (Figure 2).

Table 3: Morphology of ponticulus in the retrotympanum

Ponticulus	Classical type	Incomplete type	Communicating type
Frequency	13	0	4
Percentage	76	0	24

Out of 17 bones, ponticulus was found to be classical type in 13 bones (76%), communicating type in 4 bones (24%). None of the bones showed incomplete type of ponticulus (0%). Ponticulus was absent in 3 bones (15%) (Table 3) (Figure 3). The present study showed subiculum in 18 bones (90%). Out of which, 17(94%) were found to be complete type and 1 (6%) was found to be bridge type. Subiculum was absent in 2 bones (10%) (Table 4).

Table 4: Morphology of subiculum in the retrotympanum

Subiculum	Complete type	Bridge type
Frequency	17	1
Percentage	94	6

Among the 20 bones, 10 bones (50%) had A type of sinus tympani. 8 cases (40%) were of type B. 2 bones (10%) had type C sinus tympani. None of the bones belonged to D type of sinus tympani (0%) (Table 5). In the present study, out of 19 bones, 2 bones (11%) showed bridge type of finiculus and 17/20 bones (89%) showed ridge type of finiculus (Figure 4). Finiculus was absent in 1 bone (5%).

Table 5: Types of sinus tympani observed

Type	Frequency	Valid percent
A	10	50
B	8	40
C	2	10
D	0	0

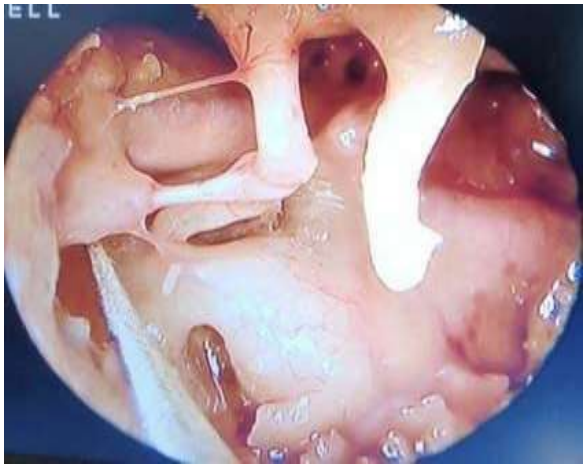


Figure 1: Subpyramidal space showing confluence with the posterior tympanic sinus and the sinus tympani

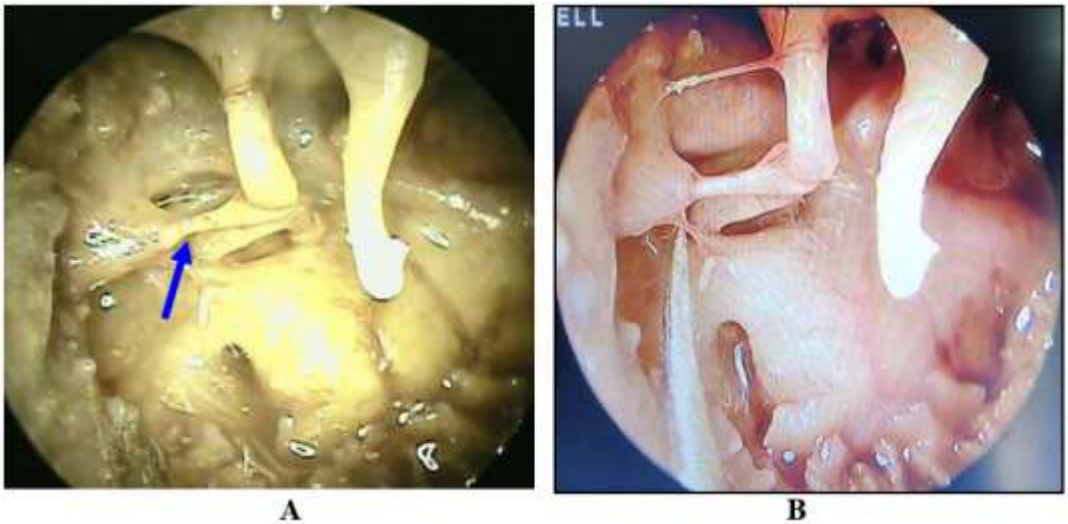
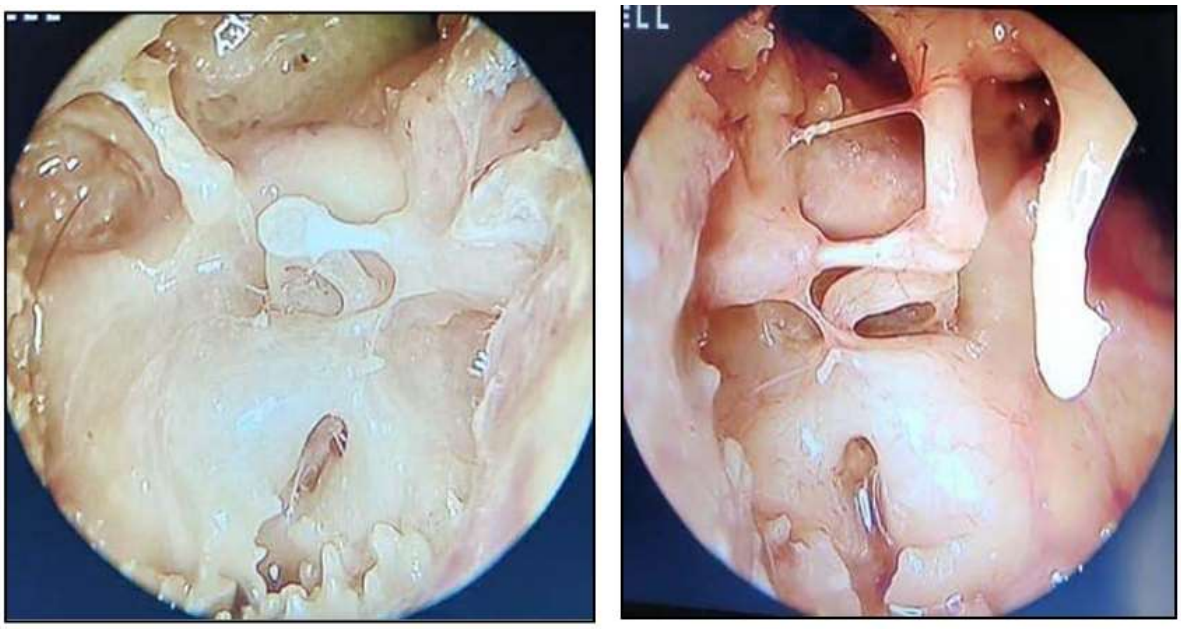
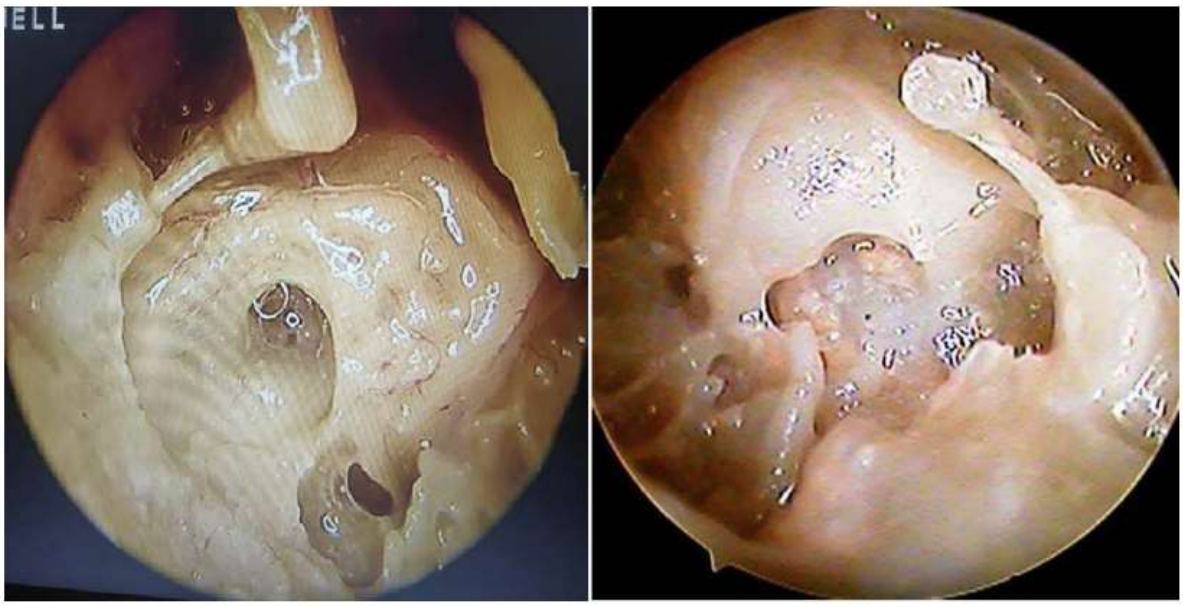


Figure 2: A – Posterior tympanic sinus (blue arrow), B – Posterior tympanic sinus showing confluence with subpyramidal space and sinus tympani



Classical type **Communicating type**

Figure 3 showing Morphological variations of ponticulus



Ridge type **Bridge type**

Figure 4: showing morphological variations of Finiculus

DISCUSSION

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 structures of the retrotympanum. (1)

Endoscopic exploration of the middle ear might guarantee a very good exposure of these structures, allowing detailed anatomic descriptions of these hidden areas that cannot be completely visualized

with a microscope. Improvement in our knowledge of its anatomy might decrease the possibility of residual disease during cholesteatoma surgery. (6)

Marchioni D et al (7) in their anatomical study first identified and defined subpyramidal space and showed its presence in 12/15 subjects. Out of 18 bones, 10 bones (56%) showed the confluence of the subpyramidal space with the posterior tympanic sinus and 1 bone (6%) showed its confluence with sinus tympani. 4 bones (22%) showed the subpyramidal space being confluent with both posterior tympanic sinus and sinus tympani. Subpyramidal space was found to be not confluent with either posterior tympanic sinus or sinus tympani in 3 bones (16%). The anatomy of this space is highly variable and related to the depth of the sinus tympani and ponticulus. Because it is a hidden space it could be a possible site for residual disease.

Out of 20 bones, 9 bones (45%) showed the confluence of posterior tympanic sinus with subpyramidal space. 6 bones (30%) showed posterior tympanic sinus being confluent with both subpyramidal space and sinus tympani under the ponticulus. The study done by Cheita AC et al, (8) posterior tympanic sinus was found in 24/37 temporal bone specimens and it was found to be confluent with sinus tympani in 10 (41%) cases which is slightly higher when compared to our study. Holt JJ (9) noted the presence of posterior tympanic sinus in 47/51 cases (92%). His study showed confluence of posterior tympanic sinus with sinus tympani in 4/51 cases (8%) and non-confluent in remaining 47 cases. The presence of the posterior tympanic sinus was reported by Parlier-Cuau C et al,(10) in 38% cases in their study.

In our study, the ponticulus was present in 17 bones (85%). In these 17 bones, it was found to be classical type in 13 bones (76%) and communicating type in 4 bones (24%). In case of Nitek et al's (13) study, the ponticulus was present in 66% of bones, 14% bones had partially formed type and 20% did not have a ponticulus at all. Holt JJ et al, (10) in their study showed the complete formation of ponticulus in 33 out of 50 specimens. Ponticulus was incomplete in 7/50 specimens and was absent in 10/50 specimens.

According to Marchioni et al (7) who performed an endoscopic study of the recesses of the posterior wall of the middle ear. They identified four types of sinus tympani: A Type: Classical shape, B Type: Confluent shape, C Type: Partitioned type and D Type: Restricted type. In our dissections, we observed classical type sinus tympani in majority of the bones (50%). Confluent and partitioned type were found in 40% and 10% of bones, respectively. We did not find restricted type of sinus tympani in any of the bones (0%).

Marchioni et al, (7) in their transcanal endoscopic approach to the sinus tympani, explained that in 38 of the 40 patients they studied, sinus tympani could be identified well. A & B types of sinus tympani was present in 35. In these cases, exposure was good. Whereas in 3 patients of Type C, it was not possible to explore the sinus tympani completely.

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,(11) in their study stated that 12/14 presents as a ridge of bone and 2/14 presents as a bridge of bone. 17 out of 19 bones presented as a ridge variety and 2 were of bridge variety.

CONCLUSION

Cadaveric dissections and endoscopic study of the retrotympanum revealed a high variability in spaces and structures. Our study included structures like sub pyramidal space, posterior tympanic sinus, finiculus, subtympanic sinus which are neglected in literature and showed high variability in their morphology and types. We conclude that thorough knowledge of the surgical anatomy of the retrotympanum is a basic prerequisite for complete eradication of disease from the retrotympanum and decrease the incidence of surgical failure or recidivism.

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