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Tympanosclerosis – Prevalence, Clinical Presentation, And Varied Post-Op Outcomes At A Rural Tertiary Care Centre

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1. INTRODUCTION

Tympanosclerosis is a chronic pathological condition of the middle ear characterized by hyalinization and subsequent calcification of the tympanic membrane and middle ear mucosa. It is commonly associated with recurrent otitis media, persistent eustachian tube dysfunction, or prior otologic surgeries such as tympanostomy tube insertion.

The underlying process involves chronic inflammation leading to fibroblast proliferation, collagen deposition, and plaque formation. These calcified plaques reduce the mobility of the tympanic membrane and ossicles, resulting in a conductive hearing loss that ranges from mild in localized cases to severe when ossicular fixation is present. While most patients present with hearing loss, some may report tinnitus or ear fullness; vertigo and pain are typically absent unless coexisting pathology exists.

In rural healthcare settings, the management of tympanosclerosis poses significant challenges. Limited access to early diagnosis, specialized surgical care, and advanced prosthetic materials often results in delayed presentations with extensive disease and suboptimal surgical outcomes. The definitive management of tympanosclerosis entails meticulous excision of sclerotic plaques from the middle ear, epitympanum, ossicular chain (including surrounding areas), posterior tympanic sinus, retro tympanum, facial shelf, and mastoid. Optimal surgical outcomes are closely linked to the restoration of ossicular chain mobility, which is achieved through comprehensive clearance of these plaques from all involved anatomical sites.. Incomplete plaque removal and ossicular fixation may limit postoperative hearing gains. There is a higher incidence in these areas due to frequent upper respiratory infections and limited healthcare infrastructure. Future strategies should prioritize early detection through community outreach, enhanced training of otologic surgeons in peripheral centers, and development of cost-effective, adaptable surgical approaches for resource-limited environments

2. MATERIALS AND METHODS

All patients of age 10-80years who were diagnosed with chronic otitis media in our department at R L Jalappa Hopsital who have undergone mastoidectomy surgeries from December 2019-December 2024 were retrospectively analysed.

The clinical details, pure-tone audiometry, radiological, surgical and histopathology details of the 549 patients diagnosed with chronic otitis media were documented from the medical records section.

The patients with incomplete or missing medical records data and patients diagnosed with hearing loss due to other causes or with congenital abnormalities and sensorineural hearing loss were excluded from the study.

An institutional ethics committee clearance was obtained for this study (SDUAHER/KLR/R&D/CEC/S/ PG/ 98 /2024-25).

Results were tabulated, a simple descriptive analysis was done using the Statistical Package Social Sciences (SPSS) software 22, and the results obtained are represented as percentages and presented in tables

leaves of *Lawsonia inermis* (Henna) were collected from a verified local source in Kota, Rajasthan, during the early flowering

3. RESULTS

Among the 549 patients who underwent mastoidectomy for chronic otitis media (COM) at R.L. Jalappa Hospital between December 2019 and December 2024, 126 patients (22.95%) were diagnosed with tympanosclerosis during surgery,as described in table 1 the condition was more frequently observed in individuals between 20 and 60 years of age. A slight male predominance was noted, with 72 male patients (57.14%) and 54 female patients (42.85%), as described in table 2.

Table 1: Age Distribution of Patients with Tympanosclerosis

Age Group (Years)	Number of Patients (%)
<20	12 (9.5%)
20–40	47 (37.3%)
41–60	52 (41.2%)
>60	15 (11.9%)

Table 2: Sex Distribution of Patients

Sex	Number of Patients (%)
Male	72 (57.1%)
Female	54 (42.9%)

Hearing loss emerged as the most frequent presenting complaint, that we observed 105 out of 126 patients (83%). Tinnitus was noted in 53 patients (42%), while 34 patients (27%) experienced intermittent or persistent otorrhea as described in table 3.

Table 3: Presenting Complaints

Symptom	Number of Patients (%)
Hearing loss	105 (83%)
Tinnitus	53 (42%)
Otorrhea	34 (27%)

Otoscopic examination revealed tympanic membrane perforations in the majority of cases. Specifically, large central perforations were observed in 59 patients (46.7%), subtotal perforations in 42 patients (33.3%), and marginal perforations in 2 patients (1.6%).

The remaining 23 patients (18.4%) had an intact tympanic membrane, with visible signs of myringosclerosis, often presenting as chalky white plaques or areas of calcification as described in table 4.

Table 4: Type of Tympanic Membrane Perforation

Type of Perforation	Number of Patients (%)
Large central	59 (46.7%)
Subtotal	42 (33.3%)
Marginal	2 (1.6%)
Intact TM with myringosclerosis	23 (18.4%)

In pure tone audiometry for the 25 patients (19.8%) that had tympanosclerosis confined to the tympanic membrane (myringosclerosis), In all these cases, the air-bone gap (AB gap) was less than 40 dB.

101 patients (80.2%) had involvement of the middle ear structures in addition to the tympanic membrane. Among these, 77 patients (76.2%) had an AB gap greater than 40 dB, while 24 patients (23.8%) had an AB gap between 20–40 dB. No cases with middle ear involvement had an AB gap less than 20 dB. Analysis of the type and size of tympanic membrane perforation showed no significant correlation with the degree of hearing loss. Patients with small, large, central, or subtotal perforations demonstrated a wide range of AB gaps. as described in table 5

Table 5: Correlation of AB Gap with Tympanosclerosis Involvement

Site of Involvement	AB Gap <20 dB	AB Gap 20–40 dB	AB Gap >40 dB
Tympanic membrane only (25)	0	25	0
Middle ear + TM (101)	0	24	77

Of the 126 ears operated, preoperative HRCT was suggestive of ossicular chain fixations in 90 cases (71.42%).

Intraoperatively tympanosclerosis with ossicular fixation was found in 102 patients , where incudomalleal fixation was seen in 54 patients, stapes fixation in 39 patients and all ossicles fixed in 9 patients. 18 cases also showed extension into attic, epitympanum, promontory, round window, facial shelf, Eustachian tube, sinus tympani, hypotympanum, and retrotympanum as described in table 6

Table 6: Ossicular Chain Involvement

Type of Fixation	Number of Patients
Incudomalleal fixation	54
Stapes fixation	39
All ossicles fixed	9

In our study, surgical management was tailored according to the intraoperative findings and extent of tympanosclerotic involvement. The most frequently performed procedure was cortical mastoidectomy with ossiculoplasty in 103 patients, particularly in cases where ossicular chain involvement was evident. In more extensive disease, canal wall down mastoidectomy with tympanoplasty was required, accounting for 23 patients. In a subset of patients where middle ear conditions were unfavorable during the initial surgery second-stage ossiculoplasty was planned and subsequently performed

in 9 patients as described in table 7

Table 7: Surgical Procedures Performed

Procedure	Number of Patients
Cortical mastoidectomy with ossiculoplasty	103
Canal wall down mastoidectomy with tympanoplasty	23
Second-stage ossiculoplasty (planned)	9

n one patient on elevating the tympanomeatal flap a bone like structure was seen obscuring the entire middle ear, in high resolution computed topography of temporal bone we had clearly visualized the head of the malleus, prompting careful drilling of the obstructing bone. The ossicles were meticulously drilled out from within this bone like mass without dislocating them, their mobility assessed and preserved. The tympanomeatal flap was repositioned, and a tympanic membrane graft was placed. Notably, only the ossicles were drilled free, while the remaining bony mass was left undisturbed.

Table 8: Postoperative Outcomes

Outcome	Number of Patients / Description
AB gap closure (significant)	85.5% (approx. 108 patients)
Graft uptake at 6 months	100%
Transient vertigo	6
Taste disturbances	10
Post-op tinnitus	9

In one patient, extensive tympanosclerosis was noted intraoperatively, with plaques obscuring the stapes footplate, the fascial canal, fascial shelf, round window niche, attic, retrotympanum and extending into the oval window niche. Upon meticulous removal of the sclerotic plaques, the stapes suprastructure was found to be necrosed, indicating significant ossicular chain involvement and likely long-standing disease.

Figure 1-tympansclerosis seen in the middle ear

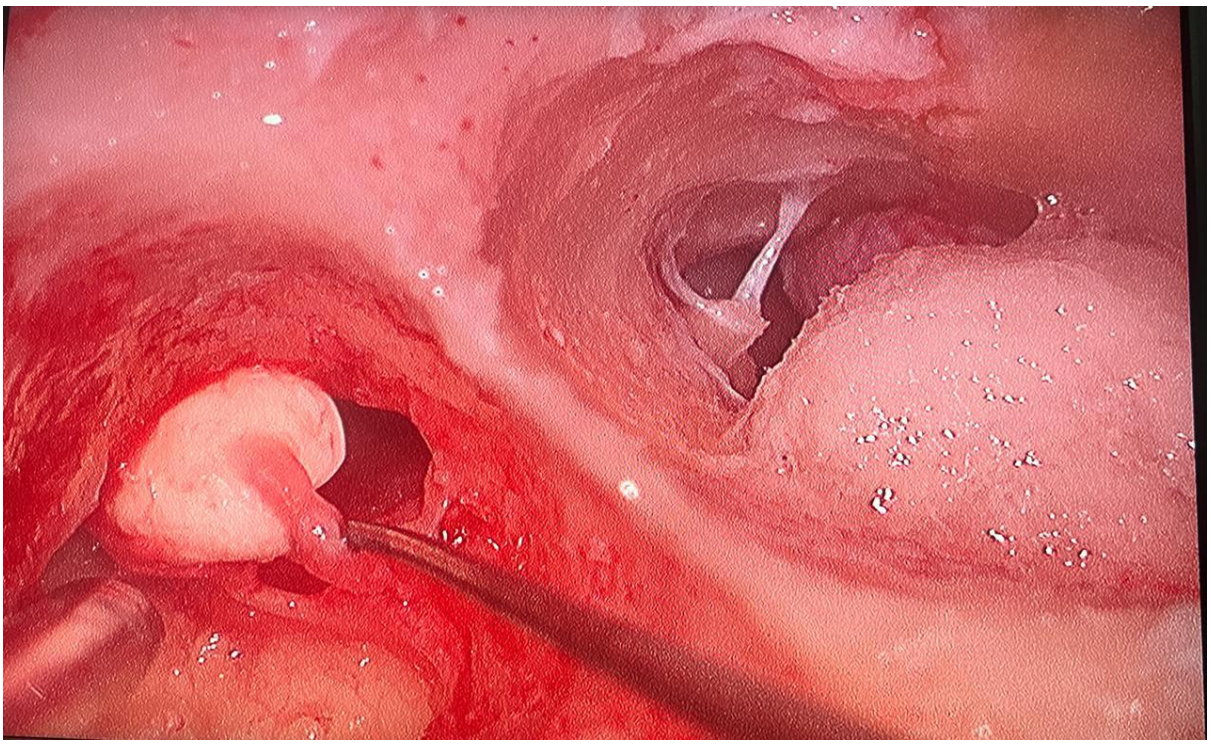

Figure 2-tympanosclerotic plaque removed from antrum

In another patient, tympanosclerosis was found to involve the round window membrane, a relatively rare site. This involvement can have implications for inner ear compliance and hearing outcomes postoperatively. Additionally, there was fixation of the incudomalleal joint, contributing to a more complex ossicular chain dysfunction. These findings highlight the variable extent of tympanosclerosis disease and the importance of thorough intraoperative assessment.

In one patient, a retraction pocket in the posterior superior quadrant was observed intraoperatively, associated with a cholesteatoma. Additionally, dense tympanosclerotic plaques were noted over the facial shelf promontory and retrotympanum, complicating disease clearance and necessitating a meticulous surgical approach to preserve inner ear and neurovascular structures.

One 17-year-old female who presented with a tympanic membrane perforation and conductive hearing loss. Intraoperatively, during mastoidectomy, it was observed that the mastoid antrum was not patent, raising suspicion for an obstructive pathology.

On further exploration, dense tympanosclerotic bone was found lodged within the antrum, acting as a mechanical block to ventilation and drainage. After careful removal of this sclerotic material, antral patency was successfully restored.

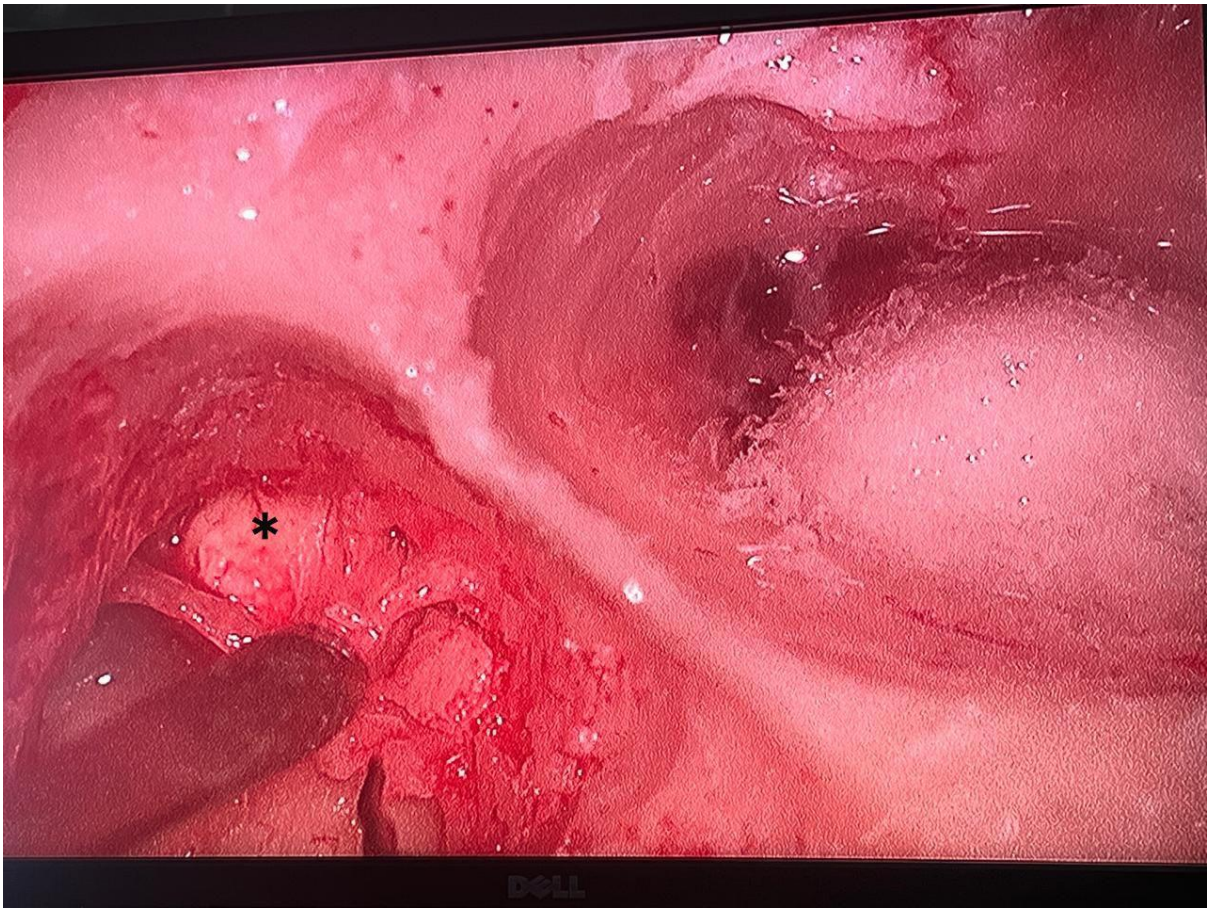

Figure3 -sclerotic bone seen in antrum which is blocking the antral patency

All patients were followed up for a period of 1 year, every two weeks for the first month, once in every month for 6 months and every 2 months for next 6 months. The patients had post operative pure tone audiometry after three months and showed 85.5% of patients with significant hearing improvement with an average of 40dB **reduction** in the air borne gap. Our study showed 100% of graft success rate at six-months follow-up. Post operatively 6 patients had transient vertigo,10 patients had taste disturbances and 9 patients had tinnitus in the follow up period and was treated conservatively.

4. DISCUSSION

Tympanosclerosis, according to Schuknecht (1974), is the thickening and fusing of collagenous fibers into a uniform mass, followed by the eventual deposition of sporadic intracellular and extracellular crystals of phosphate and calcium (Austin, 1988). These masses could be large, filling the middle ear or encircling the ossicles, or they could be isolated deposits in the tympanic membrane. According to Austin (1988), tympanosclerosis that requires direct surgical excision in order to improve hearing is considered clinically severe. In addition to creating a significant barrier to sound transmission, large masses of tympanosclerosis may also have an impact on the likelihood of a positive post-operative hearing outcome.

Tympanosclerosis (TS) remains a complex sequela of chronic otitis media, often involving extensive pathological changes that extend beyond the tympanic membrane into multiple middle ear compartments. In our study, the incidence of TS was 22.95%, consistent with previously reported rates ranging from 7% to 33% . This incidence reflects meticulous intraoperative evaluation and the inclusion of both myringosclerosis and middle ear involvement cases.

The disease predominantly affected patients between 20 and 60 years of age, reaffirming that TS is a chronic inflammatory process that develops over time due to recurrent or unresolved middle ear infections. The slight male predominance observed mirrors trends noted in other series, though sex distribution remains inconsistent across studies .

Clinically, hearing loss was the most common presenting symptom (83%), with tinnitus and intermittent otorrhea observed less frequently. These findings align with previous reports highlighting that TS is generally a “burnt-out” disease with minimal active infection, as evidenced by the predominance of dry ears in our series and others .

Our detailed otoscopic and audiometric evaluation revealed that while 19.8% of patients had TS confined to the tympanic membrane (myringosclerosis) with AB gaps less than 40 dB, the majority (80.2%) exhibited middle ear involvement. Within this group, 76.2% had AB gaps exceeding 40 dB, demonstrating that hearing loss severity correlates strongly with the extent of middle ear and ossicular chain involvement. This is consistent with prior studies showing that isolated myringosclerosis minimally affects hearing, whereas ossicular fixation leads to significant conductive deficits

Tympanosclerosis usually appears as high-density foci within the tympanic membrane or middle ear cavity. When the middle ear is involved, findings include high-density foci or calcifications on the surface of the ossicles, thickening of the stapes crura and footplate, thickening and increased density of suspensory ligaments and muscle tendons. New bone formation is often considered to fall within the spectrum of tympanosclerosis.

Intratympanic tympanosclerosis can manifest by diffuse calcifications throughout the tympanic cavity and its recesses or even calcified block formations with narrowing of the lumen of the cavity.

Analysis of the ossicular chain for possible tympanoscleosis involvement was performed on several consecutive axial cuts in the caudo-cranial direction. Coronal reconstruction allows analysis primarily of the attic fixation.

Tympanosclerosis of incudo-malleal complex be variable condensation encases the incudo-malleal complex and fixing it to the tegmen, lateral, medial, and/or anterior attic wall.

Tympanosclerosis of the stapedial complex can be seen as a global thickening of the crura and the footplate , or with apposition of calcified material on the footplate or by a diffuse obliteration of the oval niche with sclerotic material, or by calcified stapedial tendon , all are highly suggestive of tympanosclerosis.

The anatomical distribution of TS in our study was extensive and multifocal. Beyond the tympanic membrane, plaques and sclerosis involved the promontory, facial canal and shelf, retrotympanum, hypotympanum, attic, Eustachian tube, round and oval windows. This widespread involvement necessitated comprehensive preoperative planning with HRCT imaging, which was suggestive of ossicular chain fixation in 71.4% of cases. Intraoperatively, ossicular fixation was confirmed in 102 patients, with incudomalleal fixation most common, followed by stapes and combined ossicular fixation.

These findings highlight the complex nature of TS pathology: sequestration of inflammatory debris in the attic and epitympanum leads to persistent chronic inflammation and ossicular ankylosis, particularly at the incudomalleal joint. Extensive sclerosis obliterating spaces such as the retrotympanum and sinus tympani further complicates surgical clearance and hearing restoration. Our results align with Emmett and Shea, who also reported high incidences of ossicular fixation related to attic disease .

The distinction between extensive TS and cholesteatoma was underscored, emphasizing that while both can coexist, cholesteatoma's destructive keratin debris differentiates it from the fibrotic and calcific plaques of TS. Accurate diagnosis is critical, as management strategies differ significantly.

Surgically, our approach was individualized based on the extent and sites of involvement. Most patients underwent cortical mastoidectomy with ossiculoplasty, while canal wall down mastoidectomy was reserved for extensive disease involving critical recesses. Cases with unfavorable intraoperative conditions, particularly those with stapes fixation or mucosal inflammation, underwent planned second-stage ossiculoplasty to reduce complications and optimize hearing outcomes.

Rare intraoperative observations, such as a bone-like mass encompassing the middle ear and round window membrane involvement, highlighted the diverse presentations of TS. These required careful dissection aided by preoperative HRCT to preserve ossicular mobility and avoid inner ear injury.

Postoperative outcomes were encouraging, with 85.5% of patients achieving significant AB gap closure (average 40 dB reduction) and a 100% graft success rate at 6 months. Minor transient complications were managed conservatively, indicating the safety of the surgical protocol.

5. CONCLUSION

In conclusion, our study reaffirms the importance of thorough anatomical assessment and tailored surgical management in tympanosclerosis. Recognition of disease extent—including involvement of and difficult-to-access sites such as the round

window, facial shelf, facial canal, attic, retrotympanum, and oval window—is vital. Combined with staged ossiculoplasty when necessary, this approach facilitates optimal functional recovery and disease clearance.

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