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Original Research Article

A Correlation Study of Preoperative Pure Tone Audiometry Findings of Hearing Loss to Intraoperative Findings in Tubotympanic Type of Chronic Otitis Media

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Abstract:

Introduction: Chronic otitis media (COM) is a prevalent middle ear disease in developing countries, especially in rural India, with a prevalence ranging from 2-15%. COM is characterized by recurrent suppurative discharge and structural abnormalities, such as tympanic membrane perforation and ossicular chain pathologies, leading to mild to moderate conductive hearing loss. Pure tone audiometry (PTA) is a crucial tool for assessing hearing loss, but intraoperative findings remain essential for accurate diagnosis and surgical planning.

Objective: To compare preoperative pure tone audiometry findings with intraoperative findings in tubotympanic chronic otitis media.

Materials & Methods: A cross-sectional study was conducted on 110 patients with tubotympanic chronic otitis media undergoing tympanoplasty at the Department of Otorhinolaryngology, tertiary care hospital, Gujarat. Data were collected on perforation characteristics, ossicular condition, and audiometric assessments.

Results: The mean age of the patients was 29.9 ± 10.87 years, with 70.9% being female. Ear discharge (96.4%) was the most common symptom. Otoscopy detected perforation in 95.8% of cases, while surgery confirmed it in 100%. ll patients exhibited conductive hearing loss, with 48.2% having mild and 48.2% having moderate hearing loss. The air-bone gap and overall hearing loss were significantly greater in larger and posterior perforations. No significant differences in hearing metrics were noted between patients with and without ossicular defects.

Conclusion: Otoscopy and PTA provide valuable initial insights, but intraoperative examination is more comprehensive. The size and site of perforations significantly impact hearing loss, with larger and posterior perforations leading to greater impairment.

Keywords: Chronic Otitis Media, Hearing Impairment, Perforation, Pure Tone Audiometry, Ossicular Chain, Tympanoplasty.

Introduction

Chronic otitis media (COM) is a common middle ear disease in developing countries, particularly in rural India, with prevalence ranging from 2-15% due to factors like poor hygiene, overcrowding, and inadequate healthcare. [1] It is characterized by recurrent suppurative discharge and structural abnormalities, including tympanic membrane perforation, ossicular chain pathologies, tympanosclerosis, and soft tissue issues such as cholesteatoma. [2] COM is classified into tubotympanic (mucosal) and atticoantral (squamosal) types, and it commonly results in mild to moderate conductive hearing loss. [3] The condition causes permanent abnormalities in the pars tensa or pars flaccida, such as atelectasis, perforation, and retraction. [4] Ossicular erosion is a common complication in over 50% of chronic otitis media (COM) cases, particularly in the atticoantral type, leading to significant hearing loss due to failure of middle ear mechanics. [5,6] Ossicular chain dysfunction, including fixation or discontinuity, worsens with the disease duration and can cause up to 60 dB hearing loss. [7,8]

Pure tone audiometry assesses and documents the degree and type of hearing loss, indicating the integrity of the tympano-ossicular system, which

can only be confirmed during surgery. A narrow air-bone gap (ABG) at lower frequencies suggests no ossicular dysfunction, while a wide ABG at higher frequencies indicates ossicular issues. This information aids in preoperative planning and patient counseling regarding the expected surgical outcomes. [9,10] Tympanoplasty, which includes repairing the tympanic membrane and reconstructing the ossicular chain if needed, is the standard treatment for chronic otitis media.

The aim of tympanoplasty for tubotympanic COM extends beyond achieving a dry ear; it also includes improving hearing. Since 40 to 90% of tympanoplasties necessitate ossicular chain reconstruction [11], understanding preoperative hearing status—type and degree of hearing loss—is crucial for effective ossiculoplasty and accurate prognosis. Considering the importance of ossicular chain in reconstruction of transmission mechanism of the middle ear, the present study will be undertaken to compare preoperative pure tone audiometry hearing loss findings with intraopearative findings in tubotympanic chronic otitis media to correlate the PTA findings and associated middle ear pathology to help us better pre operative planning and better pre operative counselling of patients regarding type of surgery required.

Materiasl & Methods

This cross-sectional study was conducted on patients with tubotympanic chronic otitis media (COM) undergoing tympanoplasty surgery at the ENT department of Dr. N. D. Desai Faculty of Medical Science and Research, Dharmsinh Desai University, Nadiad, between January 2024 and June 2024.

Based on prevalence of ossicle erosion among COM patients was 78.8% in the study of Dudda R et al. [12]., the minimum sample size was calculated as 103 using the formula

$$n = \frac{z^2 pq}{L^2}$$

Exclusion criteria comprised patients with attico-antral type of COM, revision cases of tympanoplasty and mastoidectomy, those with extra or intracranial complications of chronic otitis media, traumatic tympanic membrane perforation, otitis externa, sensorineural hearing loss (SNHL), or mixed hearing loss, and otosclerosis.

Total 110 patients aged 18 to 60 years who were diagnosed with tubotympanic type of chronic otitis media, had undergone tympanoplasty surgery, and had pure tone audiometry performed were included through consecutive sampling.

Data was collected using a predesigned questionnaire. Perforations were categorized by site (anterior central, posterior central, central, subtotal, and total) and size (small, medium, large, subtotal, total). Audiometric assessments were performed using a clinical audiometer (Arphi SX-3) calibrated to ISO standards in a soundproof room, with hearing impairment graded per the latest WHO classification. Normal hearing level (0-25 dB), mild (26-40 dB), moderate (41-60 dB), severe (61-80 dB), profound (> 80 dB). The same investigator conducted all audiometric assessments to minimize inter-observer error. Intraoperative findings recorded the characteristics of perforations and the status of middle ear ossicles, including their integrity, mobility, and any defects.

Data were entered in Microsoft Excel 2010 and analyzed with Epi Info version 7.1. Continuous data were presented as mean and standard deviation, while categorical data were presented as frequency and percentage. The Z test compared continuous data, and the Chi-square test compared categorical data. A p-value < 0.05 was deemed significant.

Result

Table 1: Socio-demographic profile and chief complaints in patients with tubotympanic type of chronic otitis media

Characteristics	No. of case	Percentage (%)
Age (Mean ± SD**)**	29.9 ± 10.87	
Minimum to maximum	19 to 57	
Gender		
Female	78	70.9
Male	32	29.1
Chief complaints		
Ear ache	21	19.1
Ear discharge	106	96.4
Decreased hearing	72	65.5
Tinnitus	2	1.8
Vertigo	0	0.0
Headache	0	0.0
Facial weakness	0	0.0

Affected ear		
Left only	46	41.8
Right only	31	28.2
Bilateral	33	30.0

The mean age of the patients was 29.9 ± 10.87 years, with the majority of patients (88, 79.9%) in the 20 to 40 years age group. Female patients constituted 70.9% of the cases. The most common symptom was ear discharge (96.4%), followed by decreased hearing (65.5%) of cases. Other symptoms like earache (19.1%) and tinnitus (1.8%) were less common. The left ear was involved in 41.8% of cases, the right ear in 28.2%, and bilateral involvement was observed in 30.0% of patients. Therefore, total 143 ears were affected in 110 patients.

Table 2: Comparison of Otoscopy and Intraoperative Findings in Tubotympanic Type of Chronic Otitis Media

Findings	**Otoscopy**	**Intra operative findings**
Tympanic membrane		
Perforation	137 (95.8%)	143 (100%)
Retraction	3 (2.1%)	0 (0.0%)
Tympano-sclerosis	1 (0.7%)	15 (10.5%)
Myringosclerosis	0 (0.0%)	8 (5.6%)
Perforation		
Number		
Single	134 (93.7%)	140 (97.9%)
Multiple	3 (2.1%)	3 (2.1%)
Site		
Central	98 (68.5%)	102 (71.3%)
Anterior	21 (14.7%)	22 (15.4%)
Posterior	15 (10.5%)	17 (11.9%)
Anterior & Posterior	3 (2.1%)	2 (1.4%)
Size		
Small	27 (18.9%)	24 (16.8%)
Medium	76 (53.1%)	80 (55.9%)
Large	31 (21.7%)	35 (24.5%)
Sub total	3 (2.1%)	4 (2.8%)
Ossicular erosion	**1 (0.7%)**	**2 (1.4%)**
Malleus, Incus, Stapes	1 (0.7%)	0 (0.0%)
Only incus	0 (0.0%)	**2 (1.4%)**
Mobility		
Yes	NA	141 (98.6%)
No	NA	2 (1.4%)

Tympanic Membrane Condition: Otoscopy detected perforation in 137 (95.8%) patients, while surgery confirmed it in all 143 (100%) cases. Tympano-sclerosis was identified in 1 (0.7%) patient via otoscopy, compared to 15 (10.5%) intraoperatively. Myringosclerosis was missed on otoscopy but found in 8 (5.6%) patients during surgery.

Perforation Characteristics: Otoscopy reported 134 (93.7%) patients with a single perforation, compared to 140 (97.9%) identified intraoperatively. Both methods consistently detected multiple perforations in 3 (2.1%) patients. The central site was the most common location of perforation, observed in 98 (68.5%) via otoscopy and in 102 (71.3%) intraoperatively. Minor differences were noted for anterior, posterior, and anterior-posterior sites between the two methods.

Perforation Size: Otoscopy indicated small perforations in 27 (18.9%) patients, while intraoperative findings showed 24 (16.8%) cases. Medium-sized perforations were more commonly observed intraoperatively (80, 55.9%) compared to otoscopy (76, 53.1%). Large perforations increased from 31 (21.7%) on otoscopy to 35 (24.5%) intraoperatively. Subtotal perforations were slightly higher intraoperatively (2.1% vs. 2.8%).

Ossicular Erosion: Otoscopy identified ossicular erosion in 1 (0.7%) patient involving the malleus, incus, and stapes. Intraoperatively, erosion was confirmed in 2 (1.4%) patients, specifically affecting only the incus in both cases.

Ossicular Mobility: Intraoperative findings indicated that ossicular mobility was normal in 141

(98.6%) patients, with immobility observed in only 2 (1.4%) cases.

Table 3: Audiometric findings in patients with tubotympanic type of chronic otitis media (n=110)

Audiometry findings	No. of case (%) , n=110
Type of Deafness	
Conductive deafness	110 (100%)
Degree of Hearing loss	
Mild	53 (48.2%)
Moderate	53 (48.2%)
Severe	4 (3.6%)
Hearing loss (dB) (n=110)	
Air conduction thresholds	35.2 ± 12.51
Bone conduction thresholds	14.96 ± 5.53
Air-Bone Gap	20.65 ± 11.98
Hearing loss	41.89 ± 9.26

Type and Degree of Deafness: Conductive deafness was identified in all 110 patients. Among those with conductive deafness, 53 (48.2%) patients had mild hearing loss, 53 (48.2%) had moderate hearing loss, and 4 (3.6%) had severe hearing loss.

Hearing Loss: The average air conduction threshold was 35.2 ± 12.51 dB, bone conduction threshold was 14.96 ± 5.53 dB, air-bone gap was 20.65 ± 11.98 dB, and the overall hearing loss was 41.89 ± 9.26 dB.

Table 4: Audiometric Findings by Site, size of Perforation and ossicular defect in Tubotympanic Chronic Otitis Media

Characteristics of perforation	Air conduction thresholds	Bone conduction thresholds	Air-Bone Gap	Hearing loss
Site				
Posterior	43.65 ± 8.75	14.59 ± 4.72	29.27 ± 7.6	43.92 ± 8.76
Anterior	38.71 ± 11.84	15.26 ± 6.4	25.89 ± 8.44	37.62 ± 9.55
Central	38.61 ± 8.01	13.15 ± 4.9	24.74 ± 6.04	38.36 ± 8.57
p value	< 0.001	0.261	< 0.001	< 0.001
Size				
Small	36.48 ± 8.36	12.6 ± 4.49	23.42 ± 6.63	36.36 ± 9.12
Medium	42.17 ± 7.96	15.26 ± 4.67	27.55 ± 6.59	42.06 ± 7.94
Large	46.88 ± 10.96	14.4 ± 6	33.22 ± 8.13	46.38 ± 10.52
Sub total	47.5 ± 10	13.33 ± 5.05	34.33 ± 8.08	47.5 ± 10
p value	< 0.001	0.12	< 0.001	0.002
Ossicular chain				
Defect	40,0 ± 6.23	12.5 ± 3.67	28.1 ± 6.85	40.5 ± 6.75
Intact	35.18 ± 12.54	14.97 ± 5.54	20.62 ± 12	41.91 ± 9.3
p value	0.7	0.65	0.54	0.83

Site

- **Air-Bone Gap:** The mean air-bone gap differed significantly across the various perforation sites ($p < 0.001$). Posterior perforations had the largest air-bone gap (29.27 ± 7.6 dB) compared to anterior (25.89 ± 8.44) and central (24.74 ± 6.04) perforations.
- **Overall Hearing Loss:** Overall hearing loss varied significantly according to the site of the perforation ($p < 0.001$). Posterior perforations resulted in the highest mean hearing loss (43.92 ± 8.76 dB), indicating that they are associated with more severe hearing impairment compared to anterior (37.62 ± 9.55) and central perforations (38.36 ± 8.57).

Size

- **Air-Bone Gap:** The air-bone gap increased with the size of the perforation. For smaller perforations, the mean air-bone gap was 23.42 ± 6.63 dB. This gap widened for medium perforations (27.55 ± 6.59 dB), and was largest for large perforations (33.22 ± 8.13 dB). This trend highlights that larger perforations are associated with a greater conductive hearing loss, as indicated by a larger air-bone gap.
- **Overall Hearing Loss:** Overall hearing loss increased with the size of the perforation. The mean hearing loss was 36.36 ± 9.12 dB for small perforations, 42.06 ± 7.94 dB for medium perforations, and 46.38 ± 10.52 dB for large perforations. This pattern underscores that

patients with larger perforations experience more severe overall hearing loss.

Ossicular defect

- There were no significant differences in air conduction thresholds, bone conduction thresholds, air-bone gaps, or overall hearing loss between patients with ossicular defects and those with intact ossicle.

Discussion

Intact tympanic membrane (TM) and a continuous ossicular chain are essential for effective sound transmission from the external ear to the inner ear, where sound is converted into nerve impulses for hearing.[12] CSOM is a prevalent condition in otolaryngology, particularly in India and other low- and middle-income countries. In the tubotympanic type of CSOM, TM perforation with or without ossicular erosion and discontinuity leads to varying degrees of hearing loss. [12] Preoperative PTA provides an estimate of the degree and type of hearing loss, aiding in surgical planning. However, intraoperative findings are crucial for accurately assessing hearing loss, as preoperative PTA may not always predict the extent and nature of hearing impairment. [13] This study addresses this gap in a patients with CSOM.

Age and gender distribution

In the present study, the mean age of patients with tubotympanic CSOM was 29.9 ± 10.87 years, consistent with findings from Singh P et al. [4] (32.40 ± 14.94 years). Similar age distributions were reported by Patil D et al. [3] and Panicker et al. [14], with the majority of patients falling within the 21 to 40 year age group. A significant female predominance was observed, with 70.9% of the patients being female, aligning with the findings of Patil D et al. [3] (64%) and Singh P et al. [4] (53.9%).

Chief Complaint

In the present study, ear discharge was the most common complaint (96.4%), consistent with Singh P et al.[4] (100%) and Panicker et al. [14] (84.7%). Decreased hearing was reported by 65.5% of patients, lower than Singh P et al. [4] (89.5%) and Panicker et al. 14 (78.4%). Tinnitus was notably lower at 1.8%, compared to Singh P et al. [4] (30.3%) and Panicker et al. [14] (12.6%). Earache was reported by 19.1% of patients, slightly higher than in other studies. The absence of symptoms like vertigo, facial weakness, and headache suggests a milder disease presentation in this cohort.

Tympanic membrane perforation

The present study found that central perforations were most common (71%), aligning closely with Dudda R et al. [12] (65.4%) but differing from Patil D et al. [3] (32%). In the present study, medium-sized perforations were most common (55.9%), followed by large (24.5%), small (16.8%), and subtotal (2.8%) perforations. Kadambott et al. [13] found medium perforations in 40.5% of cases, with a higher incidence of subtotal perforations (15.2%). Panicker D et al. [14] also noted a significant proportion of subtotal perforations (21.6%).

Type and Degree of Hearing Loss

Conductive hearing loss in tympanic membrane perforation primarily results from reduced ossicular coupling due to decreased sound pressure across the perforation, with the greatest loss occurring at lower frequencies. [12] In this study, all patients exhibited conductive deafness, which aligns with findings from Patil D et al. [3] (96.1%), Kadambott et al. [13] (95.6%), and Dudda R et al. [12] (97.3%).

Regarding the degree of hearing loss, 48.2% of patients in the present study had mild hearing loss, comparable to Patil D et al. [3] (42%) but significantly higher than Kadambott et al.13 (31.6%) and Dudda R et al. [12] (5.8%). Moderate hearing loss was also common in the present study (48.2%), consistent with Kadambott et al. [13] (50%), though lower than Dudda R et al. [12] (40.4%). Moderately severe hearing loss was less frequent in the present study (3.6%) compared to Patil D et al. [3] (18%) and Dudda R et al. [12] (46.2%).

Hearing loss and site of perforation

The present study revealed that hearing loss was more commonly found in large posterior perforation than other perforation. Similarly, Patil et al.[3] found that hearing loss was greater in posterior and subtotal perforations, possibly due to the direct exposure of the round window to sound waves. This finding similar to Panicker et al. [14], who observed that hearing loss was more pronounced in posterior perforations, supporting the notion that posterior quadrant perforations are more detrimental to hearing. Maharjan et al.[15] also noted that patients with larger perforations involving all four quadrants exhibited greater hearing loss, further reinforcing the relationship between perforation size and hearing impairment. Kadambott et al. [13], also reported a significant impact of perforation size on hearing loss (p=0.026), and This trend underscores the association between larger perforations and greater conductive hearing loss.

Ossicular Chain Condition and Hearing Loss

Pure tone audiometry may not always accurately reflect the state of the ear transmission system, particularly in the presence of pathological tissue that can transmit sound, potentially compensating for damaged ossicles.[3] In this study, no significant differences in air conduction thresholds, bone conduction thresholds, ABG, or overall hearing loss

were observed between patients with ossicular defects and those with intact ossicles. This finding contrasts with results from Kadambott et al. [13] and Dudda R et al.[12] who found a significant association between higher ABG and ossicular discontinuity, indicating a greater likelihood of ossicular defects in these cases.

Conclusion

The findings indicate that otoscopy and pure tone audiometry provides valuable initial insights, but intraoperative examination is more comprehensive, particularly in identifying tympano-sclerosis and myringosclerosis. Audiometric analysis revealed that the size and site of the perforation significantly impact hearing loss, with larger and posterior perforations leading to greater impairment. No significant differences were noted in hearing metrics between patients with and without ossicular defects, highlighting the complexity of auditory outcomes in tubotympanic chronic otitis media.

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