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A CLINICAL STUDY ON HOW THE SIZE AND LOCATION OF TYMPANIC MEMBRANE PERFORATIONS AFFECT HEARING LOSS

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ABSTRACT

Background: Tympanic membrane perforations are common causes of conductive hearing loss. Both the size and location of the perforation are thought to influence the degree of hearing impairment, but the relationship remains incompletely understood. **Objective:** To evaluate how the size and location of tympanic membrane perforations affect the severity of hearing loss. **Methods:** A clinical study was conducted involving patients with tympanic membrane perforations. Perforations were classified by size (small, medium, large) and location (anterior, posterior). Pure tone audiometry was used to measure hearing thresholds and air-bone gaps. Statistical analysis assessed the correlation between perforation characteristics and hearing loss. **Results:** Mean hearing loss on PTA increased with perforation size: 30.49±3.90 dB for small (1–15 mm²), 37.56±3.02 dB for medium (15–27 mm²), and 46.51±7.32 dB for large (28–41 mm²) perforations. Hearing loss was significantly proportional to perforation size ($p<0.05$). Posterior perforations demonstrated a higher degree of hearing impairment compared to anterior perforations (36.29±5.31dB and 33.74±5.47dB respectively). The findings highlight the impact of perforation attributes on middle ear sound conduction. **Conclusion:** Both size and location of tympanic membrane perforations play a critical role in the extent of conductive hearing loss. These insights can guide clinical evaluation and management of patients with tympanic membrane perforations.

KEYWORDS

Tympanic membrane perforation, hearing loss, perforation size, perforation location.

INTRODUCTION

Chronic Suppurative Otitis Media (CSOM) is a long-standing infection of the middle ear and mastoid cavity characterized by persistent otorrhea through a perforated tympanic membrane[1]. It remains a prevalent cause of preventable hearing loss, particularly in low- and middle-income countries where access to early medical intervention may be limited[2]. The condition not only poses a risk of chronic infection and complications but also contributes significantly to auditory dysfunction, primarily through its effect on the integrity and function of the tympanic membrane.

The tympanic membrane plays a vital role in sound transmission by converting acoustic energy into mechanical vibrations for relay to the ossicular chain. Perforation of this membrane disrupts this process, resulting in conductive hearing loss[3]. However, the degree of hearing impairment observed in patients with CSOM varies considerably and appears to be influenced by both the size and site of the perforation.

Larger perforations are generally associated with more pronounced hearing loss due to a greater reduction in the membrane's vibratory surface area[4]. In contrast, the impact of perforation location remains less clearly defined. Some studies suggest that posterior or subtotal perforations may lead to more significant hearing deficits, potentially due to altered sound wave transmission or increased susceptibility to middle ear pathology[5].

Despite the clinical relevance of these observations, there remains a lack of consensus in the literature regarding the precise correlation between perforation characteristics and auditory outcomes. This study aims to explore the relationship between the size and anatomical site of tympanic membrane perforations in CSOM and the resulting degree of hearing loss. A clearer understanding of these associations may enhance diagnostic accuracy, inform surgical decision-making, and improve patient outcomes.

MATERIAL AND METHODS

This prospective study was conducted in the Department of ENT, Ram Lal Eye and ENT Hospital, Government Medical College, Amritsar. The study comprised of 60 patients of either sex between the ages of 15 to 45 years with tubo tympanic type of CSOM with safe perforation and conductive hearing loss. Approval from Institutional Ethics Committee, Government Medical College, Amritsar was obtained and the patients were enrolled in the study after obtaining written informed consent.

Inclusion Criteria:

1. Tubo tympanic type of CSOM with safe perforation.
2. Conductive type of hearing loss.
3. Patients (both male and female) between age group 15 to 45 years.

Exclusion Criteria:

1. Active discharging ear.
2. Sensorineural hearing loss.
3. Unsafe pathology
4. Patients with ossicular chain disruption.
5. Patients above forty five years of age.

All the cases underwent detailed history taking followed by a thorough general and physical examination and examination of ear, nose and throat. An otoscopic examination to record the site and size of perforation was done. All the findings were confirmed with examination of the ear under a microscope and with otoendoscopy. Tuning Fork tests were performed.

Methodology To Measure The Size Of Perforation:

To measure the size of perforation, thin and transparent plastic paper was used and over it graphs of 1 mm2 were drawn, oval pieces of about 9 mm x 8 mm size was cut and sterilized by keeping in cidex, under operating microscope with magnification 15X sterile plastic with graph imprinted on it was kept over the TM perforation. Number of squares occupying the perforation were directly counted, if half or more of any square was within the perforation it was taken to be one square and if less than half of a square was within the perforation, it was not counted[6].

The Total Effective Surface Area Of The Tympanic Membrane Was Taken To Be 55 Mm2 And The Sizes Of Perforation Were Categorized As:

(i) 1–14 mm2, i.e. 25% of total effective tympanic membrane surface area involved by perforation.
(ii) 15–27 mm2, i.e. 25–50%
(iii) 28–41 mm2, i.e. 50–75%
(iv) 42–55 mm2, i.e. 75–100%

To Assess The Site Of Tympanic Membrane Perforation :

The tympanic membrane was divided into four quadrants by imaginary lines-one passing through the umbo and lateral process of malleus and another perpendicular to the first line and passing through umbo (Logan Turner, 1988). The perforations were grouped according

to the quadrant or quadrants in which they are located, i.e. antero-superior, antero-inferior, postero-superior, postero-inferior and multiple (involving 2, 3 or all 4 quadrants)[7]. The site of the perforation was also documented as anterior to the handle of malleus and posterior to handle of malleus.

All patients underwent PTA (Pure Tone Audiometry) using MAICO MA 52 Pure Tone Audiometer. X-ray mastoid (Schuller"s view) was taken in all cases.

Statistical Analysis

The observations were carefully recorded and the data so obtained was collated and analysed using chi-square test and student-t test. The level of significance was determined and p value of <0.05 was taken as statistically significant.

OBSERVATIONS AND RESULTS

The present study was conducted on 60 patients. Maximum number of patients, that is, 25 (41.66%) were from the age group of 15-25 years, followed by 20 (33.33%) in 26-35 years and 15 (25%) patients in 36-45 years. The mean age of all the cases together was 28.63 years with a standard deviation of 8.34 years. The youngest enrolled subject in the study was fifteen year old female and eldest patient was a forty-five year old woman. 60% of the patients were female and 40% were male. Most of the patients were from rural background that constituted 58.33% while rest 41.67% were from urban background.

Table 1: Age Wise Distribution Of Patients

Age group	No. of cases	Percentage
15-25	25	41.66
26-35	20	33.33
36-45	15	25
Total	60	100
Mean age	28.63±8.34	

Hearing Loss According to Size of Perforation

The mean hearing loss on PTA for small perforation with size of perforation 1-15 mm^2 was 30.49±3.90 dB. For medium perforation with size of perforation from 15-27 mm^2, mean hearing loss on PTA was 37.56±3.02 dB. Large perforation with size of perforation from 28-41mm^2, the mean hearing loss on PTA was 46.51±7.32 dB. Hearing loss was found to be directly proportional to the size of perforation (p<0.05, significant) (Table 2)

Table 2: Correlation Of Size Of Tympanic Membrane Perforation With Hearing Loss

Size of Perforation			No of ears (n)	Mean Hearing Loss in dB
	In sq.mm	In percentage		
Small	1-14	<25%	20(33.33%)	30.49±3.90
Medium	15-27	25-50%	24(40%)	37.56±3.02
Large	28-41	50-75%	16(26.66%)	46.51±7.32
Total			60(100%)	
p value<0.05				

Hearing Loss According to Site of Perforation is tabulated in table 3.

Table 3: Correlation Of Site Of Tympanic Membrane Perforation With Hearing Loss

Site of Perforation	No of ears (n)	Mean Hearing Loss in dB
Anterosuperior (AS)	2	32.49±5.89
Anteroinferior (AI)	6	34.16±5.84
Posteroinferior (PI)	8	36.45±5.66
Posterosuperior (PS)	1	35
Multiple	43	38.58±8.41

Hearing loss for anterior perforation was 33.74±5.47 dB and for posterior perforation was 36.29±5.31 dB. So, the average hearing loss was found higher in posterior perforations than anterior quadrant perforations. This difference was however not statistically significant with p value >0.05.

Table 4: Showing Comparison Of Hearing Loss Between Anterior And Posterior Perforation

Site of Perforation	No of ears (n)	Average Hearing Loss in dB
Anterior	8	33.74±5.47
Posterior	9	36.29±5.31
p value>0.05		

DISCUSSION

Numerous studies have attempted to identify and analyze the different parameters of hearing impacted by tympanic membrane perforation, aiming to establish correlations among these variables for a deeper understanding. However, further research is needed to fully explore the relationship between the characteristics of tympanic membrane perforation and its effect on hearing. Our study contributes to this ongoing effort.

The present study was conducted on 60 patients. Maximum number of patients, that is, 25 (41.66%) were from the age group of 15-25 years. Our findings were similar to studies conducted by Nahata et al.[8] and Bhusal et al.[9] There were 40% males and 60% females in our study (male: female 1:1.5). Our finding was similar to that of Maharjan et al.[10] and Ibekwe et al.[11] where female preponderance seen but differed from the findings of Pannu et al.[4] and Nepal et al.[12] where there was male preponderance.

The most common symptoms were ear discharge in 88.33% followed by hearing loss in 85%, tinnitus in 13.33%, pain in 11.67% and itching in 10% patients. Gulati et al.[13] in their study reported that main symptoms were hearing loss and discharge.

In our study, a positive correlation was noted between perforation size and degree of hearing loss, with the increase being statistically significant (p<0.05). Comparable findings were reported by Kharadi P et al.[7], who observed average hearing losses of 27.1 dB, 31.4 dB, and 43.5 dB for perforation sizes of 1–15 mm^2, 15–27 mm^2, and 28–41 mm^2, respectively.

A study conducted by Gupta S[14] also demonstrated a statistically significant positive correlation between perforation size and hearing loss (p = 0.000). The mean hearing loss in Group I (0–9 mm^2) was 29.5 ± 5.9 dB, in Group II (9–30 mm^2) it was 39.3 ± 5.2 dB, and in Group III (≥30 mm^2) the mean hearing loss increased to 49.3 ± 3.2 dB.

Gulati et al.[13] in a study of 21 patients with safe otitis media reported a linear relation between size of perforation and amount of hearing loss. The same findings were also shown by Pannu et al[4] and Nepal et al[12] in their respective studies who found perforation size to be the most important determinant of hearing loss. However in a contradictory study, Ribeiro et al[15] evaluated 187 perforations and found no significant relationship between the size of tympanic membrane perforation and hearing loss.

The degree of hearing loss increases with the size of the tympanic membrane perforation because it reduces the effective vibrating area of the eardrum, which is much larger than the stapes footplate. This reduction lowers the pressure difference between the inner and outer surfaces, impairing sound transmission to the ossicles. Additionally, sound directly reaches both the oval and round windows simultaneously, eliminating the normal phase difference and worsening hearing loss—the larger the perforation, the greater the effect.

In our study, hearing loss for anterior perforation was 33.74±5.47 dB and for posterior perforation was 36.29±5.31 dB. So, the average hearing loss was found higher in posterior perforations than anterior quadrant perforations. This difference was however not statistically significant with p value >0.05. Similar results were seen in a study conducted by Sood AS et al.[16], who reported a mean hearing loss of 33dB in anterior perforations and 34.82dB in posterior perforations (p=0.689, statistically insignificant). In another study by Pannu et al.[4], hearing loss was found to be more in posterior quadrant perforation than anterior quadrant perforation but the difference was not significant statistically.

In a study by Gupta S[14], they observed that hearing loss was more in posterior and multiple perforations than in anterior perforations. (p = 0.000, highly significant). Similar findings were reported by Nepal et al.[12] and Maharjan et al.[10], who demonstrated a statistically significant correlation between the perforation site and the degree of hearing loss, with posteriorly located perforations causing the greatest hearing loss.

Those perforations with posterior quadrant involvement had a higher hearing loss. This could be due the direct exposure of the round

window in the posterior perforations which results in loss of the phase differential necessary for one to have perilymph movement.

CONCLUSION

This clinical study demonstrates a clear correlation between the size and location of tympanic membrane perforations and the degree of hearing loss experienced by patients. Larger perforations were consistently associated with greater conductive hearing loss, likely due to the reduced effective surface area available for sound transmission. Additionally, perforations located posteriorly tended to cause more significant hearing impairment compared to anterior perforations, possibly because of their proximity to the round window and the resulting alteration in middle ear mechanics.

These findings emphasize the importance of detailed otoscopic evaluation and audiometric assessment in patients with tympanic membrane perforations to accurately predict hearing outcomes. Understanding the impact of perforation characteristics can aid clinicians in making informed decisions regarding management strategies, including surgical repair, and provide patients with realistic prognostic information.

Further studies with larger sample sizes and long-term follow-up are warranted to explore the effects of additional factors such as chronicity, middle ear status, and ossicular chain involvement on hearing outcomes.

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