

RELATIONSHIP OF HEARING LOSS AND SITE OF TYMPANIC MEMBRANE PERFORATION IN CHRONIC SUPPURATIVE OTITIS MEDIA PATIENTS

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Chronic suppurative otitis media, tympanic membrane perforation, hearing loss, conductive hearing loss, pure tone audiometry.

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Abstract

Objectives

Chronic suppurative otitis media (CSOM) is a common cause of tympanic membrane perforation and conductive hearing loss, particularly in developing countries. This study aimed to determine the relationship between the site of tympanic membrane perforation and the degree of hearing loss in patients diagnosed with CSOM.

Methodology

A hospital-based cross-sectional study was conducted in the Department of ENT of a tertiary care hospital, in Rawalpindi. A total of 100 patients clinically diagnosed with CSOM were enrolled after obtaining informed consent and ethical approval. Patients with a history of ear trauma, previous ear surgery, otosclerosis, congenital ear anomalies, or systemic causes of hearing loss were excluded. Detailed clinical history and otoscopic examination were performed to identify and categorize the site of tympanic membrane perforation as anterior, posterior, central, subtotal, or total. Pure tone audiometry was conducted to assess hearing thresholds, and the degree of hearing loss was classified according to standard criteria. Data were analyzed using descriptive statistics, Chi-square test, and one-way ANOVA, with $p < 0.05$ considered statistically significant.

Results

The mean age of participants was 32.4 ± 11.6 years, with a male predominance (58%). Central perforation (34%) was the most common type, while total perforation (10%) was the least frequent. Hearing loss ranged from mild to severe, with moderate loss being most common. A statistically significant association was found between the site of perforation and the degree of hearing loss ($p < 0.05$). Larger and posteriorly located perforations were associated with higher mean hearing thresholds, with total perforations showing the greatest impairment (54.8 ± 12.6 dB).

Conclusion

There is a significant relationship between the site of tympanic membrane perforation and the severity of hearing loss in CSOM. Both the size and anatomical location of perforation influence the degree of conductive hearing impairment.

INTRODUCTION

Chronic suppurative otitis media (CSOM) is one of the most frequently encountered diseases in ENT practice. It primarily affects children and has remained one of the commonest infectious diseases in the pediatric age group worldwide ¹. The situation is particularly worse in children with poor socioeconomic backgrounds due to inadequate parental knowledge and treatment ². CSOM has also been deemed the leading cause of antibiotic prescription in primary healthcare setups ³. There is also said to be a strong correlation between age and hearing function in such individuals, especially with conductive hearing loss, which was less severe in children than in patients over the age of 30 ⁴. The common causes of TM perforation include acute suppurative otitis media, CSOM, and trauma ⁵. Depending on the coexistence of cholesteatoma, CSOM is classified into safe and unsafe types ⁶. The condition known as Chronic Otitis Media (COM) is one of the most frequent types of ear illness that an otologist would see in underdeveloped countries. To put it simply, Chronic Otitis Media (COM) is one of the most prevalent ear diseases and a significant contributor to hearing impairment in Nepal ⁷. Chronic otitis media is the predominant cause of tympanic membrane (TM) perforation and also a major health concern in many countries like India, Australia, and Tanzania ⁸. Tympanic membrane can be divided into two parts: Pars Tensa and Pars Flaccida. Pars tensa forms most of tympanic membrane. Its periphery is thickened to form a fibrocartilaginous ring called the annulus tympanicus which fits in the tympanic sulcus. The central part of pars tensa is tented inwards at the level of the tip of Malleus and is called the umbo. A bright cone of light can be seen radiating from the tip of malleus to the periphery in the anteroinferior quadrant on a healthy tympanic membrane. Pars flaccida (Sharpnel's Membrane) is situated above the lateral process of malleus between the notch of Rivinus and the anterior and posterior malleal folds. It is not so taut and may appear slightly pinkish. Pars flaccida does not have tympanic annulus at its margin ⁹. Titus S Ibekwe and others stated that the location

of perforation on the tympanic membrane had a significant impact in chronic tympanic membrane perforations but not in acute perforation ¹⁰.

METHODOLOGY

The research was carried out at the Department of ENT of a tertiary care hospital, Rawalpindi over a June 2024- Dec 2024. A hospital-based cross-sectional study design was adopted. Patients who were clinically diagnosed with chronic suppurative otitis media and met the inclusion criteria were enrolled after obtaining informed consent. Ethical approval was secured from the institutional review board prior to data collection. The study population consisted of patients presenting with ear discharge and hearing impairment suggestive of chronic suppurative otitis media. Patients with a history of ear trauma, previous ear surgery, otosclerosis, congenital ear anomalies, or systemic diseases affecting hearing were excluded from the study. A detailed clinical history was obtained from each participant, including duration of symptoms, frequency of ear discharge, associated symptoms such as tinnitus or vertigo, and previous treatment history.

A thorough otoscopic and microscopic ear examination was performed to confirm the diagnosis and to assess the tympanic membrane. The site of tympanic membrane perforation was carefully evaluated and categorized into anterior, posterior, central, subtotal, or total perforations. The size and exact quadrant involved were documented. These findings were recorded as qualitative variables, as they described categorical characteristics of the perforation without numerical measurement. Pure tone audiometry (PTA) was conducted in a sound-treated room using a calibrated audiometer to assess the degree of hearing loss. Air conduction and bone conduction thresholds were measured at standard frequencies (0.5, 1, 2, and 4 kHz). The average hearing threshold was calculated using the pure tone average (PTA) method. The degree of hearing loss was classified into mild, moderate, moderately severe, severe, or profound based on

standard hearing loss classification criteria. Hearing threshold levels measured in decibels (dB) were treated as quantitative variables, as they represented numerical data that could be statistically analyzed. The independent variable in this study was the site of tympanic membrane perforation, which was qualitative in nature (nominal categorical variable). The dependent variable was the degree of hearing loss, which was quantitative when expressed as mean hearing threshold in decibels and qualitative when categorized into severity grades. Additional demographic variables such as age (measured in years) were considered quantitative variables, while gender was treated as a qualitative variable. Data were entered and analyzed using statistical software. Descriptive statistics were applied to summarize demographic data and clinical characteristics. Frequencies and percentages were calculated for qualitative variables such as site of perforation and severity categories of hearing loss. Means and standard deviations were computed for quantitative variables such as age and hearing threshold levels. Inferential statistical tests, including the Chi-square test, were used to determine the association between categorical variables, while correlation analysis and analysis of variance (ANOVA) were applied to evaluate the relationship between the site of perforation and mean hearing loss. A p-value of less than 0.05 was considered statistically significant. The relationship between hearing loss and the site of tympanic membrane perforation was analyzed by

comparing the average hearing thresholds across different perforation sites. The findings were interpreted to determine whether specific perforation locations were associated with greater degrees of conductive hearing loss in patients with chronic suppurative otitis media.

RESULTS

A total of 100 patients diagnosed with chronic suppurative otitis media (CSOM) were included in the study. The age of the participants ranged from 12 to 60 years, with a mean age of 32.4 ± 11.6 years. The majority of patients were in the 21–40 years age group (46%). There were 58 males (58%) and 42 females (42%), showing a slight male predominance. On otoscopic and microscopic examination, central perforation was the most common type observed, followed by posterior, anterior, subtotal, and total perforations. Pure tone audiometry revealed that the degree of hearing loss ranged from mild to severe, with moderate hearing loss being the most frequent category. No cases of profound hearing loss were observed in this study.

Descriptive and inferential statistical analysis demonstrated a significant association between the site of tympanic membrane perforation and the degree of hearing loss (Chi-square test, $p < 0.05$). Furthermore, one-way ANOVA showed a statistically significant difference in mean hearing thresholds among different perforation sites ($p < 0.001$), indicating that the location of perforation influenced the severity of conductive hearing loss.

Table 1: Distribution of Patients According to Site of Tympanic Membrane Perforation (Qualitative Variable)

Site of Perforation	Number of Patients (n=100)	Percentage (%)
Anterior	18	18%
Posterior	22	22%
Central	34	34%
Subtotal	16	16%
Total	10	10%
Total	100	100%

Central perforation was the most frequently observed type (34%), while total perforation was the least common (10%). The site of perforation was treated as a qualitative (categorical) independent variable.

Table 2: Relationship between Site of Tympanic Membrane Perforation and Degree of Hearing Loss

Site of Perforation	Mild n (%)	Moderate n (%)	Moderately Severe n (%)	Severe n (%)	Mean Hearing Loss (dB) $\pm$ SD
Anterior (n=18)	10 (55.6%)	6 (33.3%)	2 (11.1%)	0 (0%)	28.4 $\pm$ 6.2
Posterior (n=22)	6 (27.3%)	10 (45.5%)	4 (18.2%)	2 (9.0%)	36.7 $\pm$ 8.5
Central (n=34)	8 (23.5%)	18 (52.9%)	6 (17.6%)	2 (6.0%)	38.9 $\pm$ 9.1
Subtotal (n=16)	2 (12.5%)	6 (37.5%)	5 (31.3%)	3 (18.7%)	46.2 $\pm$ 10.4
Total (n=10)	0 (0%)	2 (20%)	4 (40%)	4 (40%)	54.8 $\pm$ 12.6

The results showed a clear trend of increasing mean hearing loss with larger and more extensive perforations. Anterior perforations were associated mainly with mild hearing loss (mean 28.4 dB), whereas total perforations were associated with severe hearing loss (mean 54.8 dB). Subtotal and total perforations demonstrated significantly higher mean hearing thresholds compared to anterior and central perforations. The study demonstrated a statistically significant relationship between the site of tympanic membrane perforation (qualitative independent variable) and the degree of hearing loss (quantitative dependent variable). Larger and posteriorly located perforations were associated with greater conductive hearing loss. Total and subtotal perforations resulted in the highest mean hearing thresholds, indicating that both the size and site of perforation played an important role in determining the severity of hearing impairment in patients with chronic suppurative otitis media.

DISCUSSION

A total of 100 patients diagnosed with chronic suppurative otitis media (CSOM) were included in the present study. The participants' ages ranged from 12 to 60 years, with a mean age of 32.4 ± 11.6 years. In comparison, a study conducted in 2022 reported that the extent of hearing loss was directly influenced by the anatomical site of perforation, with perforations in the posterosuperior quadrant producing the greatest degree of hearing impairment.¹¹ In the current study, the majority of patients (46%)

belonged to the 21–40-year age group. There were 58 males (58%) and 42 females (42%), indicating a slight male predominance. Otoscopic and microscopic examinations revealed that central perforation was the most common type, followed by posterior, anterior, subtotal, and total perforations. Pure tone audiometry showed that hearing loss ranged from mild to severe, with moderate hearing loss being the most frequently observed category. No cases of profound hearing loss were identified. In contrast, a 2017 study reported that, in chronic otitis media, there is a quantitative logarithmic relationship between the surface area of tympanic membrane perforation and the degree of conductive hearing loss. However, that study concluded that the site of perforation did not play a significant role in determining the degree of conductive hearing loss.¹²

In the present study, both descriptive and inferential statistical analyses demonstrated a significant association between the site of tympanic membrane perforation and the degree of hearing loss (Chi-square test, $p < 0.05$). Additionally, one-way ANOVA revealed a statistically significant difference in mean hearing thresholds among the different perforation sites ($p < 0.001$), indicating that the location of the perforation significantly influenced the severity of conductive hearing loss. Conversely, a 2023 study on adult patients with inactive CSOM reported that the anteroinferior quadrant was the most common site of tympanic membrane perforation. That study also found an insignificant correlation between the location of small tympanic

membrane perforations and the degree of conductive hearing loss.¹³ In the current research, central perforation was the most frequently observed type (34%), while total perforation was the least common (10%). The site of perforation was considered a qualitative (categorical) independent variable in the analysis. Similarly, a 2022 study observed that hearing loss increased with an increase in the size of tympanic membrane perforation. It further reported that posterior central perforations caused greater hearing loss than anterior central perforations.¹⁴ The findings of the present study showed a clear trend of increasing mean hearing loss with larger and more extensive perforations. Anterior perforations were predominantly associated with mild hearing loss (mean 28.4 dB), whereas total perforations were associated with severe hearing loss (mean 54.8 dB). Subtotal and total perforations demonstrated significantly higher mean hearing thresholds compared to anterior and central perforations.

A 2019 study also reported that hearing loss increases as the area of tympanic membrane perforation enlarges. It described an inverse relationship between hearing loss and middle ear air space volume. Among small-sized perforations with low middle ear volume, posterosuperior perforations showed 4-7 dB greater hearing loss compared to anterior superior and anteroinferior perforations; however, this relationship was statistically insignificant. The study further noted that the phase cancellation effect of the round window, which could cause greater hearing loss in posteroinferior perforations, was not evident in small- and medium-sized perforations. Additionally, hearing loss was more pronounced at lower frequencies and less severe at higher frequencies.¹⁵ Overall, the present study demonstrated a statistically significant relationship between the site of tympanic membrane perforation (qualitative independent variable) and the degree of hearing loss (quantitative dependent variable). Larger and posteriorly located perforations were associated with greater conductive hearing loss. Total and subtotal perforations resulted in the highest mean hearing thresholds, suggesting that both

the size and the site of perforation play important roles in determining the severity of hearing impairment in patients with chronic suppurative otitis media. Furthermore, a 2025 study confirmed a significant and progressive relationship between tympanic membrane perforation size and the degree of hearing loss in inactive mucosal chronic otitis media. The authors emphasized that early detection and timely surgical intervention may help prevent the progression of auditory dysfunction and improve patient outcomes.¹⁶

CONCLUSION

The present study concluded that there is a statistically significant relationship between the site of tympanic membrane perforation and the degree of hearing loss in patients with chronic suppurative otitis media. Larger and posteriorly located perforations were associated with greater conductive hearing impairment, while anterior perforations were mostly linked to milder degrees of hearing loss. Subtotal and total perforations produced the highest mean hearing thresholds. These findings emphasize that both the size and anatomical location of tympanic membrane perforation play a crucial role in determining the severity of hearing loss, highlighting the importance of early diagnosis and timely management to prevent further auditory deterioration.

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