DOI: https://doi.org/10.54393/pjhs.v6i7.3359

PAKISTAN JOURNAL OF HEALTH SCIENCES
(LAHORE)
https://thejas.com.pk/index.php/pjhs
ISSN (E): 2790-9352, (P): 2790-9344
Volume 6, Issue 07 (July 2025)

Original Article

OPEN ACCESS

Sensorineural Hearing Loss in Patients with Persistent Chronic Otitis Media in Terms of Duration and Type of Tympanic Membrane Perforation

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ARTICLE INFO

Keywords:
Bone Conduction, Otitis Media, Sensorineural, Hearing Loss

How to Cite:
Anis, S., Abbas, T. G., Khan, M. M. U., Ali, M., Ahsan, N., & Iqbal, M. (2025). Sensorineural Hearing Loss in Patients with Persistent Chronic Otitis Media in Terms of Duration and Type of Tympanic Membrane Perforation: SNHL with Persistent Chronic Otitis Media: Tympanic Membrane Perforation. Pakistan Journal of Health Sciences, 6(7), 304-309. https://doi.org/10.54393/pjhs.v6i7.3359

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Received Date: 2nd June, 2025
Revised Date: 23rd July, 2025
Acceptance Date: 27th July, 2025
Published Date: 31st July, 2025

ABSTRACT

The World Health Organization (WHO) estimated that worldwide, around 65-330 million people suffer from chronic otitis media, of which as high as 50 % suffer impairment in their hearing. **Objectives:** To determine the association between Sensorineural Hearing Loss (SNHL) in patients with chronic suppurative otitis media (CSOM) in terms of duration of CSOM and type of tympanic membrane perforation. **Methods:** This multicenter study was conducted at Hamdard University, Karachi, Fatima Jinnah Medical College, Lahore, and Loralai Medical College, Loralai, between March 2024 and February 2025, on patients diagnosed with active chronic otitis media. Patients with a history of meningitis, head trauma, tympano-mastoid surgery, congenital or acquired sudden hearing loss, or post-traumatic tympanic membrane perforation were excluded. Data were analyzed using SPSS version 23.0. Pearson correlation and one-way ANOVA were applied, with a p-value of less than 0.05 considered statistically significant. **Results:** Most patients were between 12 and 30 years of age. Mean duration of CSOM was 14.85 ± 9.1 months. The most common perforation of the tympanic membrane was marginal, in 204 (50.5%) patients. A significant moderate positive correlation was found between CSOM duration and SNHL (r=0.43, p=0.002). Patients with subtotal perforations (n=32) had the highest mean SNHL (37.1 ± 6.9 dB). The most frequent symptoms were ear discharge (88.1%) and hearing loss (94%). **Conclusions:** Both the duration of CSOM and the type of tympanic membrane perforation were significantly associated with sensorineural hearing loss. Prolonged disease, marginal perforations and subtotal perforations contributed to greater hearing loss, underscoring the need for early intervention.

INTRODUCTION

It is still a major debate whether chronic inflammatory conditions such as otitis media can lead to Sensorineural hearing loss (SNHL) [1]. Impairment of hearing in patients having chronic suppurative otitis media (CSOM) in general has been shown to cause a rise in air conduction thresholds but bone conduction within normal thresholds [2]. Nonetheless, various researchers have observed persistent CSOM causing cochlear dysfunction as a commonly reported sequel; therefore, the possibility of CSOM causing SNHL cannot be ruled out [3]. The World Health Organization (WHO) estimated that worldwide, around 65-330 million people suffer from chronic otitis media, of which as high as 50 % suffer impairment in their hearing [4]. The variety of CSOM occurs in two types: the squamosal and the mucosal type. It causes mild to moderate loss of hearing in almost half of the cases [5]. Impairment in hearing is generally reported to increase thresholds of air conduction, resulting in hearing loss of a

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conductive variety. Commonly observed risk factors influencing loss of hearing include defects of the tympanic membrane, impaired ossicular chain and status of the middle ear [6]. According to estimations, 13.8 to 36.2 % of patients from the developing population with impaired hearing are associated with chronic otitis media [7]. This leads to impairment of speech development among the pediatric populations, while in adults, it leads to psychosocial issues. CSOM, causing conductive loss of hearing, is frequently reported in studies. Various studies have evaluated CSOM leading to loss of function of the cochlea and therefore SNHL, termed as CSOM sequel [8]. The majority of the speech sounds fall within the range of 500 to 4000 Hz. High frequency sounds show most hearing loss, where most patients find it challenging to understand consonants like F, H, S, CH and SH [9]. CSOM has also been reported to lead to transient shifts of thresholds or sometimes even permanent shifts in thresholds by passage of inflammatory pathogens via the round window, which could spread in an apical fashion and then be measurable even on routine audiometry [10]. Chronic otitis media with effusion (persistent) occurs when continuous negative pressure persists in the middle ear for long periods of time [11]. In such cases, effusion tends to become trapped in the middle ear cavity because of its unique anatomy. This leads to impairment of the mucociliary system coupled with impaired pumping action of the eustachian tube's opening as well as closure [12]. Published literature has demonstrated controversial results, with some studies observing positive associations while others observing negative associations between CSOM and SNHL. Confusion also persists with regard to the association of SNHL in terms of age of patient, duration of disease (CSOM) and any possible relation with the opposite normal ear [13]. Even though the prevalence of CSOM worldwide is reported to be high, there remains a gap and uncertainty in the literature with regard to the effect of CSOM on SNHL (in the inner ear) [14]. Whilst conductive loss of hearing can be surgically corrected, SNHL continues to be a permanent effect. The only management with SNHL is the use of a hearing aid [15].

This study aims to determine the association between Sensorineural Hearing Loss (SNHL) in patients with chronic suppurative otitis media (CSOM).

METHODS

This cross-sectional, multicenter study was conducted at Hamdard University, Karachi; Fatima Jinnah Medical College, Lahore; and Loralai Medical College, Loralai, from March 2024 to February 2025. After obtaining ethical approval from the Institutional Ethical Review Committee (Ref No. ERB 2024-15) of Hamdard University, data collection was initiated. Informed consent was taken from each patient after explaining the purpose of the research and ensuring the confidentiality and anonymity of their data. The sample size of the study was calculated using the OpenEpi online software. Based on a hypothesized frequency of sensorineural hearing loss (SNHL) in chronic suppurative otitis media (CSOM) of 7%, as reported in a recent local study by Anwar et al. [16], and using a 95% confidence level with 5% confidence limits, the required sample size was calculated to be 404 (see Table 1).

Table 1: Sample Size for Frequency in a Population and for Various Confidence Levels

Sample Size for Frequency in a Population	
Variables	**Values**
Population size (for finite population correction factor or fpc) (N):	1000000
Hypothesized % frequency of outcome factor in the population (p):	7%+/-5
Confidence limits as % of 100 (absolute +/- %) (d):	5%
Design effect (for cluster surveys-DEFF):	1
Sample Size (n) for Various Confidence Levels	
Confidence	Sample Size
95%	404

Equation Sample size (n) = (DEFF*Np(1-p))/ ((d2/Z21-α/2*(N-1) + p*(1-p))

The sample size was calculated using OpenEpi, Version 3 (SSPropor calculator). After obtaining ethical approval and informed consent, patients between 12 and 60 years of age with active chronic otitis media (COM) were recruited. COM was defined as a disease duration of at least three months. Patients presenting with unilateral otorrhea and a persistent tympanic membrane perforation for at least three months, while having a normal tympanic membrane in the contralateral ear, were included in the study. Patients with a history of meningitis, head trauma, tympano-mastoid surgery, ototoxic drug use, family history of acquired or congenital sudden hearing loss, or post-traumatic tympanic membrane perforation were excluded. The contralateral ear of each patient served as a control to rule out disorders such as presbyacusis, metabolic diseases, noise-induced trauma, and ototoxicity. In cases where presbyacusis was suspected, audiometric correction was applied to minimize confounding. A non-probability consecutive sampling technique was used. Following informed consent, eligible patients were enrolled after an explanation of the study's purpose and procedures. Demographic details, medical history, and complete ENT examination were recorded on a pre-designed proforma. The examination was performed using a Welch Allyn otoscope. Patients presenting with active ear discharge were prescribed systemic and topical antibiotics for one week and were reassessed after the discharge had subsided. Audiometric evaluation was carried out in a soundproof room by a trained audiologist using a clinical

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audiometer, according to ISO standards. The frequencies tested were 500, 1000, 2000, and 4000 Hz. A total of 404 patients were finally included in the analysis of sensorineural hearing loss (SNHL) parameters. A bone conduction threshold of 20 dB was used to define SNHL in order to improve the sensitivity of the study. Data analysis was performed using SPSS version 23.0. Categorical variables were expressed as frequencies and percentages, while continuous variables were reported as mean and standard deviation after testing for normality with the Shapiro–Wilk test. For group comparisons, independent t-test and one-way ANOVA were applied after adjustment for confounding variables. A p-value of less than 0.05 was considered statistically significant.

RESULTS

A total of 404 patients with persistent chronic suppurative otitis media (CSOM) were included, comprising 228 male and 176 females. Among male, the most prevalent age group was 12–20 years (64, 28.07%), followed by 21–30 years (52, 22.81%) and 31–40 years (48, 21.05%). In female, the most common age group was 41–50 years (44, 25%), followed by 12–20 years (40, 22.73%) and 51–60 years (32, 18.18%). The mean duration of CSOM was 14.46 ± 9.7 months in male and 15.24 ± 8.5 months in female. Regarding the type of tympanic membrane perforation, marginal perforations were most frequently observed in both 112 (49.12%) male and 92 (52.27%) female, followed by central perforations in 96 (42.11%) male and in 72 (40.91%) female. Subtotal perforations were the least common, occurring in 20 (8.77%) male and 12 (6.82%) female (Table 2).

Table 2: CSOM Patients Distribution According to Various Demographics (n=404)

Age Groups	Male (%), (n=228)	Female (%), (n=176)
12-20 Years	64 (28.07%)	40 (22.73%)
21-30 Years	52 (22.81%)	32 (18.18%)
31-40 Years	48 (21.05%)	28 (15.91%)
41-50 Years	36 (15.79%)	44 (25%)
51-60 Years	28 (12.28%)	32 (18.18%)
Mean Duration of CSOM (Months)	14.46 ± 9.7	15.24 ± 8.5
Type of Tympanic Membrane Perforation		
Central	96 (42.11%)	72 (40.91%)
Marginal	112 (49.12%)	92 (52.27%)
Subtotal	20 (8.77%)	12 (6.82%)

This study illustrated the frequency of key clinical features observed in patients with chronic suppurative otitis media (CSOM). The most commonly reported symptom was ear discharge, seen in 356 (88.1%) patients, followed by hearing loss in 300 (74.3%) and earache in 168 (41.6 %) cases. Tinnitus was reported by 112 (27.7%) participants, and vertigo was the least frequent symptom, affecting 60 (14.9%) individuals (Figure 1).

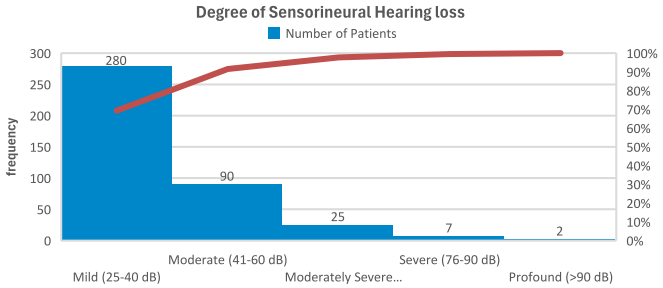

Figure 1: Representation of Clinical Features Associated with CSOM (n=404)

In tuning fork testing, Weber's test showed lateralization to the right in 164 (40.59%), to the left in 148 (36.63%), and was central in 92 (22.77%). Rinne's test was negative on the left in 172 (40.19%), on the right in 132 (36.27%), and positive bilaterally in 100 (22.55%). The differences were not statistically significant (Weber's test χ^2 = 1.77, p>0.05; Rinne's test χ^2 = 1.95, p>0.05) (Table 3).

Table 3: Results of Tuning Fork Testing in CSOM Patients (n=404)

Weber's Test	Frequency (%)	Rinne's Test	Frequency (%)
Shifted + Left	148 (36.63%)	Right –ve test	132 (36.27%)
Shifted + Right	164 (40.59%)	Left –ve test	172 (40.19%)
Central	92 (22.77%)	Right + Left +ve test	100 (22.55%)

*Weber's test x2 = 1.77 p>0.05. *Rinne's test x2 = 1.95 p>0.05

The analysis of 404 patients establishes a quantifiable link between chronic otitis media and sensorineural deterioration. The moderate positive correlation ($r = 0.49$, $p < 0.001$) indicates that for every unit increase in disease duration, the severity of SNHL increases, with the duration of illness accounting for 24% ($r^2 = 0.24$) of the variation in hearing loss. Furthermore, the type of tympanic membrane perforation has a significant impact (p=0.01), with mean SNHL severity escalating from 29.5 ± 6.3 dB in central perforations, to 32.6 ± 5.8 dB in marginal perforations, and peaking at 37.1 ± 6.9 dB in subtotal perforations. This clear gradient demonstrates that larger, more anatomically significant perforations pose a greater risk to cochlear function, underscoring that CSOM is a progressive condition requiring timely intervention to prevent permanent inner ear damage.

Table 4: Association of Duration and Type of Tympanic Membrane Perforation with Sensorineural Hearing Loss (SNHL) (n=404)

Variables	Frequency / Mean	Mean SNHL (dB ± SD)	Test Applied	p-Value	Effect Size
Duration of CSOM (Months)	14.85 ± 9.1	29.5 ± 6.3	Pearson Correlation	<0.001	$r = 0.49$, $r^2 = 0.24$)
Type of Tympanic Membrane Perforation	-	-	One-way ANOVA	0.01	$n^2 = 0.09$
Central	(n=168)	29.5 ± 6.3	-	-	-
Marginal	(n=204)	32.6 ± 5.8	-	-	-
Subtotal	(n=32)	37.1 ± 6.9	-	-	-

DOI: https://doi.org/10.54393/pjhs.v6i7.3359

DISCUSSIONS

The results of the study showed that the duration of CSOM was positively correlated with SNHL. A similar type of tympanic membrane perforation was also significantly associated (p=0.01) with SNHL. However, on tuning fork testing, both Rinne's and Weber's tests showed an insignificant difference between the ears. In otorhinolaryngological practice, CSOM is one of the commonly observed conditions [17]. Although some researchers have reported associations between CSOM and SNHL, a difference of opinion persists in terms of the significance of the concept [18]. Even though literature demonstrates that at present, there is no consensus regarding the pathogenesis of SNHL because of CSOM, consistent reports of increasing damage made clinicians believe that the pathogenicity of CSOM passing through the round window membrane is the most probable hypothesis for causing SNHL [19]. The most frequent age groups in our study were patients between 12 and 20 years, followed by the 21-30 years' age group. As the age increased, the frequency of patients showed a decline, with the 51-60 years' age group reporting the least common age group. The mean duration of CSOM was slightly higher in female (15.24 ± 8.5 months) as compared to male (14.46 ± 9.7 months). The most common type of tympanic membrane perforation was marginal, in 204 (50.5%), central in 168 (41.58%) and subtotal in 32 (7.92%) patients. Similarly, other studies have also reported similar age groups and types of tympanic membrane perforation [20]. For instance, a study by Rasouli et al. reported a mean age of 21.93 in patients with CSOM [21]. Another study by Nahata *et al.* reported a maximum patient age between 15 and 24 years, i.e. 24 (38 %) patients [22]. Likewise, Naveen et al. also observed that most patients included in the study were between 11 and 30 years, i.e. 66 (66 %) [23]. This shows that the trend of SNHL in CSOM occurs mostly in the younger ages. Our study observed that the duration of CSOM was significantly associated with SNHL. In line with our study findings, Naveen *et al.* also observed that as the duration of CSOM increased, the incidence of SNHL also increased [23]. Nahata *et al.* reported that the majority of patients in their study (69) were found to have a central type of tympanic membrane perforation, followed by posterior in 16 and anterior in 15 (together they constitute the marginal type of perforation) [22]. As observed in this study, other researchers have also documented that perforations in the tympanic membrane have been associated with conductive loss of hearing with varying degrees. Similar to our study, the larger the perforation (subtotal) of the tympanic membrane, the greater the loss in decibels of hearing has been observed [24]. Perforations are more commonly observed in the posterior (marginal) quadrants of the tympanic membrane. This was in line with our study as well. This shows that the locality of perforations also has a direct impact on hearing loss severity. Numerous researchers have also observed contradicting impacts of the type and location of perforation on the degree of SNHL. However, anatomically, any perforation in the margins (anterior or posterior) may lead to worsening of hearing since the round window is in direct approximation to sound [25].

CONCLUSIONS

The study concluded that both the duration of chronic suppurative otitis media (CSOM) and the type of tympanic membrane perforation were significantly associated with sensorineural hearing loss. A longer duration of disease and marginal perforations showed a strong association with Sensorineural Hearing Loss (SNHL), while subtotal perforations were also found to contribute to greater overall hearing loss. These findings highlight the importance of early detection and management of CSOM to prevent progression to irreversible cochlear damage.

Authors Contribution

Conceptualization: SA
Methodology: TGA
Formal analysis: SA, MMUK, MA
Writing review and editing: SA, TGA, MA, NA, NI

All authors have read and agreed to the published version of the manuscript

Conflicts of Interest

All the authors declare no conflict of interest.

Source of Funding

The author received no financial support for the research, authorship and/or publication of this article.

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