



## ORIGINAL ARTICLE

## Audiological Profile of Sensorineural Hearing Loss in Mucosal-Type Chronic Suppurative Otitis Media

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## ABSTRACT

**Background:** Chronic suppurative otitis media (CSOM) is a long-standing inflammation of the middle ear. Mucosal CSOM, the most prevalent form, typically causes conductive hearing loss due to perforation of the tympanic membrane. However, sensorineural hearing loss (SNHL) may also occur. This study aims to assess the frequency of SNHL in mucosal CSOM and characterize its features.

**Methods:** A cross-sectional study was conducted from October 2024 to March 2025 at the Otolaryngology and Audiovestibular Consultation Unit, College of Medicine, Mustansiriyah University, Iraq. Sixty patients with unilateral mucosal chronic suppurative otitis media were enrolled, with the non-diseased ear serving as a control. All participants underwent tuning fork tests and pure tone audiometry.

**Results:** Nine out of 60 patients (15%) exhibited mixed hearing loss. The degree of SNHL was moderate in 7 patients (77.8%) and mild in 2 patients (22.2%). SNHL was significantly associated with longer disease duration and the presence of active disease ( $p = 0.018$  and  $0.032$ , respectively). Higher-frequency hearing was more affected than speech frequencies, with significantly elevated bone conduction thresholds in the diseased ear compared to the control ear ( $p < 0.001$ ).

**Conclusion:** Mucosal CSOM may contribute to SNHL in 15% of cases, particularly among patients with longer disease duration and active discharge. Early diagnosis and appropriate management are essential to prevent permanent sensorineural hearing impairment.

**Key words:** Mucosal chronic otitis media; Sensorineural hearing loss; Conductive hearing loss; Audiometry; Hearing thresholds.



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## INTRODUCTION

**C**hronic suppurative otitis media (CSOM) is a persistent inflammation of the middle ear lasting more than three months. It is typically associated with a permanent perforation of the tympanic membrane and recurrent otorrhea. CSOM is classified into two main types: mucosal (tubotympanic), which is the more common form, and squamosal (atticoantral) [1].

Based on disease activity, CSOM is further divided into active and inactive forms. The active form is characterized by ongoing mucosal inflammation accompanied by mucopurulent otorrhea [2, 3].

While CSOM commonly causes conductive hearing loss due to tympanic membrane perforation and ossicular erosion, it may also result in sensorineural hearing loss (SNHL) [4]. This occurs through the diffusion of bacterial toxins and inflammatory mediators across the round window membrane, leading to cochlear hair cell damage particularly at the basal turn, and irreversible auditory impairment [5].

CSOM represents a significant global health concern, especially in low income and overcrowded communities [6, 7]. It affects approximately 31 million people annually. Prevalence ranges from around 7% in some Middle Eastern countries to below 1% in developed regions [8].

The gold standard for assessing hearing thresholds is pure tone audiometry [9]. Management of CSOM focuses on infection control and hearing restoration. Topical fluoroquinolones are preferred over aminoglycosides to minimize ototoxicity. Surgical interventions such as tympanoplasty and mastoidectomy are employed in refractory or extensive cases [10]. Auditory rehabilitation, including hearing aids or cochlear implants, may be necessary to address residual hearing deficits [11].

If left untreated, CSOM can result in severe extracranial and intracranial complications [12]. The prognosis largely depends on the activity of the disease and timely intervention. Active CSOM, particularly when caused by pathogens such as *Staphylococcus aureus* or *Pseudomonas aeruginosa*, may lead to antibiotic resistance and serious sequelae [13].

Prolonged hearing loss can contribute to communication difficulties and cognitive decline, adversely affecting quality of life [14].

This study aims to determine the frequency and severity of sensorineural hearing loss in mucosal-type CSOM and to identify its key audiological characteristics.

## MATERIALS AND METHODS

A cross-sectional study was conducted at the Otolaryngology and Audiovestibular Consultation Unit, College of Medicine, Mustansiriyah University, Baghdad, Iraq, between October 2024 and March 2025. Using a consecutive sampling method, 60 patients with unilateral mucosal chronic suppurative otitis media (CSOM) were enrolled. The contralateral, non-diseased ear served as a control for each patient.

To minimize potential confounders, the following exclusion criteria were applied: age over 45 years, bilateral CSOM, pre-existing sensorineural hearing loss (SNHL) in the opposite ear, history of noise exposure, head trauma, previous ear surgery, chronic medical illnesses, and prior use of ototoxic medications.

Ethical approval was obtained from the institutional ethics committee of the College of Medicine. Informed consent was secured from all participants after a clear explanation of the study's objectives, potential risks and benefits, and assurance of confidentiality and the right to withdraw at any time.

Following diagnosis confirmation by an Ear, Nose, and Throat (ENT) specialist, all participants underwent detailed history-taking and otological examination using otoscopy and 0° rigid endoscopy (50 mm in length). Tuning fork tests (Rinne and Weber) were conducted with a 512 Hz tuning fork. In cases of active discharge, pus was gently suctioned from the diseased ear with appropriate precautions to ensure patient safety.

Audiological evaluation was performed using pure tone audiometry in a sound-treated booth, employing a Diagnostic Audiometer (Amplivox 240 Ltd., UK). Air conduction thresholds were assessed at 250, 500, 1000, 2000, 4000, and 8000 Hz, while bone conduction thresholds were measured at 500, 1000, 2000, and 4000 Hz using the Hughson-Westlake technique. Narrow-band noise was used to mask the contralateral ear when necessary.

Hearing loss was classified as follows:

- **Conductive hearing loss (CHL):** Elevated air conduction thresholds with normal bone conduction thresholds and an air-bone gap  $> 10$  dB
- **Sensorineural hearing loss (SNHL):** Elevated air and bone conduction thresholds with an air-bone gap  $\leq 10$  dB.
- **Mixed hearing loss (MHL):** Elevated air and bone conduction thresholds with an air-bone gap  $> 10$  dB.

A sensorineural component was considered present when the average bone conduction threshold exceeded 25 dB. The degree of SNHL was categorized according to Goodman's classification:

- Mild: 26–40 dB
- Moderate: 41–55 dB
- Moderately severe: 56–70 dB
- Severe: 71–90 dB
- Profound: >90 dB

Data analysis was performed using SPSS version 28 (IBM Corp., Armonk, NY, USA). Given the sample size and data distribution, non-parametric tests (Mann–Whitney U test and Fisher's exact test) were employed. A  $p$ -value  $\leq 0.05$  was considered statistically significant.

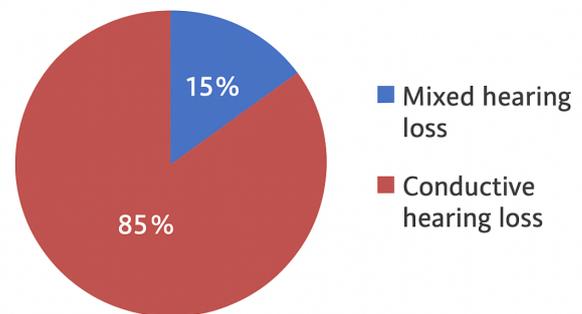
## RESULTS

The study included a total of 60 patients, comprising 32 females (53.3%) and 28 males (46.7%). The mean age was  $30.6 \pm 8.7$  years, and the mean disease duration was  $8.27 \pm 4.1$  years. Among them, 26 patients (43.3%) had active disease. Detailed demographic and disease-related characteristics are summarized in Table 1.

Sensorineural hearing loss (SNHL) was detected in 9 out of 60 patients (15%), while the remaining 51 patients (85%) had conductive hearing loss. This distribution is illustrated in Figure 1.

**Table 1. Distribution of Patients According to Demographic Characteristics and Disease Parameters**

Variable	Category	n (%)
Age (years)	15–25	16 (26.7)
	26–35	27 (45.0)
	36–45	17 (28.3)
	Mean (SD)	30.6 (8.7)
Gender	Male	28 (46.7)
	Female	32 (53.3)
Disease duration	<5 years	15 (25.0)
	5–10 years	29 (48.3)
	>10 years	16 (26.7)
	Mean (SD)	8.27 (4.1)
Disease activity	Active	26 (43.3)
	Inactive	34 (56.7)



**Figure 1. Frequency of SNHL component in the studied population**

Analysis of associations between SNHL and demographic or disease variables is presented in Table 2. There was a significant association between the presence of SNHL and longer disease duration ( $p = 0.018$ ) as well as active disease status ( $p = 0.032$ ). No significant associations were observed with age group ( $p = 0.204$ ) or gender ( $p = 0.721$ ).

Regarding the severity of SNHL, 7 patients (77.8%) had moderate hearing loss, and 2 patients (22.2%) had mild loss. No patients demonstrated moderately severe, severe, or profound SNHL.

Bone conduction thresholds were significantly higher in the diseased ears of patients with SNHL compared to their non-diseased ears at all tested frequencies. This difference was statistically significant at each individual frequency (500, 1000, 2000, and 4000 Hz) and in the overall average threshold ( $p < 0.001$ ). Moreover, the high-frequency threshold at 4000 Hz was markedly more elevated than lower frequencies, indicating greater high-frequency involvement. These results are shown in Table 3.

Table 2. Association of Sensorineural Hearing Loss with Age, Gender, Disease Duration, and Activity

Variable	Conductive		Mixed		Total		P-value
	No.	%	No.	%	No.	%	
<b>Age (years)</b>							
15–25	15	29.4	1	11.1	16	26.7	0.204
26–35	24	47.1	3	33.3	27	45.0	
36–45	12	23.5	5	55.6	17	28.3	
<b>Gender</b>							
Male	23	45.1	5	55.6	28	46.7	0.721
Female	28	54.9	4	44.4	32	53.3	
<b>Disease Duration</b>							
<5 years	14	27.5	1	11.1	15	26.7	0.018
5–10 years	27	52.9	2	22.2	29	48.3	
>10 years	10	19.6	6	66.7	16	26.7	
<b>Activity</b>							
Active	19	37.3	7	77.8	26	43.3	0.032
Inactive	32	62.7	2	22.2	34	56.7	

Fisher's exact test

Table 3. Bone Conduction Thresholds in the Ears of the Patients with Mixed Hearing Loss

Frequency (Hz)	Diseased Ear		Control Ear		P-value
	Mean	SD	Mean	SD	
500	28.3	5.6	11.1	2.2	<0.001
1000	37.2	7.9	10.0	2.5	<0.001
2000	47.2	6.2	10.0	0.0	<0.001
4000	61.1	10.5	7.2	3.6	<0.001
Overall	43.5	14.1	9.6	1.7	<0.001

Mann–Whitney U test

## DISCUSSION

Chronic suppurative otitis media (CSOM) is a common public health problem in developing countries, characterized by chronic inflammation of the middle ear and persistent tympanic membrane perforation lasting more than three months [15].

While CSOM typically results in conductive hearing loss (CHL) due to tympanic membrane perforation and ossicular chain disruption, increasing evidence indicates that it may also lead to sensorineural hearing loss (SNHL), particularly in the mucosal (tubotympanic) type. This has important implications for long-term auditory disability and quality of life, especially in underserved populations [16].

The mechanism underlying SNHL in CSOM is believed to involve the anatomical proximity between the middle and inner ear. Permeation of bacterial toxins and inflammatory mediators through the round window membrane contributes to cochlear hair cell damage, particularly affecting the basal turn of the cochlea and resulting in high-frequency hearing loss [17].

The current study highlights the frequency of SNHL in mucosal-type CSOM and explores its main characteristics through audiological assessment using pure tone audiometry. In this study, SNHL was identified in 15% of patients. This

finding is consistent with previous studies: Babu reported a rate of 10% [18], Philipose et al. reported 18.05% [19], while George [20] and Pramanik et al. [21] found comparable results.

A statistically significant association was observed between the presence of SNHL and longer disease duration, particularly in patients with disease lasting more than 10 years ( $p = 0.018$ ). This supports earlier observations by Soni et al. and Ahmed et al., who attributed SNHL to prolonged middle ear inflammation causing cochlear damage [22, 23]. Similarly, Abdul-Aziz et al. and Babu linked chronic inflammation and sustained toxin exposure to progressive inner ear damage via the round window membrane [18, 24].

Furthermore, the current study demonstrated a significant relationship between SNHL and the active form of CSOM ( $p = 0.032$ ). This aligns with findings from Nanda et al. and Thakur et al., who reported that active mucosal disease increases the risk of SNHL due to persistent mucosal inflammation and toxin-mediated inner ear injury [25, 26].

Although mixed hearing loss was more common among older patients, no statistically significant correlation was found between SNHL and age ( $p = 0.204$ ), consistent with the result of Oh KH et al. study, who suggested that age alone is not a risk factor for SNHL in CSOM [27]. In contrast, Moruskar et

al. observed an increase in SNHL prevalence with age, while Anwar et al. found that CHL predominates among younger patients [28, 29].

Gender distribution in this study showed a slight male predominance among patients with mixed hearing loss (55.6%); however, the association between SNHL and gender was not statistically significant ( $p = 0.721$ ). This finding supports previous studies by Soni et al. [22], and Rana et al. [30], all of whom concluded that gender does not significantly influence SNHL development in mucosal CSOM.

In terms of severity, the SNHL component in patients with mixed hearing loss was moderate in 77.8% and mild in 22.2% of cases. The predominance of moderate hearing loss reinforces the likelihood of progressive cochlear damage and underscores the importance of early detection and intervention to prevent irreversible auditory impairment.

Audiometric evaluation revealed significantly higher bone conduction thresholds in the diseased ear compared to the control ear ( $p < 0.001$ ), particularly at higher frequencies. This pattern supports the hypothesis that cochlear damage, especially to the basal turn, results from inflammatory mediator diffusion through the round window. Similar findings were reported by Thakur et al. and Rana et al. [26, 30].

This study has several limitations that should be acknowledged. First, its cross-sectional design limits the ability to assess the progression of sensorineural hearing loss over time, and the relatively short study period may not fully capture the chronic effects of long-standing disease. Additionally, the sample size was modest, which may reduce the statistical power and limit the generalizability of the findings to broader populations. As the study was conducted at a single center, the results may not be representative of other demographic or geographic settings. Furthermore, some data relied on patient recall, introducing the potential for recall bias, particularly regarding disease duration and past medical interventions. The development of SNHL in patients with CSOM can significantly impact quality of life, particularly when it coexists with conductive hearing loss.

Based on the current findings, several recommendations are proposed to mitigate this risk. Future studies should include larger sample sizes and adopt multicenter designs to enhance the validity and generalizability of the results. Additionally, longer follow-up through prospective longitudinal studies, such as cohort designs, is essential to better understand the progression of SNHL in CSOM. Routine auditory monitoring is advised to facilitate early detection of SNHL and enable timely interventions aimed at preventing irreversible cochlear damage, including the consideration of early tympanoplasty.

Finally, an aggressive management strategy is recommended for patients with CSOM, particularly those exhibiting risk factors for SNHL, to preserve auditory function and improve long-term outcomes.

## CONCLUSION

Mucosal CSOM was associated with sensorineural hearing loss in 15% of cases, particularly among patients with longer disease duration and active disease. The findings suggest that prolonged exposure to inflammatory mediators and toxins passing through the round window membrane may lead to cochlear damage and progressive hearing impairment. Patients with mixed hearing loss showed significantly elevated bone conduction thresholds in the diseased ear compared to the control ear, with high-frequency hearing more affected than speech frequencies.

## ETHICAL DECLARATIONS

### • Ethics Approval and Consent to Participate

All participants gave informed consent before being enrolled in the study. Ethical approval was granted by the Ethics Committee of the College of Medicine, Mustansiriyah University (Document No. 8041, dated 29 October 2024).

### • Consent for Publication

Non.

### • Availability of Data and Material

The datasets are available from the corresponding author upon reasonable request.

### • Competing Interests

The authors declare that there is no conflict of interest.

### • Funding

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### • Use of Generative Artificial Intelligence

The authors declare that no generative artificial intelligence tools were used in the preparation, writing, or editing of this manuscript.

## • Authors' Contributions

All authors contributed significantly, directly, and intellectually to the work and consented to its publication.

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