

Sensorineural hearing loss in patients with chronic suppurative otitis media: Is there a significant correlation?Amin Amali¹, Nima Hosseinzadeh², Shahram Samadi³, Shirin Nasiri², Jayran Zebardast⁴

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Type of article: Original**Abstract**

Introduction: Hearing loss as a sequel of chronic suppurative otitis media (CSOM) is often conductive, but recent studies have found an additional sensorineural component in these patients, thus demonstrating inner ear damage. The aim of the study was to determine the association between CSOM and sensorineural hearing loss (SNHL) and to assess the influence of patient's age, duration of disease, and presence of cholesteatoma and ossicular erosion on the degree of SNHL.

Methods: In a retrospective study, the medical records of 119 patients who underwent surgery was reviewed. Seventy patients met the inclusion criteria of unilateral otorrhea, normal contralateral ear on otoscopy, and age between 10–65 years with no history of head trauma or ear surgery or familial hearing loss. Bone conduction (BC) thresholds for affected and contralateral ear were measured at frequencies of 500, 1000, 2000, and 4000 Hz. Data analysis was performed using SPSS 13 with independent-samples t-test, Pearson correlation test, and two-tailed analysis. A $p \leq 0.05$ was considered statistically significant.

Results: Significant higher BC thresholds were found in the affected ear than in the normal ear for each frequency ($p < 0.001$), which increased with increasing frequency (7.00 dB at the 500 Hz and 9.71 dB at the 4000 Hz). There was a significant correlation between age and degree of SNHL ($r = 0.422$, $p < 0.001$) but no significant correlation was in duration of the disease ($r = 0.119$, $p > 0.05$). There was no relationship between presence of cholesteatoma and ossicular erosion with SNHL ($p > 0.05$).

Conclusion: These findings demonstrate that CSOM is associated with some degree of SNHL and cochlear damage, and higher frequencies are more affected. Aging can act as a precipitating factor in this pathological process.

Keywords: Hearing loss, Sensorineural, Otitis media, Suppurative, Bone conduction

1. Introduction**1.1. Background**

Chronic suppurative otitis media (CSOM) is the chronic inflammation of the middle ear fossa with discharge through a perforated tympanic membrane. CSOM is the most chronic infectious disease in children (1) and is considered the leading cause of acquired hearing loss (2). Hearing loss is a public health problem in developed and developing countries. In the United States, 48.1 million or 20.3% of the population older than 12 years have unilateral or bilateral hearing loss (3). Hearing loss causes impaired language development and speech skills in children and poorer life quality and psychological problems for adults (2, 4).

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Received: August 12, 2016, Accepted: January 11, 2017, Published: February 2017

iThenticate screening: January 11, 2017, English editing: February 01, 2017, Quality control: February 09, 2017

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1.2. Statement of problem

Tympanic membrane rupture and ossicular chain changes often result in conductive hearing loss in CSOM (5). Recently numerous studies have reported an additional sensorineural hearing loss (SNHL) in these patients, demonstrating impaired cochlear function (5-7). Kaur et al. (8) and De Azevedo et al. (9) found a 24% and 13% incidence of SNHL in CSOM patients, respectively. Several studies also have investigated the correlation between SNHL with patient's age, duration of the disease, and presence of cholesteatoma and ossicular erosion. Kolo et al. (10) found a significant degree of SNHL in patients with CSOM, but the patient's age and duration of otorrhea did not have any correlation with it. Raqib (11) and Kaur (8) observed a significant relationship between SNHL and the disease duration.

1.3. Objective of research

The objective of the current study was to evaluate the association between CSOM and SNHL in patients who underwent surgery in a tertiary referral university hospital, Tehran, Iran, between 2011 and 2013. We also aimed to assess the correlation among patient's age, duration of disease, and presence of cholesteatoma and ossicular erosion with the degree of SNHL.

2. Material and Methods

2.1. Research design and participants

A cross-sectional study was carried out from April 2011 to March 2013 in Tehran, Iran. The medical records of patients who underwent middle ear surgery in the Imam Khomeini Hospital complex, Valiasr Hospital, were evaluated. Patients were recruited based on the following inclusion criteria: 1) presence of unilateral otorrhea lasting at least for 3 months and tympanic membrane perforation on otoscopy; 2) normal tympanic membrane in contralateral ear based on otoscopy; 3) patients with age ranging from 10–65 years. Patients were excluded if they had a history of head trauma or traumatic tympanic membrane perforation, meningococcal meningitis, chronic exposure to noise, prior ear surgery, previous ototoxic drug therapy, and family history of congenital or acquired hearing loss.

2.2. Measurement tool and data collection

Demographic variables, duration of the disease, main symptoms, and pure tone audiometry (12) results were obtained from the patients' medical records by a qualified otorhinolaryngologist and recorded in valid and reliable data forms. To define the presence of cholesteatoma and ossicular erosion, we assessed the reports of the operation and direct observation of the surgeon. Bone conduction (BC) hearing thresholds for both diseased and control ear at frequencies 500, 1000, 2000, and 4000 Hz were extracted to determine the SNHL.

2.3. Ethical consideration

The institutional review board of our university approved this study and aspects of its research ethics (registration number: 21853). Patients' information during and after the study remained confidential.

2.4. Statistical analysis

Data analysis was performed using SPSS 13 (SPSS Inc., Chicago, Illinois, United States of America). Independent-samples t-test was used to evaluate differences between bone-conduction thresholds for affected and control ears for each patient. A Pearson correlation test was used to determine the association among age, duration of disease, and degree of SNHL as well. Two-tailed analysis was applied for all of these tests, and a $p \leq 0.05$ was considered statistically significant.

3. Results

The medical records of 119 patients were reviewed, and only 88 patients met the inclusion criteria. Twelve patients excluded because of the previous ear surgery, six patients had history of trauma, family history of hearing loss, and incomplete medical records. Seventy patients, including 36 females (51.4%) and 34 males (48.6%) with mean age \pm SD of 37.9 ± 15 years (ranging from 11 to 65 years), were selected for analysis. Mean duration \pm SD of the disease was 6.5 ± 7.06 years ranging from 3 months to 30 years. Most common symptoms of the patients were hearing loss (94.3%), Otorrhea (81.4%), tinnitus (37.1%), otalgia (27.1%), and vertigo (12.9%). The mean BC threshold in the affected ear was 21.41 dB (SD = 15.95), and 13.21 dB (SD = 10.29) in the normal ear ($p < 0.001$). Table 1 shows paired bone-conduction threshold averages for the affected and normal ears across the frequencies (500, 1000, 2000, and 4000 Hz). There were higher thresholds in the affected ear than in the normal ear for each frequency. All of them were statistically significant ($p < 0.001$) The mean BC threshold differences between affected and normal ears range from 7.00 to 9.71 dB across the frequencies, which tend to increase with increasing frequency. A significant

correlation between the patients' age and degree of SNHL was observed across the tested frequencies ($r = 0.295$, $p = 0.013$; $r = 0.398$, $p = 0.001$; $r = 0.287$, $p = 0.016$; $r = 0.497$, $p < 0.001$ for the frequencies 500, 1000, 2000 and 4000 respectively. $r = 0.422$, $p < 0.001$ for mean of them). Although the correlation between duration of the disease and degree of SNHL was investigated, no statistically significant correlation was found between them ($r = 0.041$, $p > 0.05$; $r = 0.081$, $p > 0.05$, $r = 0.126$, $p > 0.05$; $r = 0.161$, $p > 0.05$ for the frequencies 500, 1000, 2000, and 4000 respectively. $r = 0.119$, $p > 0.05$ for mean of them). Eight patients (11.4%) had cholesteatoma in their surgical reports. Table 2 shows mean BC threshold differences between the affected and normal ears based on the presence of cholesteatoma. No significant difference was found between ears with or without cholesteatoma across all frequencies ($p > 0.05$). Ossicular erosion was seen in 13 patients (18.6%). Table 3 shows the affected ears divided on the basis of the presence or absence of ossicular erosion. No significant difference was observed in mean BC threshold differences between those with or without cholesteatoma across the tested frequencies ($p > 0.05$).

Table 1. Paired bone-conduction threshold averages for the affected and normal ears

Frequency (Hz)	Bone conduction thresholds		p-value
	Affected ear	Normal ear	
500	17.57 ± 13.93 ^a	10.57 ± 9.07	<0.001
1000	18.36 ± 16.30	10.81 ± 9.96	<0.001
2000	21.71 ± 16.92	13.21 ± 12.10	<0.001
4000	28.00 ± 21.42	18.29 ± 14.77	<0.001

^aMean ± Standard Deviation

Table 2. Mean BC threshold differences between the ears based on the presence of cholesteatoma

Frequency (Hz)	Mean BC threshold difference		p-value
	Without cholesteatoma (n=62)	With cholesteatoma (n=8)	
500	7.34	4.37	0.489
1000	8.11	3.12	0.286
2000	8.63	7.5	0.815
4000	10.24	5.62	0.418

Table 3. Mean BC threshold differences between the ears based on the presence of ossicular erosion

Frequency (Hz)	Mean BC threshold difference		p-value
	Without ossicular erosion (n=57)	With ossicular erosion (n=13)	
500	7.37	5.38	0.572
1000	7.63	7.15	0.901
2000	8.68	7.69	0.801
4000	10.35	6.92	0.463

4. Discussion

Although several studies have proposed the association between CSOM and SNHL, there is still lack of consensus about its importance. In the current study, we investigated the medical records of the CSOM patients to evaluate the association among SNHL and CSOM, age, duration of otorrhea, and presence of cholesteatoma and ossicular erosion. A significant increase was found in BC thresholds in the diseased ear in comparison with the normal ear across the speech frequencies (500, 1000, 2000, and 4000 Hz). There was a greater difference in the high frequencies than in the low frequencies (7.00 dB at 500 Hz increasing to 9.71 dB at 4000 Hz). Our findings comply with those found by Noordzij et al. (13) and Levine et al. (14). In a similar study, MacAndie and O'Reilly (6) found a significant degree of SNHL in the diseased ear, which tended to be increased in higher frequencies. These findings supports the hypothesis that proposes middle ear inflammation may change the permeability of round window membrane, so remnants of the bacteria such as endotoxins could pass through it and cause dysfunction of the inner ear, especially in high-frequency region anatomically located close to the round window (15, 16). A direct and strongly significant correlation was observed between patients' age and the degree of SNHL ($r = 0.422$, $p < 0.001$). Redaelli et al. (17) and Vartiainen (18) also have reported similar findings. It seemed that older patients are more vulnerable to the effects of middle ear inflammation on cochlear function, and this can intensify hearing impairment due to aging. Age-related hearing loss (ARHL) or presbycusis is one of the most common disabilities in elderly people, which affects approximately 27.6% of individuals between 65 to 79 years and 36.5% of those aged 80 and older (19). To decrease the effect of ARHL, we excluded patients older than 65 years and considered the mean BC

threshold differences for analysis because presbycusis often cause bilateral and symmetric hearing loss. There was no significant correlation between duration of otorrhea and degree of SNHL. ($r = 0.119$, $p > 0.05$). Our findings are consistent with those found in several studies (6, 10, 13). In contrary, Papp (20) found that bone conduction threshold at either the speech frequencies or at 4 kHz increased gradually according to the duration of the CSOM. In a study with similar methodology, SNHL was progressively increased with increasing the CSOM duration (8).

Comparison of the ears with and without cholesteatoma showed no significant association between presence of cholesteatoma and SNHL; nevertheless, there were only eight patients with cholesteatoma and such number of patients might be not enough to judge about it. This concurs with the findings of MacAndie (6) and de Azevedo (9). Although the number and proportion of CSOM patients with cholesteatoma in their studies was greater than our study, they found no difference in SNHL between patients with or without cholesteatoma. The present study did not demonstrate a significant relation between ossicular erosion and severity of SNHL ($p > 0.05$), but Levine et al. (14) found significant association with the presence of ossicular erosion and SNHL. We used a strict criterion to decrease the effect of confounding factors, but we could not exclude patients using topical ototoxic antibiotics. Medications such as topical aminoglycosides are commonly used for treatment of otitis, and nearly all patients have used them before ear surgery. There is still controversy about their toxicity and effects on cochlear function. In the investigations of Lundy and Graham about toxicity of ototoxic medications, from 2235 otolaryngologists only 3.4% reported irreversible inner ear damage. Also 80% of respondents mentioned that the risks for ototoxicity of otitis media is greater than using ototoxic preparations (21) Browning et al. (22) used gentamicin in their investigations on adults with chronic otitis media and found no evidence of ototoxic inner ear damage. The difference found in BC thresholds between the affected and normal ear is significant but small. This difference only demonstrates the audiometric changes and might have a negligible influence on patient's hearing in comparison with the changes in tympanic membrane and ossicular chains. Further studies are needed to elucidate this subject. In addition, the Carhart's effect must be considered when dealing with bone conduction thresholds in chronically infected ears. In chronic otitis media, mechanical occlusion of the window by granulations, cholesteatoma and pus, or stiffness of the ossicular chain may result in loss of bone conduction (23).

5. Conclusions

A significant association between SNHL and CSOM was found in this study. The difference in BC thresholds increased with increasing frequency. Patients' age was significantly correlated with the degree of SNHL, but no significant association was observed between SNHL with duration of disease and presence of cholesteatoma and ossicular erosion. However, these findings demonstrate significant audiometric cochlear damage, clinical relevancy should be evaluated in future studies.

Acknowledgments:

Tehran University of Medical Sciences and Health Services Grant supported this study, and this article was extracted from a thesis prepared by Mr. Nima Hosseinzadeh.

Conflict of Interest:

There is no conflict of interest to be declared.

Authors' contributions:

All authors contributed to this project and article equally. All authors read and approved the final manuscript.

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