



# Clinical evaluation of inner ear changes as result of chronic otitis media and its surgery

## Kronik otitis media ve cerrahisi sonucunda görülen iç kulak değişikliklerinin klinik değerlendirmesi

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### ABSTRACT

**Objectives:** This study aims to evaluate whether chronic otitis media (COM) may cause inner ear damages or middle ear surgery may improve this damage with regard to sensorineural hearing loss (SNHL) and tinnitus and dizziness-related disability.

**Patients and Methods:** An observational prospective study was performed on a series of 65 patients (41 males, 24 females; mean age 26.4±12.6; range 11 to 62 years) who were diagnosed with COM and were scheduled for surgical intervention at the Department of Otorhinolaryngology of the Haydarpaşa Numune Education and Research Hospital. Patients were divided into two subgroups as tympanoplasty and mastoidectomy group according to the surgical procedure. Standard patient work-up included otomicroscopy, pure tone audiometry and completion of the Turkish translation of Dizziness Handicap Inventory (DHI) and Tinnitus Handicap Inventory (THI) before surgery and eight weeks after surgery.

**Results:** We found higher bone conduction thresholds in the group of patients with mastoidectomy preoperatively. There was a statistically significant difference in the mean preoperative and postoperative THI and DHI scores between the groups (p<0.05).

**Conclusion:** Our study results suggest that a successful surgery results in improved tinnitus and vertigo symptoms in patients with COM.

**Keywords:** Chronic otitis media; tinnitus; vertigo.

### ÖZ

**Amaç:** Bu çalışmada kronik otitis media (KOM)'nın iç kulak hasarına yol açıp açmadığı veya sensörinöral işitme kaybı, tinnitus ve baş dönmesi açısından, bu hasarın orta kulak cerrahisi ile düzeliş düzelmediği değerlendirildi.

**Hastalar ve Yöntemler:** Haydarpaşa Numune Eğitim ve Araştırma Hastanesi Kulak Burun Boğaz Kliniği'nde KOM tanısı konulan ve cerrahi planlanan 65 hasta (41 erkek, 24 kadın; ort. yaş 26.4±12.6 yıl; dağılım 11-62 yıl) serili gözlemsel prospektif bir çalışma yapıldı. Hastalar cerrahi işleme göre timpanoplasti ve mastoidektomi grubu olarak iki alt gruba ayrıldı. Standart hasta değerlendirmesi cerrahi öncesi ve cerrahiden sekiz hafta sonra uygulanan otomikroskopi, saf ses odyometrisi, Baş Dönmesi Engellilik Envanteri (DHI) ve Tinnitus Engellilik Anketininin (THI) tamamlanmasını içerdi.

**Bulgular:** Mastoidektomili hasta grubunda ameliyat öncesi kemik yolu işitme eşikleri daha yüksek bulundu. Ameliyat öncesi ve ameliyat sonrası THI ve DHI skorları açısından gruplar arasında istatistiksel olarak anlamlı bir fark görüldü (p<0.05).

**Sonuç:** Çalışma sonuçlarımız, KOM hastalarının tinnitus ve vertigo semptomlarının başarılı bir cerrahi ile iyileşebileceğini göstermektedir.

**Anahtar Sözcükler:** Kronik otitis media; tinnitus; vertigo.



The association between chronic otitis media (COM) and its inner ear effects has been widely studied in recent years. High frequency sensorineural hearing loss (SNHL) is commonly seen in COM patients in conjunction with the evidence that human temporal bones demonstrated more severe pathological changes in the basal turn of the cochlea. Furthermore Joglekar et al.<sup>[1]</sup> also demonstrated labyrinthine inflammatory changes in temporal bones of COM patients.

The actual clinical repercussions of these changes continue to be discussed and remain a controversial topic. While there are many studies investigating the correlation between COM with SNHL, tinnitus and vertigo, we evaluated all these parameters in a single study.

The major aim of this study was to evaluate whether COM causes inner ear damage with regard to SNHL and reported tinnitus and dizziness-related disability. Secondary aims were to investigate the effect of extent of pathological changes in the middle ear and different otologic surgeries on tinnitus and vertigo symptoms using the tinnitus handicap inventory (THI) and dizziness handicap inventory (DHI).

#### PATIENTS AND METHODS

Approval was obtained from Haydarpasa Numune Education and Research Hospital Ethical Committee (HNEAH-KAEK 2012/22). Written informed consent was obtained from all patients.

An observational prospective study was performed on a series of patients who were diagnosed with COM and scheduled for surgical intervention at the Department of Otorhinolaryngology of the Haydarpasa Numune Education and Research Hospital. Patients who had had head trauma, meningitis, labyrinthine fistula, noise exposure or ear surgery, or those who used ototoxic drugs were excluded from the study. A total of 65 patients with COM (41 males, 24 females; mean age 26.4±12.6; range 11 to 62 years) were enrolled in this study. Thirty-nine patients (26 males, 13 females; mean age 26.4±12.6 years) had tympanoplasty and 26 patients (15 males; 11 females; mean age 32.7±17.4 years) had canal wall up tympanomastoidectomy or canal wall down mastoidectomy as a surgical procedure.

The duration of COM ranged from six months to 30 years.

Participants were divided into two subgroups, a tympanoplasty group and mastoidectomy group according to the surgical procedure. Tympanoplasty group patients had chronic dry perforations and mastoidectomy group patients had active disease such as cholesteatoma or polypoid or consistent granulation tissue. Preoperative bone conduction threshold averages and DHI and THI before and after surgery were compared between these two groups.

The standard patient workup included otomicroscopy, preoperative audiogram and completion of two surveys: Turkish translation of DHI and THI.<sup>[2,3]</sup> Bone conduction thresholds were determined at frequencies of 500, 1,000, 2,000 and 4,000 Hz. Patients underwent repeated otomicroscopy, audiogram, DHI and THI surveys at two months postoperatively. Combined together all the data were analyzed.

Statistical analysis was performed using SPSS 10.0 version software program (SPSS Inc., Chicago, IL, USA). Consistent variables were considered as mean ± standard deviation and categorical variables were considered as percent (%). Student t test was used in comparison of quantitative parameters, the normal distribution of parameters and Mann-Whitney U test were used in comparison of abnormal distribution of parameters. Chi-square and Fisher's exact test were used in comparison of categorical variables. Wilcoxon signed rank test was used for considering recursive scale. Significance was evaluated at p<0.05 level.

#### RESULTS

When we compared the preoperative bone conduction threshold averages frequency-by-frequency between the tympanoplasty and mastoidectomy group, we found higher thresholds in the mastoidectomy group. The differences were statistically significant for every tested frequency (p<0.05) (Table 1).

Tympanoplasty and mastoidectomy group patients underwent evaluation of changes in tinnitus and vertigo symptoms following middle ear surgery. We compared these symptoms before and after surgery in each group. Thirty-five participants reported tinnitus preoperatively,

**Table 1.** Comparison of preoperative bone conduction threshold averages between the tympanoplasty and mastoidectomy group

	Tympanoplasty		<i>p</i>
	Mean±SD	Mean±SD	
500 Hz	7.95±6.04	24.23±27.37	0.001
1,000 Hz	7.69±7.51	22.69±28.47	0.003
2,000 Hz	8.85±7.73	28.46±28.03	<0.001
4,000 Hz	7.18±7.42	27.50±32.93	<0.001

SD: Standard deviation.

which completely disappeared in 14 after middle ear surgery. Thirty-three participants reported vertigo symptoms that completely disappeared in 17 after middle ear surgery. Many patients reported complete disappearance of symptoms but only tympanoplasty group demonstrated statistically significant data ( $p<0.05$ ).

It is noteworthy that when we compared the preoperative and postoperative data for THI and DHI scores, we found statistically significant improvement in both the tympanoplasty and mastoidectomy group of patients ( $p<0.05$ ) (Table 2 and 3).

## DISCUSSION

There are many studies suggesting COM originated damage to inner ear function.<sup>[4-6]</sup> It is generally believed that the passage of inflammatory mediators through the round window membrane into the scala tympani induced inner ear damage and SNHL.<sup>[7,8]</sup> MacArthur et al.<sup>[9]</sup> suggested another point of view, that the inner ear could manifest a direct inflammatory response to COM resulting in SNHL. They demonstrated the capability of

cochlear tissues to express cytokine mRNA that contributes to the inflammation and remodeling, occurring in association with middle ear disease.

Sensorineural hearing loss in COM patients was used as a marker of inner ear changes and many studies were done on this entity. Papp et al.<sup>[5]</sup> compared diseased ears with normal contralateral ears and found elevated bone conduction thresholds in the ears with COM. They emphasized that COM associated hearing loss was greater at higher frequency ranges and explained this by closer location of the hair cells to the basal turn of the cochlea and to the round window as these hair cells are responsible for high frequency hearing. Their report is consistent with the present investigation as we found greater bone conduction thresholds at higher frequency ranges in the mastoidectomy group of patients.

Correspondingly the mastoidectomy group of patients had notably higher bone conduction thresholds for every tested frequency in comparison with the tympanoplasty group. The explanation for this might be greater active mucosal disease due to existing cholesteatomatous, polypoid, or thick granulation tissue in the middle ear cavity and patients being associated with increasing morbidity in the mastoidectomy group. Although our data reached statistical significance, the sample of the mastoidectomy group was small that further studies with larger groups should be performed. Besides, contrary to the present study, Redaelli de Zinis et al.<sup>[10]</sup> found no correlation between cholesteatomatous and non-cholesteatomatous cases or between active mucosal disease and dry ears.

**Table 2.** Comparison of tinnitus handicap inventory and dizziness handicap inventory before and after surgery in patients who underwent tympanoplasty procedure

	Tympanoplasty		<i>p</i>
	Preoperative	Postoperative	
	Mean±SD	Mean±SD	
THI	34.45±19.78	13.68±18.40	0.001
DHI	38.00±17.41	11.82±12.82	0.003

SD: Standard deviation; THI: Tinnitus handicap inventory; DHI: Dizziness handicap inventory.

**Table 3.** Comparison of tinnitus handicap inventory and dizziness handicap inventory before and after surgery in patients who underwent mastoidectomy procedure

	Mastoidectomy		<i>p</i>
	Preoperative	Postoperative	
	Mean±SD	Mean±SD	
THI	38.57±24.81	9.71±14.84	0.01
DHI	39.83±21.17	7.83±6.58	0.002

SD: Standard deviation; THI: Tinnitus handicap inventory; DHI: Dizziness handicap inventory.

Previous studies just focused on hearing levels but patients with COM may also have tinnitus and vertigo symptoms. We reported both tinnitus and vertigo symptoms and analyzed THI and DHI scales as we investigated the clinical outcomes of inner ear damage of COM.

Patients with COM usually complain about hearing loss and constant otorrhea. Hence, tinnitus is often neglected by physicians. However, this symptom can be quite a bothersome problem. Although most patients may tolerate tinnitus, it may affect the quality of life of others. The satisfaction expressed by some patients with COM corresponds with the improvement of tinnitus. Baba et al.<sup>[11]</sup> investigated the degree of satisfaction assessed by 'visual analog scale (VAS)' value in patients with COM after tympanoplasty and found improvement in 66% of patients in terms of relation between tinnitus and satisfaction. They emphasized that patients with preoperative tinnitus had had much expectation of tinnitus improvement after the operation.

The actual mechanism of onset of tinnitus as a complication of COM is unknown but we hypothesized that tinnitus might be dependent on cochlear damage. This is supported by histological studies.<sup>[1]</sup>

We evaluated tinnitus symptoms of participants before and after middle ear surgery. Although it was not a primary complaint, 35 patients had a complaint of tinnitus and this symptom completely disappeared in 15 of 35 patients following surgery. When we compared the change of tinnitus symptoms after surgery in each group, although many patients reported complete disappearance of symptoms following middle ear surgery, the only statistically significant difference was detected in the tympanoplasty group ( $p < 0.05$ ). These results were consistent with those found by Lima et al.<sup>[12]</sup> who, in a similar study of 23 patients, reported that eight patients (34.8%) had full remission and 11 patients (47.8%) had some improvement after tympanoplasty. Moreover Kim et al.<sup>[13]</sup> investigated the clinical features of tinnitus in patients with COM and evaluated changes in tinnitus following middle ear surgery using THI. They observed diminished THI scores in 82% of patients (23/28). They demonstrated that the group of patients whose THI scores were reduced by more than 10

showed a significantly greater improvement in mean air-conduction thresholds.<sup>[13]</sup> Many studies evaluated the correlation between tinnitus and tympanoplasty procedure, nevertheless the data regarding the correlation between tinnitus and mastoidectomy procedure are scarce.<sup>[13,14]</sup> Habesoglu et al.<sup>[15]</sup> investigated the relationship between many types of otologic surgeries and tinnitus and they found no difference between preoperative and postoperative THI scores according to type of surgeries. Similarly we hypothesized that not only the improvement of air-conduction thresholds but also the eradication of middle ear inflammation and its inner ear effect that might also occur with mastoidectomy procedures could induce elimination or reduction of tinnitus symptoms following both surgical procedures. Besides it is noteworthy that we observed statistically significant reductions in THI scores following both surgical procedures. This finding is consistent with our hypothesis that after eradication of middle ear inflammation, repair of a perforated tympanic membrane, and/or restoration of hearing, patients might experience favorable variance in tinnitus symptoms following surgery.

Lastly when a history of dizziness/vertigo is obtained from a patient with COM, labyrinthine fistulization comes into mind initially. However some patients with COM may have dizziness/vertigo symptoms without any fistulization. Although the incidence of clinical labyrinthitis is ~5% for otitis media,<sup>[16,17]</sup> it is believed that the incidence of pathological labyrinthine changes could be more severe. This idea was supported by the histological experiments of temporal bones. Joglekar et al.<sup>[1]</sup> showed 19% labyrinthine inflammatory changes in temporal bones with COM. Meyerhoff et al.<sup>[18]</sup> reviewed 123 temporal bones with COM accompanied by labyrinthitis. Takumida and Anniko<sup>[19]</sup> suggested that COM could destroy not only the cochlea but also the vestibular end organs.

Recently, some reports with a set of vestibular tests have been done to evaluate the labyrinthine dysfunction in patients with COM. A high rate of abnormal results in vestibular function tests such as caloric tests, rotational chair testing and other vestibular tests were reported in patients with COM.<sup>[20,21]</sup> We could not perform these tests as we do not have videonystagmography.

Lee et al.<sup>[22]</sup> demonstrated that despite any complaint of definite vestibular symptoms, an high incidence of vestibular impairment in patients with unilateral COM was observed.

The results of our study are consistent with all of the studies mentioned above. In the present study, the history of dizziness/vertigo was obtained from 23 of 65 patients with COM. This symptom completely disappeared in seven of these patients. Additionally DHI scores were significantly reduced following both surgical procedures.

Combined together, improvement of tinnitus and dizziness/vertigo symptoms with diminished THI and DHI scores confirms the hypothesis that the clinical outcomes of inner ear damage in patients with COM could be alleviated and afford a better quality of life to patients with COM following middle ear surgery.

Having no placebo group could be considered as a limitation of this study. Tinnitus and vertigo are subjective symptoms and we cannot assess their objective improvement after surgery. Other possible factors, such as emotional stability after surgery or satisfaction with surgical outcomes, vary in each individual, which may also have exerted an influence on the results of THI and DHI scores. In this study, we couldn't create a placebo group because it could have been ethically inappropriate to convince the unoperated patients that they had been undergone surgery.

Consequently, an important contribution of this study is that tinnitus and vertigo symptoms could also be quite bothersome problems and affect the quality of life in patients with COM and improvement could fortunately be observed following middle ear surgery. However further studies with larger groups should be performed in order to confirm these findings.

### Conclusions

1. Chronic otitis media damage on inner ear function is a widely accepted issue. Although the actual clinical outcomes of these changes remain controversial, many studies demonstrated SNHL.
2. After surgery, pronounced improvement of tinnitus and vertigo symptoms in patients with COM have been observed.
3. In summary, surgeons should document not only the hearing loss and otorrhea but also tinnitus/vertigo symptoms preoperatively. As this study suggests that even though patients with COM are usually more inconvenienced by hearing loss and otorrhea rather than by tinnitus and vertigo, these symptoms could also be quite bothersome problems and affect quality of life. Fortunately, improvement can be observed following middle ear surgery. This study and others in the literature suggest that the inner ear effect of COM is an accepted issue and clinical outcomes could be ameliorated after surgery.

### Declaration of conflicting interests

The authors declared no conflicts of interest with respect to the authorship and/or publication of this article.

### Funding

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

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