

# Hearing outcomes after suppurative chronic otitis media surgery

## Süpüratif kronik otitis media cerrahisi sonrası işitme sonuçları

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### ABSTRACT

**Objectives:** This study aims to compare the hearing outcomes after canal wall up mastoidectomy (CWUM) and canal wall down mastoidectomy (CWDM).

**Patients and Methods:** Ninety-two patients (74 males, 18 females; mean age 30.1 years; range 9 to 67 years) who were diagnosed with chronic suppurative otitis media (CSOM) between January 2009 and May 2011 were enrolled in this retrospective study. Based on hospital data, patients were separated into two groups as having mucosal or squamous disease. Patients were also categorized into two groups based on the type of mastoidectomy: CWUM (n=51) and CWDM (n=41). Hearing results between the groups were evaluated using the air-bone gap (ABG) recorded by audiogram before surgery and at three months after ossiculoplasty. Relationship between obtained hearing results and performed ossiculoplasty techniques were also discussed.

**Results:** We were able to perform ossiculoplasty in 42.3% (n=39) of patients diagnosed with CSOM. Presurgical ABG in CWUM and CWDM groups were 35.38±10.82 dB and 37.92±5.80 dB, respectively. Postsurgical ABG value was ≤20 dB in 27% of CWUM patients and 7.7% of CWDM patients. Mean hearing gain of patients with active squamous disease was 3.8 dB in CWUM group and 11.9 dB in CWDM group (p<0.5).

**Conclusion:** The pathology affecting the middle ear had influence on the hearing results of the two groups. Canal wall down mastoidectomy may be a beneficial procedure to improve hearing in patients with CSOM.

**Keywords:** Chronic suppurative otitis media; hearing gain; ossicle; surgery.

### ÖZ

**Amaç:** Bu çalışmada açık kavite teknik (AKT) ve kapalı kavite teknik (KKT) ile mastoidektomi sonrası işitme sonuçları karşılaştırıldı.

**Hastalar ve Yöntemler:** Ocak 2009 - Mayıs 2011 tarihleri arasında kliniğimizde kronik süpüratif otitis media (KSOM) tanısı konulan 92 hasta (74 erkek, 18 kadın; ort yaş 30.1 yıl; dağılım 9-67 yıl) bu retrospektif çalışmaya alındı. Hastalar hastane verilerine dayanılarak mukozal veya skuamöz hastalıklı olarak iki gruba ayrıldı. Hastalar mastoidektomi tipine göre de iki grup olarak sınıflandırıldı: KTM (n=51) ve ATM (n=41). İki grup arasındaki işitme sonuçları cerrahi öncesi ve ossiküloplastiden üç ay sonra odyogram ile kaydedilen hava-kemik aralığı (HKA) kullanılarak değerlendirildi. Elde edilen işitme sonuçları ile uygulanan ossiküloplastik teknikleri arasındaki ilişki de tartışıldı.

**Bulgular:** Ossiküloplastik KSOM tanısı konulan hastaların %42.3'üne (n=39) yapılabildi. Kapalı teknik mastoidektomi ve ATM gruplarında cerrahi öncesi HKA sırasıyla 35.38±10.82 dB ve 37.92±5.80 dB idi. Kapalı teknik mastoidektomi hastalarının %27'sinde ve ATM hastalarının %7.7'sinde cerrahi sonrası HKA değeri ≤20 dB idi. Aktif skuamöz hastalığı olan hastaların ortalama işitme kazancı KTM grubunda 3.8 dB, ATM grubunda 11.9 dB idi (p<0.5).

**Sonuç:** Orta kulağı etkileyen patoloji iki grubun işitme sonuçları üzerinde etkiliydi. Açık kavite teknik mastoidektomi KSOM'lu hastalarda işitmeyi iyileştirmede faydalı bir işlem olabilir.

**Anahtar Sözcükler:** Kronik süpüratif otitis media; işitme kazancı; ossikül; cerrahi.



Achieving successful hearing outcomes following tympanomastoidectomy in patients with chronic suppurative otitis media (CSOM) depend on several factors. Besides experience of the surgeon, pathology in the middle ear and extent of disease influence the choice of treatment procedure.<sup>[1,2]</sup> In the past, eradication of disease was the primary target in the treatment of cholesteatoma. Therefore, radical mastoidectomy was the most popular procedure in cases of extensive cholesteatoma. Since the first half of the 20<sup>th</sup> century, hearing protection or restoration has also become a priority of treatment. But this goal is not always attainable because inadequate or improper surgery can cause residual or recurrent disease.<sup>[3-5]</sup>

Several prognostic factors affect hearing results. Black<sup>[6]</sup> and Kartush<sup>[7]</sup> used statistical methods to exclude confounding factors and determine the factors that have a significant impact on successful hearing outcomes. Austin<sup>[8]</sup> also emphasized that residual ossicles are the most important prognostic factor for ossiculoplasty success.

Recently, surgical procedures were classified into two categories; canal wall up mastoidectomy (CWUM) and canal wall down mastoidectomy (CWDM).<sup>[9]</sup> However, deciding which surgical procedure should be chosen for best hearing gain is still controversial. Tos and Lau<sup>[3]</sup> argued that postoperative hearing results in patients that underwent CWUM were better than those who underwent CWDM. However, Cook et al.<sup>[4]</sup> did not find any significant difference in postoperative hearing results between the two surgical procedures.

Our study evaluated postoperative hearing gains in CSOM patients that underwent mastoidectomy. Functional results were discussed according to tympanomastoidectomy options and compared with the literature.

#### PATIENTS AND METHODS

Ninety-two patients (74 males, 18 females; mean age 30.1 years; range 9-67 years) who underwent tympanomastoidectomy for CSOM in our clinic between January 2009 and May 2011 were analyzed, retrospectively. We reviewed the medical records to obtain demographics as well as hearing outcomes of the patients. The age, gender, surgical procedure, surgical findings, and the

type of material used in ossicular reconstruction were noted. The postoperative pure tone audiometric thresholds were recorded on the last follow-up visit. The included data was obtained at least three months after ossiculoplasty. Hearing results following the guidelines of the Committee on Hearing and Equilibrium of the American Academy of Otolaryngology Head and Neck Surgery standards were adapted to reflect the UK practice of not routinely recording hearing levels at 3 kHz. The pure tone average (PTA) was calculated as a mean of thresholds at 0.5, 1, 2, and 4 kHz.<sup>[9]</sup> Hearing gain was defined according to preoperative and postoperative PTA values. Air-bone gap (ABG) was calculated from air-conduction and bone-conduction thresholds. Preoperative and postoperative mean ABG and hearing gains were calculated for evaluation of surgical success. Patients were divided into two groups based on the type of mastoidectomy: the CWUM group (n=51) and the CWDM group (n=41). The mean postoperative ABG were divided into four groups ( $\leq 20$  dB, 21-30 dB, 31-40 dB and  $>40$  dB) in patients that underwent tympanomastoidectomy with ossiculoplasty. Hearing gains after surgery were classified into two groups ( $<10$  dB and  $>10$  dB). A postoperative ABG of 20 dB or less and a  $>10$  dB hearing gain were taken to represent successful surgery. We also analyzed the effects of the ossicular reconstruction materials on the hearing results. We compared the difference of the mean postoperative ABG and the ABG closure between the CWUM and CWDM groups, and assessed the effect of the ossicular reconstruction material on hearing.

Analysis of the results was made using SPSS for Windows version 17.0 software program (SPSS Inc., Chicago, IL, USA). Relations between two groups and variables were calculated with chi square Fisher's exact test and chi-square with Yates correction. All *p* values were two-tailed and the statistical significance was set at  $p < 0.05$ .

#### RESULTS

All patients were operated on via retro-auricular approach under general anesthesia. Revision CWUM was carried out in 16/51 patients (11 patients with revision ossiculoplasty), while 17/41 patients (7 patients with revision ossiculoplasty) had revision

**Table 1.** Relationship between age group and tympanomastoidectomy type in patients

Mastoidectomy type	Number of patients ≤18 years		Number of patients >18 years		Total patients n
	n	%	n	%	
	Canal wall down mastoidectomy	5	23.8	36	
Canal wall up mastoidectomy	16	76.2	35	49.3	51
<i>Total</i>	21		71		92

CWDM. The relationship between age and tympanomastoidectomy options is shown in Table 1. The postoperative follow-up period after ossiculoplasty was 3-12 months.

The existing middle ear pathologies were evaluated. Active squamous COM was present in 71 (77.2%) of 92 patients while active mucosal COM (middle ear mucosa filled with granulation tissue) was present in the remaining 21 (22.8%) of 92 patients. There was an intact malleus in 47/92 (51%) patients and intact stapes suprastructure in 38/92 (41%) patients. Malleus and stapes suprastructure were intact in 28 (30.4%) patients. The relationship between middle ear disease and postoperative hearing gain in patients that underwent CWDM and CWUM is shown in Table 2.

Ossiculoplasty was carried out in 39/92 (42.4%) of the patients in our study. The relationship between tympanomastoidectomy and ossiculoplasty options is shown in Table 3. There was a significant relationship between tympanomastoidectomy type and ossiculoplasty option (p=0.06).

We compared the hearing outcomes according to the materials used in ossiculoplasty. Regarding the types of reconstruction material, autologous material was used in 12/26 (46.1%) of patients that underwent CWUM with ossiculoplasty. The stapes and/or the footplate were intact in this CWUM subgroup. Bone cement was used in 7/26 (26.9%) of the patients; the stapes suprastructure was intact in all patients in this subgroup. Prosthesis was used in 7/26 (26.9%) of the patients;

**Table 2.** Relationship between middle ear disease and postoperative hearing gain in patients that underwent canal wall down mastoidectomy and canal wall up mastoidectomy

Patients (n=92)	Mean (preoperative) ABG/dB	Mean (postoperative) ABG/dB	Mean gain dB	p
Mucosal disease				
CWDM (n=1)	25	18	7	-
CWUM (n=20)	37.1±11.08	28.9±14.25	8.2	-
Squamous disease				
CWDM (n=40)	38.6±4.95	26.6±7.91	11.9	0.453
CWUM (n=31)	36.3±9.67	32.5±10.94	3.8	

ABG: Air-bone gap; CWDM: Canal wall down mastoidectomy; CWUM: Canal wall up mastoidectomy.

**Table 3.** Ossiculoplasty option between mastoidectomy type and option of ossiculoplasty

Mastoidectomy type	Number of patients CWDM		Number of patients CWUM		Total patients	p
	n	%	n	%		
	Applied	13	31.7	26		
Not applied	28	68.3	25	49.1	53	
<i>Total</i>	41		51		92	

CWDM: Canal wall down mastoidectomy; CWUM: Canal wall up mastoidectomy.

**Table 4.** Relationship between tympanomastoidectomy option and ossiculoplasty materials

Ossiculoplasty material	CWUM		CWDM		Total	
	n	%	n	%	n	%
Autologous	12	46.1	10	76.9	22	56.4
Prosthesis	7	26.9	3	23.1	10	25.6
Bone cement	7	26.9	-	-	7	17.9
Total	26		13		39	

CWUM: Canal wall up mastoidectomy; CWDM: Canal wall down mastoidectomy.

only footplates were intact and mobile in this subgroup of patients. In patients that underwent CWDM; autologous material was used in 10/13 (76.9%) of the patients, while prosthesis was used in 3/13 (23.07%) of the patients. The stapes suprastructure was intact in only 4/13 (30.7%) of patients with CWDM (Table 4).

The mean pre- and postoperative ABG and surgical gains are shown in Table 5. Hearing gain averaged 12.52 dB in patients that underwent CWDM with ossiculoplasty. This value was higher than in the CWUM group. No significant relation was found between tympanomastoidectomy options and postoperative hearing gains. However, mean ABG gains were 3.8 dB in patients that underwent CWUM and 11.9 dB in patients that underwent CWDM for active squamous disease ( $p < 0.5$ ).

The relationship between postoperative ABG values and surgical techniques are given in Table 6. Postoperative ABG levels were found to be  $\leq 20$  dB in only eight of the 39 (20.5%) patients that underwent ossiculoplasty in our study.

## DISCUSSION

Chronic suppurative otitis media is a chronic infection or inflammation of the middle ear and mastoid. It is accompanied by otorrhea

and hearing loss. Treatment objectives include eradication of infection and restoration of tympanic membrane and hearing. Achieving all of these parameters in CSOM patients is difficult and controversial.<sup>[10,11]</sup> Although ear surgery has been quite developed in the last 20-30 years, the most appropriate surgical procedure is not clear in some patients with CSOM. Postoperative hearing results are affected by certain variables such as current otorrhea, perforation type, ossicular status, granulation tissue or cholesteatoma in the middle ear. Canal wall up mastoidectomy or CWDM techniques were preferred for eradication of disease according to these changing conditions, with advantages and disadvantages of each technique.<sup>[7,8,12]</sup>

Although open cavity techniques are preferred over other techniques for common cholesteatoma, it has been stated in several studies that long-term hearing results in closed techniques are at least as successful as open techniques in treating cholesteatoma. Although recurrence has been more associated with closed cavity techniques, this risk cannot be eliminated entirely by open-cavity techniques.<sup>[4,12]</sup> In our study, a similar recurrence rate was observed in both groups. However, ossiculoplasty was possible in 54.5% patients of all revision cases.

**Table 5.** Relationship between canal wall up mastoidectomy and canal wall down mastoidectomy in terms of postoperative hearing gain

Mastoidectomy type	Mean ABG (dB)	Mean ABG (dB)	Hearing gain (dB)	<i>p</i>
	Preoperative	Postoperative	Postoperative	
	Mean±SD	Mean±SD	dB	
CWUM + ossiculoplasty	35.38±10.82	27.92±12.25	7.46	0.647
CWDM + ossiculoplasty	37.92±5.80	25.38±6.98	12.54	

ABG: Air-bone gap; SD: Standard deviation; CWUM: Canal wall up mastoidectomy; CWDM: Canal wall down mastoidectomy.

**Table 6.** Relationship between postoperative air-bone gap and surgical procedure with ossiculoplasty

Postoperative mean ABG	CWDM with ossiculoplasty		CWUM with ossiculoplasty		Total patients	
	n	%	n	%	n	%
≤20 dB	1	7.7	7	27.0	8	20.5
21-30 dB	10	76.9	9	34.6	19	48.7
31-40 dB	1	7.7	3	11.5	4	10.3
>40 dB	1	7.7	7	26.9	8	20.5
Total patients	13		26		39	

ABG: Air-bone gap; CWDM: Canal wall down mastoidectomy; CWUM: Canal wall up mastoidectomy.

These days we refer to improvement of hearing as well as eradication of disease when we mention surgical success in patients. Umit et al.<sup>[13]</sup> suggested that CWDM should be the surgical procedure of choice for best results in middle ear disease. They said that this procedure provides both good hearing results and safe ears in a single stage. In our study, hearing gain was more than 10 dB in patients who were operated due to active squamous COM. Our results were consistent with the literature. We concluded that we should choose a CWDM procedure for treating a wide or recurrent lesion in order to achieve surgical success.

Chang and Chen<sup>[14]</sup> said they obtained better hearing results in patients with an intact stapes suprastructure. De Corso et al.<sup>[15]</sup> reported that the status of middle ear mucosa and presence or absence of stapes suprastructure are the most important factors for the successful restoration of postoperative hearing. In our study, stapes suprastructure was intact in 38/92 (41%) patients. And also, ossiculoplasty could be performed in 42.4% (39/92) patients. We concluded that the CWDM procedure is not a disadvantage for healing of hearing if ossiculoplasty was possible in patients with CSOM.

Canal wall down mastoidectomy and CWUM procedures can result in an acoustically different middle ear structure and change the external ear resonance. Cho et al.<sup>[16]</sup> reported that the frequency of the first peak in the external ear resonance after CWDM was significantly lower than that after CWUM, but the gain was not changed. In cadaveric temporal bones, it was reported that patients could achieve hearing improvement under 1 kHz after CWUM, and over 1 kHz after CWDM. Those authors concluded that CWDM generally caused less than 10 dB

changes in the middle ear sound transmission relative to CWUM.<sup>[1,16-18]</sup>

Kim et al.<sup>[19]</sup> emphasized that the middle ear volume and the resonance of the external auditory canal changed after CWDM. But these changes might be too minimal to be noticed in a clinical setting. They found similar hearing in the CWDM group with the CWUM group. They recommended that surgeons can choose CWDM for treating a wide or recurrent lesion and expect to achieve similar hearing results as CWUM.

Vartiainen et al.<sup>[20]</sup> evaluated long-term hearing results in their patients that underwent CWDM. Healing of hearing was >10 dB in one-third of the patients but it did not change in one third and worsened in another third. In our study, CWDM with ossiculoplasty was carried out in 13/41 (31.7%) patients. The average postoperative hearing gain was 11.9 dB in patients with squamous disease. Hearing gain was considered successful because this value was above 10 dB.

Galm et al.<sup>[9]</sup> reported that if ossiculoplasty was performed in CSOM patients regardless of middle ear pathology, no significant relation was found between CWDM and CWUM according to hearing results in their study. They showed that hearing gain was 13 dB in patients that underwent CWDM with ossiculoplasty; it was 10 dB in patients that underwent CWUM with ossiculoplasty. In our study, hearing gain was 11.9 dB and 3.8 dB in the CWDM and CWUM groups with squamous disease, respectively. These results suggest that eradication of the disease should take priority in the decision of surgical procedure.

Ossiculoplasty is performed via tympanomastoidectomy using various synthetic materials or autografts if remnant ossicles allow any ossiculoplasty procedure. Umit et al.<sup>[13]</sup>

reported that an ideal material is characterized by high biocompatibility, easy manipulation with minimal operation time and also high stability without extrusion or displacement. The status of autologous ossicles affected ossiculoplasty options in our study too. The best hearing results were obtained in all patients that underwent CWUM together with bone cement ossiculoplasty with mean postoperative ABG of 14.7 dB. Indeed, the best hearing gains were obtained with bone cement technique in our study. For example, the incus remnant was pasted with bone cement to connect between malleus and stapes in two of our patients. Air-bone gap values were decreased from 22 dB to 7 dB and from 43 dB to 5 dB in these patients, respectively.

Improvement in hearing as well as eradication of disease is important for surgical success. For improvement in hearing, a surgical process with ossiculoplasty is required. Considering all CSOM patients with active squamous disease in our study, hearing gain was 11.9 dB in CWDM and 3.8 dB in CWUM. We thought that the eradication of disease must be the primary target in CSOM patients with active squamous disease in order to expect hearing restoration. Also, intact ossicular residue was the best subsequent decisive parameter affecting ossiculoplasty options. Considering our results, we thought that bone cement was quite an encouraging ossiculoplasty material.

#### Declaration of conflicting interests

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