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Original Article

Hearing Outcomes According to the Types of Mastoidectomy: A Comparison between Canal Wall Up and Canal Wall Down Mastoidectomy

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Objectives. The aim of this study was to compare the hearing outcomes between canal wall up mastoidectmy (CWUM) and canal wall down mastoidectmy (CWDM).

Methods. One hundred seventy one chronic suppurative otitis media (CSOM) patients were enrolled in this retrospective study. The patients who underwent the second staged ossiculoplasty at least 6 months after mastoidectomy and who had an intact, well aerated tympanic cavity as well as intact mobile stapes at the time of operation were selected from the medical record. Based on the type of mastoid surgery, the patients were categorized into two groups: the CWUM (n=38) and CWDM groups (n=133). The hearing results of the CWUM and CWDM groups were compared using the pre- and post-operative air-bone gap (ABG) at 3 months after ossiculoplasty.

Results. The preoperative ABG in both groups (CWUM and CWDM) were 28.4±15.6 dB and 31.8±14.5 dB, respectively (P=0.18). Both groups didn't show any significant difference (10.9 dB vs. 13.5 dB, respectively) (P=0.21) for the postoperative ABG closure. The proportion of patients with an ABG less than 20 dB was 58.6% of the CWDM patients and 68.4% of the CWUM patients (P=0.25).

Conclusion. The type of mastoid surgery (CWUM and CWDM) did not affect the hearing results of CSOM patients. When choosing the type of mastoidectomy procedure for CSOM surgery, the hearing outcomes are basically the same for both types of procedure.

Key Words. *Hearing, Otitis media, Ossicle, Surgery*

INTRODUCTION

Achieving successful hearing outcomes following tympanomastoidectomy in patients with chronic suppurative otitis media (CSOM) depend on several factors. The types of mastoid surgery such as canal wall up mastoidectomy (CWUM) and canal wall down mastoidectomy (CWDM) are considered to be one of these factors because of the structural changes (1, 2). However, the clinical reports related to this issue have been controversial. Tos reported that the hearing results following CWUM are better than that after CWDM (3). Yet Cook et al. (4) found no difference between the two methods.

It is difficult to assess the true acoustic effects of the surgical modification because of the coexisting pathology and condition of the middle ear. The postoperative hearing results are influenced by various factors (3, 5-8). Black (9) introduced the Surgical, Prosthetic, Infection, Tissues and Eustachian tube (SPITE) system. Austin (10) included residual ossicular remnants. More recently, Kartush (7) introduced the Middle Ear Risk Index (MERI). The MERI combined the known preoperative and intraoperative risk factors into a numeric value for determining the

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prognosis of tympanoplasty. These factors were otorrhea, perforation of the tympanic membrane, middle ear granulation, cholesteatoma and otitis media with effusion, revision surgery and the ossicular status. They used statistical methods to exclude the confounding factors and to determine the factors that have a significant impact on successful outcomes.

Few studies had compared the hearing results between two different types of mastoidectomy with excluding these confounding factors. In this study, the hearing outcomes were compared between CWUM and CWDM by selecting the patients with an intact tympanic cavity and stapes and who underwent staged ossiculoplasty.

MATERIALS AND METHODS

The patients who underwent second staged ossiculoplasty at least 6 months after mastoidectomy in our clinic from 1997 through 2005 were retrospectively analyzed. All the surgeries were performed by three specialized otologic surgeons.

To exclude the confounding factors that might influence the hearing outcomes, the following selection criteria were used. Every patient had well aerated, healthy mucosa lining the tympanic cavity to ensure intact E-tube function. To exclude the ossicular remnants factor, every patient had intact mobile stapes and a handle of the malleus. At the time of the staged operation, the patients with otorrhea, perforation or retraction of tympanic membrane were also excluded. In addition, the patients with a decreased bone conduction threshold more than 10 dB were excluded because of the possibility of combined inner ear damage. Every patient underwent ossicular reconstruction by partial ossicular replacement (POR) with polycel (11) or short columellization (SC) (12) with autologous cartilage (e.g., cavum concha).

We retrospectively reviewed the medical records to obtain the demography as well as the hearing outcomes of the patients. The age, gender, side of surgery, 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 6 months after staged ossiculoplasty. The average of the air-bone gap (ABG) was calculated at 500, 1,000, 2,000, and 3,000 Hz. The closure of the ABG after staged ossiculoplasty, as well as the mean postoperative ABG, was divided into within 10, 20, and 30 dB. We also analyzed the effects of the ossicular reconstruction materials (POR vs. SC with autologous cartilage) on the hearing results.

Based on the type of mastoidectomy, the patients were divided into two groups; the CWUM group and the CWDM group. We compared the difference of the mean postoperative ABG and the ABG closure between the CWUM and CWDM groups, and we also assessed the effect of the ossicular reconstruction material on hearing. The Student *t*-test and chi-square test were used for statistical analysis.

Table 1. Characteristics of the CWUM and CWDM patients

	CWUM (n=38)	CWDM (n=133)	*P*-value
Male:Female	22:16	75:58	0.33
Mean age (years)	42.4 (6-54)	39.2 (13-66)	0.48
Mean follow-up periods (months)	15.4 (2-68)	18.3 (3-104)	0.37
POR:SC	25:13	73:60	0.26

CWUM: canal wall up mastoidectmy; CWDM: canal wall down mastoidectmy; POR: partial ossicular replacement; SC: short collumelization.

RESULTS

One hundred seventy one eligible patients were included in this study. The patients with CWUM and CWDM were 38 and 133, respectively. Ninety seven patients were male and 74 patients were female. The mean age was 40.1 years (range, 6 to 66 years) old. The mean interval between mastoidectomy and second stage ossiculoplasty was 11.3 months and this ranged from 6 to 98 months. The mean postoperative follow-up period after ossiculoplasty was 17.0 months. Regarding the types of reconstruction material, POR was used in 98 patients and short columellization autologous cartilage was used in 73 patients (Table 1). There was no statistical difference of the reconstruction material in each group.

Fig. 1 shows the hearing results for the two groups. Both groups had a similar mean preoperative ABG before staged ossiculoplasty (P=0.18). After second staged ossiculoplasty, the mean ABG closure was 10.9±19.5 dB in the CWUM group and

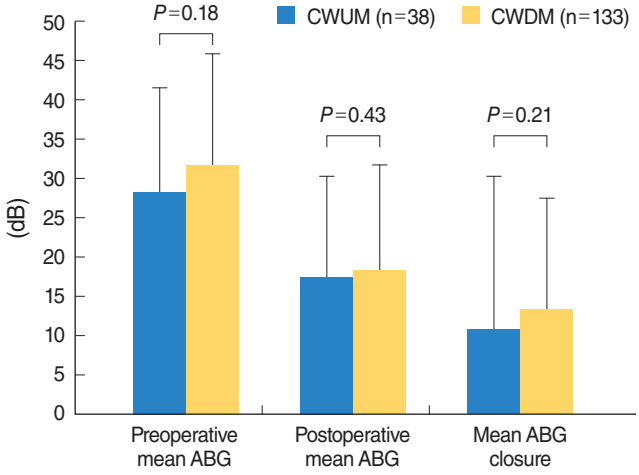

Fig. 1. Hearing outcomes according to the type of mastoidectomy (mean±standard deviation). After second staged ossiculoplasty, the air-bone gap (ABG) closure was 10.9±19.5 dB in the canal wall up mastoidectmy (CWUM) group and 13.5±14.1 dB in the canal wall down mastoidectmy (CWDM) group.

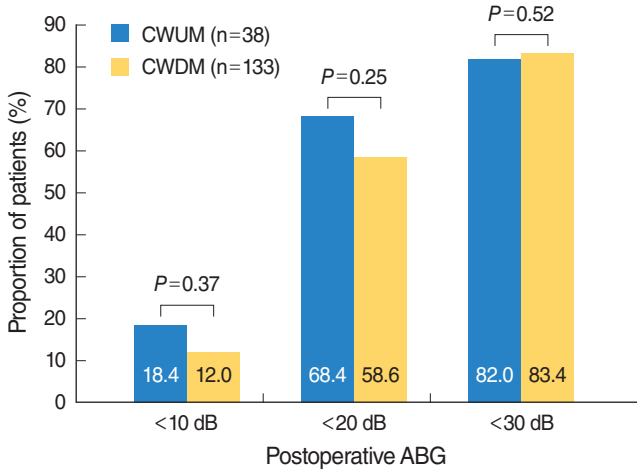

Fig. 2. The air-bone gap (ABG) closure according to the type of mastoidectomy. The patients with ABG closure didn't show any differences according to the type of mastoidectomy. CWUM: canal wall up mastoidectmy; CWDM: canal wall down mastoidectmy.

13.5±14.1 dB in the CWDM group, and the difference was not statistically significant (P=0.21).

The proportion of ABG closure within 20 dB was 58.6% in the CWDM group and 68.4% in the CWUM group (P=0.25). The patients with ABG closure within 10 and 30 dB also didn't show any differences according to the type of mastoidectomy (Fig. 2).

We compared the hearing outcomes according to the materials used in ossiculoplasty. The patients who received POR had 19.1 dB of the mean ABG while the patients who received SC had 17.3 dB of the mean ABG, but there was no statistical difference (P=0.28).

DISCUSSION

Our study showed that there was no difference of the postoperative hearing outcomes according to the types of mastoid surgery (CWUM vs. CWDM) in CSOM patients.

There has been controversy regarding the hearing outcomes according to the type of mastoidectomy (3, 4). This difference in hearing outcomes could be partly explained by possible confounding factors that affected the prognosis of CSOM surgery. In this study, we tried to exclude every possible confounding factors related with the outcomes of ossiculoplasty except the types of mastoidectomy.

Many previous studies reported on the prognostic factors that affect the hearing results in CSOM patients. For example, Black (9) made the SPITE score to predict the prognosis of ossiculoplasty. This score included twelve significant features that were classified as surgical, prosthetic, infection, tissue and Eustachian factors. Kartush (7) reported the MERI as the preoperative and intraoperative risk factors for tympanoplasty. The MERI is the total score of each index such as otorrhea, perforation of tympanic membrane, middle ear granulation, cholesteatoma and otitis media with effusion, revision surgery and the ossicular status (10, 13).

For our selection criteria, every patient underwent second staged ossiculoplaty at least 6 months after tympanomastoidectomy. At the time of the staged operation, the tympanic cavity should be well aerated and lined with healthy mucosa. The stapes and handle of the malleus were intact and well mobile. There was no recent otorrhea, perforation or any retraction of the tympanic membrane. In addition, patients with a decreased bone conduction threshold more than 10 dB were excluded because of the possibility of inner ear damage. Every patient underwent ossicular reconstruction by POR or SC with autologous cartilage. These criteria were selected to exclude the previously reported confounding factors as much as possible.

To the best of our knowledge, there have not been any previous reports on comparing the hearing results after CWDM and CWUM with excluding many possible confounding factors.

For CWUM, we removed the air cells in the mastoid cavity and the mastoid cavity is connected directly into the middle ear through the aditus ad antrum; therefore, the volume of the middle ear cavity is increased. However, in CWDM, by removing the canal wall and mastoid air cells, the middle ear cavity is shallow and the volume of the middle ear would be decreased. In addition, the external auditory canal and mastoid cavity are made into one larger cavity than that with CWUM. These different surgical procedures can result in an acoustically different middle ear structure and change of the external ear resonance (14). In cadaveric temporal bones, it was reported that patients could achieve hearing improvement under 1 kHz after CWUM, and over 1 kHz after CWDM (1, 8). Those authors concluded that as long as the middle ear space is aerated and it has a volume larger than 0.7 mL, CWDM generally caused less than 10 dB changes in the middle ear sound transmission relative to CWUM.

We previously 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 (15).

In this study, there was no significant difference in the hearing results after second staged ossiculoplasty between the CWUM and CWDM groups. Although the middle ear volume and the resonance of the external auditory canal changed, these changes might be too minimal to be noticed in a clinical setting.

We found that the proportion of ABG less than 20 dB in the CWDM group was 58.6% and this was 68.4% in the CWUM group. There was no statistical difference between the two groups. These results were comparable with the results of other reports (3, 13).

In conclusion, the hearing in the CWDM group was similar with that of the CWUM group. This means the operator can choose CWDM for treating a wide or recurred lesion and ex-

pect to achieve similar hearing results as CWUM.

CONFLICT OF INTEREST

No potential conflict of interest relevant to this article was reported.

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