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Preserving the Canal Wall in Mastoidectomy: Functional and Anatomical Outcomes

ABSTRACT

Background: In this study, we aimed to investigate the functional and anatomical outcomes of the intact canal wall approach compared to modified canal wall down tympanomastoidectomy, for assessing the benefits or disadvantages of canal wall preservation.

Methods: Patients who had a tympanomastoidectomy operation either with intact canal wall or canal wall down approach were retrospectively reviewed. The main indications for surgery, recurrent disease, and need for revision surgery, along with graft status for anatomic and air-bone gap and gain in decibel hearing level for hearing outcomes were noted.

Results: Of 97 patients, 48 without a cholesteatoma had intact canal wall approach, and among 49 cholesteatoma cases, 36 had intact canal wall and 13 had canal wall down approaches. Recurrence was detected only in 4 cases (11.1%) operated with intact canal wall technique. In all groups, graft success rates were similar. Conversely, regarding hearing outcomes, a significant difference was detected in favor of intact canal wall approach in terms of postoperative air-bone gaps ($P = 0.41$).

Conclusions: Our results showed a significant advantage of intact canal wall procedure in terms of better postoperative air-bone gaps in the functional benefit of our patients. Nevertheless, for a smaller group of patients, a canal wall down approach remains to be the optimum choice in management.

Keywords: Ear, otologic surgical procedures, cholesteatoma

INTRODUCTION

The main goals of the middle ear and mastoid surgery are eradication of disease, getting a safe and dry ear, as well as reaching the most achievable hearing outcomes through preservation or restoration.[1-3] In order to achieve these goals in the treatment of various pathologies, different surgical approaches have been utilized through different centers and groups. One of the major differences in those approaches includes the canal wall down (CWD) and intact canal wall (ICW) approaches. Removing the posterior canal in the CWD approach is utilized only in cholesteatoma cases and enables improved visualization and thus better control of the disease in a single-stage surgery but requires lifelong care of the mastoid cavity.[4,5] On the other hand, ICW mastoidectomy is used for various pathologies as well as suitable cholesteatoma cases and preserves the posterior canal wall that maintains a natural external auditory canal. This enables simpler postoperative care and maintenance, nevertheless, risks recurrent or residual disease in case of cholesteatoma and could require a second look operation thereafter.[6-8] Nevertheless, the requirement for a second look operation is also gradually decreasing due to the constant improvements being achieved in diagnostic imaging, especially through special magnetic resonance imaging techniques.[9-11] However, comparing surgical approaches, in the literature, there is a constant dispute on CWD and ICW approaches among strong advocates of both.[12-13] Apart from the issue of recidivism in the case of cholesteatoma, the decision of bringing the posterior CWD could have a direct influence on the anatomical and functional outcomes.

In this study, we aimed to evaluate and compare anatomical and hearing outcomes of our caseload, in order to assess if preserving the canal wall brings up any benefits or disadvantages.

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MATERIAL AND METHODS

A retrospective chart review was conducted for patients who had undergone a tympanomastoidectomy either with an ICW or a CWD approach in our Department of Otolaryngology during a 5-year period with a minimum follow-up of 1 year. All surgeries were performed by the senior author (C.M.) or under his supervision. Patients who had myringoplasty or tympanoplasty type 1 were excluded. All patients without a cholesteatoma were operated with an ICW approach. In cholesteatoma cases also the ICW approach was mainly preferred, unless either posterior canal wall was extensively eroded by disease or the disease was not controllable under the operating microscope's direct vision with the posterior wall in place. Then, a modified CWD procedure was conducted situating the graft at the level of the facial nerve and leaving a shallow middle ear cleft and a radical cavity at the end. According to the specific needs of each case, the cause for conductive hearing loss was reconstructed with grafting, with bone cement, or with titanium (Kurz GmbH, Dusslingen, Germany) or Plastipore (Xomed; Jacksonville, Fla, USA) prostheses. In relation to the status of stapes superstructure, either a partial ossicular reconstruction prosthesis (PORP) or a total ossicular reconstruction prosthesis (TORP) was used. Temporalis muscle fascia and conchal cartilage were used as grafting materials and the underlay technique was used for tympanic membrane grafting.

The main indications for surgery, any recurrent disease, and the need for revision surgery as well as anatomical and hearing outcomes were noted. All patients had a preoperative audiological evaluation from 250 Hz to 8 kHz. Postoperative audiometry results (the air-bone gap (ABG) and the gain in decibel hearing level (dB HL)) were evaluated according to the guidelines of the American Joint Committee on Hearing and Equilibrium.[14] Anatomical outcomes were assessed in terms of graft status. Follow-up evaluations were done by clinical, audiologic, and radiologic examinations including non-epi is non-echo-planar (non-EPI) diffusion-weighted magnetic resonance imaging (non-EPI DW-MRI) in cholesteatoma patients.

For further evaluation, patients were divided first into 2 main groups: ICW and CWD, then ICW group was divided into 2 subgroups according to pathology as with cholesteatoma (ICW w/Ch) and without cholesteatoma (ICW wo/Ch). The abovementioned data are then analyzed and compared between groups. This study was approved by the Ethics Committee of Ankara University (No: 07-272-19 29.04.2019), and informed consent was taken from all the participants.

MAIN POINTS

- In this study, the hearing results of canal wall up and down mastoidectomy were compared.
- In this study, the indications of canal wall up and down mastoidectomy in treatment of cholesteatoma were compared.
- Comparison of the graft take and the recurrence of cholesteatoma in canal wall up and down mastoidectomy was performed in this study.

The differences in proportions between groups were compared by using chi-square test or Fisher's exact test, where appropriate. Continuous variables such as gain and gap were compared using Kruskal–Wallis test among categories of the grouping variable. General descriptive statistics are summarized as counts and percentages for categorical variables. Statistical analyses were performed by using Statistical Package for the Social Sciences (version 15.0, SPSS Inc., Chicago, Ill, USA) and a *P* value of less than .05 was considered statistically significant.

RESULTS

A total of 97 patients had undergone tympanomastoidectomy surgery within the mentioned time frame with the given criteria. Demographic data of all are summarized in Table 1. The main indication was cholesteatoma in 49 patients (0.50%), followed by chronic suppurative otitis media in 25 patients (0.25%) and chronic non-suppurative otitis media in 23 patients (0.23%). Among patients who had cholesteatoma, only 13 (0.26%) of them required a CWD procedure. Eight (0.61%) of them were primary cases and 5 (0.38%) were referred cases, who already had surgery with ICW technique elsewhere. None of the 13 cases had recurrent disease during the follow-up time, requiring revision surgery. Their graft status was intact except for 2 patients (0.15%) in the CWD group, who are in close follow-up without any complaints. Of the 84 patients who had an ICW approach, 36 (0.42%) had cholesteatoma. According to the surgery notes, the cholesteatoma matrix was completely removed in all. Nevertheless, in follow-up examinations of 4 patients (0.11%), a recurrence was suspected and confirmed in further surgery. Recurrent disease was controlled with a CWD procedure in 3 patients (0.75%) and again with an ICW technique in 1 patient (0.25%) with further follow-up of at least 2 years without any evidence of disease. The remaining 32 patient's follow-up examinations did not indicate a recurrence, holding back a requirement for a second-stage surgery. Among them, only 1 had revision surgery for ossiculoplasty due to displacement of the TORP.

There was no significant difference in graft success rates among all groups as shown in Table 2. The highest graft success rate was achieved in ICW wo/Ch with 0.93%. On the other hand, a significant difference was detected in audiologic outcomes regarding the postoperative ABG between CWD and ICW groups, in favor of the ICW approach ($P = 0.41$). The same significance was seen between the CWD and ICW subgroups as seen in Figure 1. Nevertheless, although the postoperative gain in dB HL was higher after ICW procedures, the difference was not significant ($P = 0.63$). When reviewed in detail, in the ICW wo/Ch group, 54.1% of patients (n = 26) did not require any ossicular chain reconstruction in comparison to 0.38% (n = 14) in ICW w/Ch group. Bone cement reconstruction was used in 0.83% (n = 4) and 0.27% (n = 1) in the same

Table 1. Demographic Features of Both Groups

	ICW (n = 84)	CWD (n = 13)
Age	32.8	41.3
Gender (male/female)	51/33	5/8
Side (left/right)	39/45	6/7

CWD, canal wall down; ICW, intact canal wall.

Table 2. Hearing Status and Graft Success Rates in All Groups

	Preoperative ABG (dB)	Postoperative ABG (dB)	Gain (dB)	Graft Success
CWD	43.8	26.5	17.3	0.84
ICW	34.9	15.7	19.2	0.90
ICW w/ch	35.8	17.5	18.3	0.86
ICW wo/ch	34.2	14.3	19.9	0.93

ABG, air-bone gap; CWD, canal wall down; ICW, intact canal wall; ICW w/ch, intact canal wall with cholesteatoma; ICW wo/ch, intact canal wall without cholesteatoma.

groups, respectively. In ICW wo/Ch group, a PORP was used in 0.16% (n = 8) and a TORP in 0.20% (n = 10), whereas in ICW w/Ch group, a PORP was used in 0.36% (n = 13) and a TORP in 0.22% (n = 8) of the patients.

DISCUSSION

Preserving or not preserving the posterior canal wall is a historically long-going debate in the otological world. There are strong advocates among experts for both ICW and CWD approaches.[4,5,15,16] Many advantages and disadvantages of both techniques have been already pointed out by them in cholesteatoma management. The CWD approach being principally a single-stage surgery provides a non-obscured visualization of the surgical field enabling the foundation for better control of disease in the long term. Nevertheless, the reported recurrence rates of up to 17% after CWD tympanomastoidectomy point toward other factors rather than only the visual masking effect of the posterior canal wall. From our own experience, for example, the cholesteatoma matrix in a very deep sinus tympani could not be seen and eradicated with the removal of posterior canal wall, as it requires an angle of view with the microscope from the location of temporomandibular joint, which is not applicable in real-life surgical situations. Additionally, the destruction of the posterior canal wall also leads to the requirement of lifelong care of the mastoid cavity with some limits on the future activities of patients. Furthermore, CWD procedures mostly end up with poorer hearing outcomes, while also making the use of conventional hearing aids harder.[3,4]

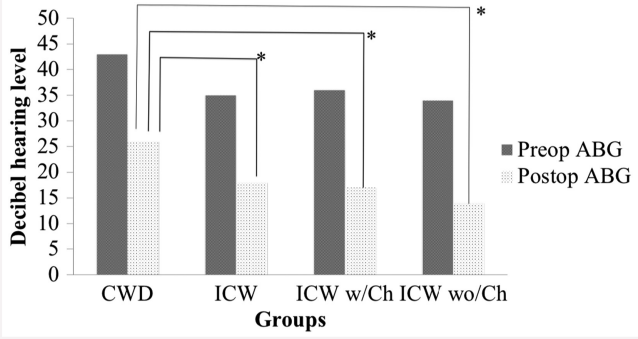

Figure 1. Audiological outcomes regarding the postoperative ABG in all groups. *Statistically significant difference ($P = 0.41$). ABG, air-bone gap; ICW, intact canal wall; CWD, canal wall down; ICW w/ch, intact canal wall with cholesteatoma; ICW wo/ch, intact canal wall without cholesteatoma.

On the other hand, ICW approaches enable simpler postoperative care, letting the maintenance easier for the surgeon as well as the patient without any limits in activities like swimming due to maintaining a natural external auditory canal. Although this also leads to better hearing outcomes in many series, these also report higher residual and recurrent disease rates, varying between 8% and 70% with this approach. Therefore, a second-look surgery that occurs months or years after the first is traditionally advocated to control tympanomastoid cavity for any recurrence, which could be troublesome to the patient for personal and financial reasons.[1-3] Nevertheless, the requirement for a second-look operation is also gradually decreasing due to the constant improvements being achieved in diagnostic imaging. The non-EPI DW-MRI visualization of the surgical field for detection of residual cholesteatoma has opened a new era providing high diagnostic accuracy. This noninvasive technique, together with otomicroscopy and audiologic examinations, makes the need for a second-look operation inappropriate when there are no clinical signs of recurrent cholesteatoma.[9-11] Thus, in our series of 36 ICW w/Ch patients, we have done second-look surgery in only 5 cases, finding and eradicating cholesteatoma in 4 patients and doing simply further ossiculoplasty in 1 patient.

As already well demonstrated in the literature, ICW and CWD approaches have various advantages and disadvantages. Nevertheless, the summation of the advantages of both techniques should be integrated into the treatment plans. In reaching the ultimate goal of a safe, dry, and disease-free ear, a tailored approach should be implemented according to the individual anatomy and disease extent of the patient. Recent evidence also is suggesting that, residual cholesteatoma is strongly attributed to the surgeon's experience rather than the chosen strategy.[17] The ICW approach principally tries to keep the normal anatomy intact while removing the disease, thus offering better functional results without the limiting effects of a radical cavity. This is why we mainly prefer and force to use the ICW approach first in the management of cholesteatoma, unless either posterior canal wall was extensively eroded by disease or the disease was not controllable under the operating microscope's direct vision with the posterior wall in place. By doing so, as seen in our results, we have reached a recurrence rate of 11.1% after using the ICW technique, which is at the lower limits of ICW recurrences as reported in a meta-analysis. The same source shows that the recurrence rates after CWD procedures could also be as high as 0.13%-0.17%.[3] The residual disease left at locations like sinus tympani or stapes footplate during an ICW procedure could also be left there during a CWD approach, explaining the failures of the CWD technique. These altogether indicate an acceptable recurrence rate in our series for the sake of using the benefits of the ICW approach in our patients firsthand.

Nevertheless, the higher recurrence rates seen in ICW cases are thought to be due to the increased tendency to form retraction pockets.[4] We routinely perform cartilage tympanoplasty to overcome this issue, and perhaps this is why our recurrence rates are at the lower limits reported in the literature[2-4] However, using cartilage could pose difficulties in the otomicroscopic follow-up evaluations, which could necessitate a second-look surgery in the absence of non-EPI DW-MRI evaluation. With the integration of this imaging modality into the management algorithms,

ICW approaches have gained an important adjunctive tool in their support.[9-11]

Regarding the anatomical outcomes, graft success rates have been investigated. In all cases, grafting was done both with cartilage and temporalis muscle fascia. Although both of these materials give equal and comparable functional results, the use of cartilage graft is known to bring better morphological results in terms of intact ear drum. In the literature, it is reported that adding cartilage to the restoration of the tympanic membrane gives graft take rates between 0.80% and 0.97%.[18-20] In our study, the successful graft status was reached in 0.84% of CWD approaches and 90.5% of ICW approaches regardless of the underlying pathology validating our results with earlier published data. The difference between both CWD and ICW groups was statistically not significant also in accordance with the study of Ryan and Briggs[21] reporting 0.93% and 0.95%, respectively. The slight difference between our and their results could be due to the technique, where we used the underlay technique and they had the overlay.

Several studies have compared the hearing outcomes of CWD and ICW groups. Brown[22] has found in his series that in the CWD approach only 0.34% of adult patients had a serviceable hearing, defined as ABG of ≤20 dB with speech discrimination over 0.80% compared to 0.62% in the ICW approach. Tos and Lau[8] found similar results in their study. They have shown that 0.36% of their patients in the CWD group had an ABG ≤ 20 in contrast to 0.50% in the ICW group. In another study, 0.59% of the ICW patients had an ABG ≤ 20.[2] In our study, when compared to other studies, 0.85% of ICW approach patients had an ABG ≤ 20, while this was 0.76% in CWD patients, supporting the findings in the literature. In our caseload, the mean postoperative ABG of the ICW group was 15.67 dB, while that of the CWD group was worse with 26.30 dB. As shown in Table 2, according to the presence of cholesteatoma, the reached mean postoperative ABGs were slightly different in the ICW group. In ICW w/Ch group, the mean preoperative ABG was 35.8 dB which turned out to be 17.5 dB postoperatively. For the ICW wo/Ch group, this was 34.2 dB preoperatively and became 14.3 dB after the operation. Although we used different reconstruction methods such as graft only, bone cement or prosthesis, we used the global mean dBs results, due to the fact that our caseload numbers were not sufficient to do analysis for each subgroup. Although this might seems like a limitation of our study, we believe that in terms of hearing outcome it was possible to show a clear advantage of the ICW approach regardless of the conductive hearing reconstruction method. Finally, one of our aims was to assess the functional outcomes of canal wall preservation, not the type or material of the reconstruction for hearing itself.

In conclusion, most of the patients in our caseload were managed with an ICW approach, although in half of the cases cholesteatoma was the indication for surgery. Preserving the posterior canal wall in those cases led to an acceptable revision rate of 0.11% and conversion to the CWD approach in 0.8% requiring additional surgery as a disadvantage. At the end point, graft success rates were similar both in ICW and CWD approaches, yet a significantly better functional benefit of hearing in terms of better postoperative ABGs was achieved in the ICW group. Nevertheless, although the CWD approach could limit the future activities of the patients and requires lifelong care, as demonstrated in this study, it keeps being the optimum choice in the management of a smaller group of patients with cholesteatoma.

Ethics Committee Approval: Ethical committee approval was received from the Ethics Committee of Ankara University (Approval No: 07-272-19 29.04.2019).

Informed Consent: Informed consent was obtained from all participants who participated in this study.

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