Efficacy of the 2-Staged Procedure in the Management of Cholesteatoma

Steven Y. Ho, MD; John F. Kveton, MD

Objective: To demonstrate the efficacy of intact canal wall procedure coupled with a second-stage exploration for the treatment of cholesteatoma.

Design: Retrospective case study of patients with cholesteatomas treated with staged surgical extirpation. A minimum of 6 months' postoperative follow-up time was required for inclusion into the study.

Setting: Tertiary academic referral center.

Patients: A total of 35 adult and pediatric patients, ranging from 9 to 65 years of age, who underwent 2-stage procedures for removal of cholesteatomas.

Interventions: Two-stage procedures, separated by 6 months, performed with posterior tympanotomy approaches.

Main Outcome Measures: The presence or absence of cholesteatoma on second-stage look and the subsequent surgical treatment for recurrent cholesteatoma. The overall hearing results after the completion of the 2-staged procedure were calculated.

Results: Disease was controlled in 26 (74%) of the patients. Residual and/or recurrent cholesteatomas were found in 9 (26%) of the patients during the second-stage operation. Of these patients, 5 (14% of the total group) ultimately required conversion to canal-wall-down procedure. Average hearing gain at the completion of the second-stage procedure was 9 dB.

Conclusions: A planned 2-stage procedure that uses the posterior tympanotomy approach for the control of cholesteatoma is an effective technique. This approach offers significant potential for hearing preservation and restoration.

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A number of surgical approaches and treatment paradigms have been published and described for the management of cholesteatoma. Radical mastoidectomy was the only means of cholesteatoma removal before the 1900s. This procedure, done primarily to avoid intracranial complications, led to profound hearing loss. The advance in microscopic surgical techniques provided the first step in hearing preservation after cholesteatoma removal. In the first part of the 20th century, refinement of surgical techniques focused on regaining or retaining hearing after cholesteatoma removal. During the 1950s, the technique of tympanoplasty became widely accepted. This procedure, when combined with radical mastoidectomy, preserved aeration of the middle ear space and ossicles. The combined procedure, known as modified radical mastoidectomy, achieved the first reliable cholesteatoma removal with hearing preservation.

Further evolution in the management of cholesteatoma centered on the preservation of the posterior canal wall via the posterior tympanotomy, or facial recess, approach. In this approach, simple mastoidectomy was combined with the opening of the facial recess. The bony external auditory canal was preserved in an attempt to maintain a normal canal anatomy and avoid the creation of mastoid bowl. The overall exposure provided access to and visualization of the middle ear space, the epitympanum, and the mastoid antrum.

Currently, surgical approaches for the treatment of cholesteatoma are broadly divided into 2 categories. The canal-wall-up procedure consists mainly of a posterior tympanotomy approach, while the canal-wall-down procedure consists mainly of modified radical mastoidectomy. The canal-wall-down technique generally results in a lower rate of recurrence while requiring more intensive postoperative aural care from the loss of self-cleansing ability. The
postoperative follow-up time after the second-look procedures were included in the study.

The posterior tympanotomy, or facial recess, technique was used as the primary procedure in all cases. Figure 1 illustrates the prominent anatomic landmarks seen in the facial recess approach. After removal of all visible cholesteatoma, residual ossicles, if present, were preserved for second-stage ossiculoplasty. Initially, the staged second-look procedure used the same facial recess approach created during the primary surgery. If cholesteatoma was noted, extirpation was attempted via this exposure. Typical recurrent cholesteatomas were seen as well-circumscribed pearls and could be easily removed. Conversion to a canal-wall-down procedure was done if complete removal of the disease was hindered by the canal wall. The patients or the parents of the children were made fully aware of this possibility before the staged-second-look procedure.

Preoperative audiograms were obtained within 1 month of the surgery. Postoperative audiograms were performed after the second-stage procedure at 6-week and 6-month intervals. Speech reception thresholds were used for comparison of the hearing status. Paired t test with unequal variance was used for the computation of statistical significance.

Standard postoperative follow-ups were provided. Recidivism, including both recurrent and residual diseases, was defined as identification of cholesteatoma during the staged second-look procedure.

Table 1 gives the demographics of the patient cohort in this study. Preoperative speech reception thresholds ranged from 15 to 60 dB, with an average of 30.5 dB. The time interval between the first and second procedures ranged from 6 to 14 months, with the average being 8.2 months.

During the staged second-look procedure, 26 patients (74%) were free of disease. Nine patients were found to have cholesteatomas, representing an overall recidivism rate of 26%. Five (56%) of these 9 patients required conversion to a canal-wall-down procedure for removal of extensive disease. The other 4 patients were found to have well-circumscribed cholesteatomas manageable via the original facial recess exposure. Overall, only 5 (14%) of 35 patients required canal-wall-down conversion at the staged second-look procedure. Figure 2 provides a concise breakdown of surgical findings and interventions.

Figure 3 shows disease locations and their effects on surgical outcomes. The location of cholesteatoma was noted during the primary surgery, designated either epitympanic or mesotympanic depending on the configuration of the observed disease. Twenty-seven patients (77%) had cholesteatomas primarily occupying the epi-

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the mesotympanum. Of the 8 patients with primary cholesteatomas in the mesotympanum, 5 were found to have cholesteatomas during the staged second-look procedures, representing a recidivism rate of 62%. Of these 5 patients, 3 (60%) required conversion to a canal-wall-down procedure for cholesteatoma removal. In contrast, of the 27 patients with epitympanic cholesteatomas, only 4 (15%) were found to have cholesteatomas. Similarly, only 2 of these 4 patients with recidivism required conversion to canal-wall-down operations at the time of staged second-look procedures. The difference in rates of recidivism between epitympanic and mesotympanic lesions was statistically significant ($P=0.04$).

**Table 2** shows the hearing levels achieved after second-stage surgery. Twenty-six patients were free of disease during the second-look procedure. In these patients, the average speech reception thresholds improved from 31 dB preoperatively to 22 dB postoperatively, representing an overall improvement of 9 dB in hearing gain ($P=0.002$). More important, 20 patients in this group had postoperative speech reception thresholds better than 25 dB, representing 77% of postoperative patients with normal hearing level.

In the 9 patients with recidivism, the hearing outcome was less promising. The average postoperative speech reception threshold increased to 38 dB from a preoperative average of 31 dB. However, the small sample size failed to show any statistical significance ($P=3$). More significant is that only 2 (22%) of the 9 patients had speech reception thresholds better than 25 dB.

**Table 3** categorizes hearing outcomes in patients with recurrent disease. In the 4 patients treated with canal-wall-up procedures, the average speech reception threshold increased from 31 to 42 dB, a net increase of 11 dB. However, the small sample size failed to demonstrate statistical significance ($P=0.4$). In contrast, patients with conversion to canal-wall-down procedures on the staged second-look had increases in speech reception threshold from 30 to 35 dB, a net increase of only 5 dB.

### Comment

The management of cholesteatoma continues to be challenging and controversial for otolaryngologists. Even with the best surgical modality, the innate causes of cholesteatoma frequently persist, namely, the tendencies for these diseased ears to develop negative pressure and sub-sequently to form retraction pockets and cholesteatomas. This tendency makes differentiation of postoperative recurrent disease from residual disease complicated. For this reason, the term *recidivism* has been advocated to include both recurrent and residual disease. Given the tendency for retraction pockets to develop in the pars flaccida region, the identification of epitympanic cholesteatomas during the second-look procedure suggests recurrent disease, while those in the sinus tympani area suggest residual disease.

Two major approaches have been advocated for the treatment of cholesteatoma, namely, the canal-wall-up and canal-wall-down techniques. Paparella et al. and Sade clearly delineated the swings in popularity of these 2 techniques, from canal-wall-up initially to canal-wall-up and finally back to the canal-wall-down approach now.

The present study includes only patients who had undergone canal-wall-up procedures with a staged second-look procedure. Canal-wall-up procedures are preferred for the surgical treatment of cholesteatoma in our center. However, the goal of any cholesteatoma surgery is complete removal of the disease. When necessary, primary canal-wall-down procedures are performed to ensure complete removal of the disease. The most common indications include patients with poorly pneumatized mastoid bone, questionable follow-up reliability, and impending complications from cholesteatomas. Intraoperative decisions regarding the feasibility of complete cholesteatoma removal can also lead to primary canal-wall-down operations.

Epitympanic and mesotympanic cholesteatomas have distinct behaviors as well as prognoses. Supported by several anatomic and embryologic studies, Jackler elegantly detailed the pattern of spread of cholesteatomas on the basis of their origins. In summary, epitympanic cholesteatoma, the most common type of acquired cholesteatoma, usually develops from a long-standing re-
traction pocket in the pars flaccida region. This type of cholesteatoma commonly spreads into the mastoid air cells by passing lateral to the body of the incus (Figure 4). The small pars flaccida retraction and cholesteatoma can easily escape notice on examination because of their hidden location and innocuous appearance.

Mesotympanic cholesteatoma originates from retraction of the posterior portion of pars tensa. It tends to spread into the recesses within that space, such as the sinus tympani and facial recess. As it expands, a mesotympanic cholesteatoma can spread into epitympanum and gain access into the mastoid air cells by spreading medial to the body of incus (Figure 5). Both the involvement of mesotympanic recesses and the spread medial to the body of incus make surgical extirpation technically more difficult. These factors undoubtedly contribute to a higher incidence of residual diseases after surgical treatment, a well-known fact that is reflected in the present study.

The primary disadvantage of the canal-wall-up procedure is the higher rate of recidivism. A review of the literature during the past 10 years yielded 5 series comparing the rates of recidivism for these 2 procedures. Table 4 lists the results of the literature search. In all 5 series, canal-wall-up procedures carried much higher rates of recidivism than canal-wall-down procedures, ranging from 9% to 70%. In comparison, the reported recidivism rates for canal-wall-down procedures ranged from only 4% to 15%. These results suggest that the canal-wall-up technique carries more than twice the rate of recidivism of the canal-wall-down technique.

The 2 series conducted within the United States5,6 reported similar rates of recidivism for canal-wall-up procedures, at approximately 20%. This number is in close agreement with the result found in the present study (26%). This finding strongly suggests a second-stage look for the canal-wall-up technique.

This study also highlights another disadvantage of canal-wall-up procedures, namely, in treating mesotympanic cholesteatomas. In the present study, 8 patients had cholesteatomas located primarily in the mesotympanum and sinus tympani regions. During the second-stage look, 5 of these 8 patients were found to have cholesteatomas. This represented a recidivism rate of 62%. Furthermore, 3 patients eventually required canal-wall-down procedures to remove the disease. This represents a conversion rate of 60%. Given the high rate of recidivism and the subsequent conversion to canal-wall-down procedures, cholesteatomas located in the mesotympanum and sinus tympani regions are not as amenable to use of the canal-wall-up technique. Cholesteatomas in this region may be better treated with the canal-wall-down technique in the primary settings.

The often-quoted disadvantages of the canal-wall-up procedure include loss of aural function and hearing. It is widely acknowledged that the open cavity resulting from the procedure requires more extensive

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**Table 4. Published Recidivism Rates for Canal-Wall-Up (CWU) and Canal-Wall-Down (CWD) Techniques in the Past 10 Years**

<table>
<thead>
<tr>
<th>Series</th>
<th>Procedure</th>
<th>No. of Patients</th>
<th>Recidivism Rate, %</th>
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<tbody>
<tr>
<td>Nyrop and Bonding4</td>
<td>CWU</td>
<td>60</td>
<td>70</td>
</tr>
<tr>
<td></td>
<td>CWD</td>
<td>27</td>
<td>15</td>
</tr>
<tr>
<td>Hirsch et al5</td>
<td>CWU</td>
<td>36</td>
<td>19</td>
</tr>
<tr>
<td></td>
<td>CWD</td>
<td>81</td>
<td>5</td>
</tr>
<tr>
<td>Roden et al6</td>
<td>CWU</td>
<td>54</td>
<td>20</td>
</tr>
<tr>
<td></td>
<td>CWD</td>
<td>43</td>
<td>5</td>
</tr>
<tr>
<td>Vartiainen and Nuutinen7</td>
<td>CWU</td>
<td>86</td>
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<td>CWD</td>
<td>297</td>
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</tr>
<tr>
<td>Karmarkar et al8</td>
<td>CWU</td>
<td>257</td>
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<td>CWD</td>
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postoperative care and regular debridement. However, postoperative hearing losses are not as clearly documented. Ragheb et al.6 and Karmarker et al.7 reported better hearing outcomes with canal-wall-up procedures when compared with canal-wall-down procedures. On the contrary, both Roden et al.6 and Hirsch et al.5 disputed these findings and reported that the overall hearing improvement was comparable with both techniques. This conclusion was echoed by Toner and Smyth.10 and Sheehy.11

In the present study, we found that canal-wall-up procedures achieved significant hearing improvement, with 77% of the patients maintaining speech reception thresholds of less than 25 dB. Direct comparison with canal-wall-down procedures is difficult, considering that all patients had already undergone canal-wall-up procedures in the primary settings. However, in cases with recidivism, hearing results can be compared between these 2 techniques. Table 3 demonstrates the comparison of hearing results. Patients treated with canal-wall-down techniques demonstrate slightly better hearing outcomes compared with patients treated with canal-wall-up techniques. Because of small sample sizes, statistical significance was not achieved. From this perspective, canal-wall-up and canal-wall-down techniques provide similar hearing outcomes.

Unfortunately, as shown in Table 2, patients with recidivistic cholesteatomas appear to have worse hearing outcomes regardless of the subsequent procedures used. These patients have an average reception threshold elevated from 31 to 38 dB. In contrast, patients without disease have an improvement of 9 dB in the same comparison. This well-known fact was again clearly reflected in our study.

CONCLUSIONS

This study demonstrated that the canal-wall-up technique is effective in the treatment of cholesteatoma. Using the canal-wall-up technique as the primary surgical modality, we found a 26% recidivism rate. This finding strongly supports a staged second look. More precisely, mesotympanic lesions carry a significantly higher rate of recidivism than epitympanic lesions (62% vs 15%). With the higher rate of recidivism and subsequent conversion to canal-wall-down procedure at the time of second look, mesotympanic lesions are probably more efficiently treated with primary canal-wall-down approaches. Therefore, the canal-wall-up technique is better suited for cholesteatomas located in epitympanic areas. Overall, the speech reception thresholds showed statistically significant improvement from 31 dB preoperatively to 22 dB postoperatively in patients without recidivism. As was expected, recidivism led to poor hearing outcomes. In those cases, hearing levels were similar regardless of surgical techniques used to extirpate the disease. These findings point to the controversial nature of the treatment of cholesteatomas. Surgical treatment should be individualized, and no single procedure should be used exclusively for the management of this disease. While yielding a higher rate of recidivism, the canal-wall-up technique provides excellent potential for hearing preservation in carefully selected patients and should remain an essential technique in the treatment of cholesteatomas.

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Corresponding author and reprints: Steven Y. Ho, MD, Department of Otolaryngology, Northwestern University School of Medicine, 1000 Central St, Suite 610, Evanston, IL 60202 (e-mail: syh_me109y@yahoo.com).

REFERENCES