Residual Cholesteatoma

Incidence and Localization in Canal Wall Down Tympanoplasty With Soft-Wall Reconstruction

Shin-Ichi Haginomori, MD; Atsuko Takamaki, MD; Ryuzaburo Nonaka, MD; Hiroshi Takenaka, MD

Objective: To compare the incidence and localization of residual cholesteatomas in canal wall down tympanoplasty with soft-wall reconstruction with results with the canal wall down and open tympanoplasty or canal wall up tympanoplasty.

Design: Retrospective case-series study.

Setting: Tertiary care university hospital.

Patients: Eighty-five patients (85 ears) with fresh extensive cholesteatomas who underwent canal wall down tympanoplasty with soft-wall reconstruction as first-stage surgery and a second operation after 1 year to confirm residual cholesteatomas and perform ossiculoplasty.

Main Outcome Measures: The incidence and localization of residual cholesteatomas in the middle ear were compared between surgery using the canal wall down and open tympanoplasty and canal wall up tympanoplasty. Possible technical causes of the residua were reviewed in a retrospective videotape analysis of the first-stage operations.

Results: Of the 85 ears operated on, 18 had residual cholesteatomas, for an overall incidence of 21%, with 1 residuum per ear. Six cholesteatomas were located in the epitympanum (33%), 3 in the sinus tympani (17%), 3 in the antrum (17%), 2 on the stapes (11%), 2 on the tympanic membrane (11%), 1 on the tympanic portion of the facial canal (6%), and 1 just under the skin of the external auditory canal (6%). The retrospective videotape analysis revealed that the main cause of residual cholesteatomas in the epitympanum and sinus tympani was incomplete removal of the matrix under an indirect surgical view because of insufficient drilling. Residual matrix in a bony defect in the middle cranial fossa or facial canal was the cause of residual cholesteatomas in the antrum or facial canal. Inappropriate keratinizing epithelium rolling during tympanic membrane or external auditory canal reconstruction was the cause of residual cholesteatomas in the tympanic membrane or external auditory canal.

Conclusions: The incidence of residual cholesteatomas in patients who underwent canal wall down tympanoplasty with soft-wall reconstruction was similar to that in patients who underwent surgery involving the canal wall down and open tympanoplasty or canal wall up tympanoplasty. In terms of localization, with canal wall down tympanoplasty with soft-wall reconstruction, there is the possibility of residua not only in the tympanic cavity but also in the antrum or mastoid cavity, as with the canal wall up method. Results of this study suggest that in patients with extensive cholesteatoma, canal wall down tympanoplasty with soft-wall reconstruction should be followed by a second procedure to detect any residual cholesteatomas in the tympanic cavity, antrum, or mastoid cavity.
(CWU; closed-cavity) procedures. The CWD procedure provides sufficient approach to the facial recess and tympanic sinus, with an adequate surgical view, and is thought to result in a low rate of recurrence of cholesteatoma. However, an incompletely cleaned cavity leads to wet granulation tissue covered by debris and otorrhea. This “cavity problem” in the open cavity is caused by bacterial or fungal infection and disturbed external auditory canal (EAC) skin migration. Conversely, the CWU procedure maintains the shape of the EAC with normal skin migration, which enables quick postoperative wound healing but involves a restricted surgical view and a higher rate of cholesteatoma recurrence compared with CWD tympanoplasty.

The most reasonable procedure for overcoming the disadvantages of CWD and open tympanoplasty or CWU tympanoplasty is CWD tympanoplasty with reconstruction of the posterior wall of the EAC. Several materials for reconstruction have been reported, including cartilage, 

Smith et al. first reported CWD tympanoplasty with soft-wall reconstruction in 1986, and use of this method has spread as a modified tympanoplasty. In this method, as much of the posterior EAC wall skin as possible is preserved, and after the cholesteatoma is removed, the defect in the tympanic membrane (TM) and posterior EAC wall is reconstructed using free soft tissue such as the deep temporal fascia. Several advantages of this method have been documented, including the little additional time required during surgery, the recovery of tympanomastoid aeration when the middle ear mucosa is preserved during surgery, and early postoperative wound healing.

We examined the incidence and localization of residual cholesteatomas in planned revision tympanoplasty in patients in whom cholesteatomas had been removed at previous CWD tympanoplasty with soft-wall reconstruction and compared them with the reported incidence in the CWU and CWD and open tympanoplasties. In addition, we reviewed videotapes of the first operations in the patients with residua to determine which surgical maneuvers might have caused the residual cholesteatomas. Our ultimate goals were to determine the technical pitfalls of this surgery and to make the best use of our experience to decrease the incidence of residual cholesteatomas after CWD tympanoplasty with soft-wall reconstruction.

METHODS

Between January 1, 2000, and December 31, 2005, 85 patients (85 ears) in our hospital underwent planned 2-stage CWD tympanoplasty with soft-wall reconstruction because of extensive cholesteatomas in which there was suspicion of residua after the first-stage operation. All 85 patients had fresh cholesteatomas and no history of ipsilateral ear surgery. As evaluated at microscopy and computed tomography, 46 cholesteatomas were of the pars flaccida type, 34 were of the pars tensa type, and 5 were congenital.

All patients underwent tympanoplasty twice, performed by 2 of us (S.-I.H. and R.N.). The surgery was recorded throughout on minidigital videotape using a 3-CCD video camera (MKC-305; Ikegami Tsushinki Co, Ltd, Tokyo, Japan) attached to a surgical microscope and a digital videocassette recorder (WV-DR9; Sony Corp, Tokyo). In the first-stage operation, the cholesteatoma was removed using the CWD procedure and reconstruction with soft tissues (soft-wall reconstruction) such as free deep temporal fascia, as described by Smith et al. Hosoi and Murata, and Takahashi et al. During surgery, the posterior half of the bony EAC wall was drilled down and as much as possible of the intact TM and EAC wall skin was preserved. After the cholesteatoma was removed, the defects in the TM and EAC skin were lined with a piece of deep temporal fascia. This method differs from the conventional CWD tympanoplasty and open procedure, which opens the mastoid cavity to the EAC, insofar as postoperative separation of the mastoid cavity from the EAC. The posterior EAC wall was not reinforced or reconstructed using hard tissue or material (eg, cortical bone or EAC bone) in any ears. A 0.5-mm-thick polymeric silicone (Silastic; Corning Dow Corporation, Midland, Michigan) sheet was placed between the tympanic cavity and the antrum or mastoid cavity. The incus and head of the malleus were removed. One year later, all patients underwent revision tympanoplasty with ossiculoplasty. The recorded videotapes were stored in the video library in our department. In this second-stage operation, the tympanic cavity was approached through the mastoid cavity with the soft wall of the EAC and the TM was lifted. After removing the polymeric silicone sheet, we meticulously checked the entire middle ear, including the antrum, mastoid cavity, and tympanic cavity, for residual cholesteatoma. When a residual cholesteatoma was found, its location in the middle ear was recorded and the incidence of residual cholesteatomas after CWD tympanoplasty with soft-wall reconstruction was calculated. In addition, the 2 surgeons (S.-I.H. and A.T.) reviewed the videotapes of the first-stage tympanoplasty of the patients with residua using a monitor screen (TM2150M; Ikegami Tsushinki, Co, Ltd) and analyzed the maneuvers performed in the first surgery that might have caused the residual cholesteatomas.

RESULTS

Of 85 ears operated on in 85 patients (50 male and 35 female; mean age, 47 years [age range, 5-81 years]), 18 had residual cholesteatomas (10 of the pars flaccida type, 7 of the pars tensa type, and 1 congenital), for an overall incidence of 21%. There was 1 residuum per ear. Six cholesteatomas (5 of the pars flaccida type and 1 of the pars tensa type) were in the epitympanum (33%), 3 of the pars tensa type were in the sinus tympani (17%), 3 (2 of the pars flaccida type and 1 congenital) were in the antrum (17%), 2 (1 of the pars flaccida type and 1 of the pars tensa type) were on the stapes (11%), 2 (1 of the pars flaccida type and 1 of the pars tensa type) were in the TM (11%), 1 of the pars tensa type was on the tympanic portion of the facial canal (6%), and 1 of the pars flaccida type was just under the skin of the EAC (6%). No residual cholesteatomas were observed in the mastoid cavity, protympanum, hypotympanum, or tympanic orifice of the eustachian tube (Figure 1). In terms of postoperative EAC retraction, 24 of 85 ears operated on (28%) had posterior EAC wall retraction at the second-stage operation. Of these 24 ears, 6 had residual cholesteatomas (25%), and there was no correlation between the residual cholesteatoma and posterior EAC retraction. Although another 6 of the 85 ears (7%) had a deep, wide retraction pocket without a crust in the attic and did not
require cleaning, no recurrent cholesteatomas were observed in 85 ears at the second-stage operation.

On the basis of findings at retrospective videotape analysis, the residual cholesteatomas observed in the epitympanum were thought to be caused by an insufficient surgical view resulting from incomplete opening of the attic, incomplete cleaning around the head and neck of the malleus, or residual matrix on a bony defect of the middle cranial fossa. The cause of the residual cholesteatomas observed in the sinus tympani was insufficient removal of the matrix under indirect surgical view attributable to insufficient drilling into the facial ridge (Figure 2). The residual cholesteatomas in the antrum resulted from residual matrix on the bony defect of the middle cranial fossa (Figure 3) and incomplete opening of the cells of the antrum. The cholesteatomas remaining on the stapes resulted from incomplete removal of the matrix owing to maneuvers performed under indirect surgical view. A residual cholesteatoma on the facial canal was thought to arise from insufficient removal of the matrix from the bony dehiscence of the facial canal. The residual cholesteatomas observed in the TM and EAC resulted from unsuitable keratinizing epithelium rolling during TM and EAC skin reconstruction (Figure 4).

**COMMENT**

The incidence of residua found at planned second-stage operations was 21%. This is similar to the 20% to 25% incidence with CWU tympanoplasty, and slightly higher than the 14.6% incidence with the CWD and open tympanoplasty, in other articles that included both CWU and CWD tympanoplasties, the incidence of residua ranged from 26% to 31%, slightly higher than reported herein. According to these results, CWD tympanoplasty does not demonstrate great advantage over CWU tympanoplasty insofar as the incidence of residual cholesteatoma. The differences among these rates might arise from variations in the surgical procedures, grade of cholesteatoma expansion, and individual surgeon skills. Sanna et al performed CWU tympanoplasty at the first-stage operation and reported the incidence of residua by location, as follows: 47.5% in the mesotympanum, 41% in the epitympanum, and 11.6% in the aditus or mastoid cavity. Syms and Luxford reported similar incidence. Sheehy et al and Sheehy and Robinson also performed CWU tympanoplasty and reported that the middle ear, which includes the mesotympanum and protympanum, contained residual cholesteatomas more frequently than did the epitympanum or mastoid cavity. We found that the incidence of residua in the mesotympanum was the same as that in other regions involving the antrum and epitympanum, which is similar to that reported by Sanna et al. The difference between the results of Sheehy et al, Sheehy and Robinson, and the present study could be attributed to the grade of cholesteatoma expansion to the middle cranial fossa. Some of our patients had bony defects in the middle cranial fossa, which is one of the causes of residual cholesteatomas.

It is still unclear whether CWU or CWD is better for decreasing the incidence of residua. Most otologists think that CWD tympanoplasty is more effective, although others hold the opposite opinion. In theory, the CWD and open tympanoplasty prevents residual cholesteatomas in the antrum, epitympanum, and mastoid cavity, and revision surgery is not necessary in most cases, which is a great advantage of CWD and open tympanoplasty. However, the problem still remains in the mesotympanum, where the probability of residual cholesteatomas is high because the sinus tympani in the mesotympanum is hidden from surgical view under the microscope even if the CWD is performed. To prevent residual cholesteatomas and to improve hearing, Sheehy et al and Sheehy and Robinson recommended planned 2-stage tympanoplasty in patients with cholesteatomas who underwent CWU tympanoplasty. Sanna et al reported a similar opinion. On the basis of our experience with second-stage tympanoplasty performed 1 year after the first-stage CWD tympanoplasty with soft-wall reconstruction, residual cholesteatomas are found not only in locations in which residua are expected but also where they are unexpected, such as the antrum and epitympanum, where not much attention is paid to residua in ears operated on using the CWD and open tympanoplasty. Therefore, a planned 2-stage tympanoplasty should be considered in patients with extensive cholesteatomas removed at CWD with soft-wall reconstruction to ensure ears that are absolutely free of cholesteatomas after the second-stage tympanoplasty, similar to results with the CWU procedure. However, the necessity of second-stage tympanoplasty is a relative disadvantage of CWD tympanoplasty with soft-wall reconstruction compared with the CWD and open tympanoplasty insofar as operating time and medical economy.

We used the CWD procedure with soft-wall reconstruction rather than using the bony EAC wall. Although we performed CWD before posterior wall reconstruction, the incidence of residua was similar to that with CWU. Hence, our experience supports the opinion that CWD has no advantages over CWU insofar as reducing the possibility of residual cholesteatomas. As a result, CWD tympanoplasty with soft-wall reconstruction did...
not reduce the incidence of residua compared with CWU tympanoplasty. With the combined use of a surgical microscope and endoscopes, there is no longer thought to be an obvious difference between CWD and CWU tympanoplasties insofar as the incidence of residual cholesteatoma. In general, CWU tympanoplasty, which is an ideal surgical procedure for maintaining the shape of the normal EAC with skin migration and results in slightly better hearing compared with CWD tympanoplasty,

15 was thought to have a high associated incidence of recurrent cholesteatoma. Nyrop and Bonding

17 reported that approximately 55% of ears treated using the CWU procedure from 1979 to 1981 developed a recurrent cholesteatoma in the 10 to 13 years of postoperative follow-up. In contrast, only 4% of ears treated using the CWD procedure in the same period developed recurrent cholesteatoma.17 Before 1970, Sheehy et al1 and Yanagihara et al18 reported recurrence rates of 10% to 20% and 41%, respectively, in ears operated on with the CWU procedure. With the adoption of planned 2-stage tympanoplasty and placement of a polymeric silicone or plastic sheet in the tympanic cavity to facilitate aeration of the middle ear in the first-stage operation, the incidence of recurrent cholesteatoma has decreased to 0% to 5%.1,2,12,18 However, Yanagihara et al18 also reported that 23% of ears treated using the CWU procedure still developed a deep retraction pocket,18 which has the potential for development of a recurrent cholesteatoma. In our study of 85 ears treated using CWD tympanoplasty with soft-wall reconstruction, no recurrent cholesteatoma was observed and the incidence of a deep retraction pocket (7%) was lower than in ears treated with CWU tympanoplasty. Although long-term observation of the ears is necessary, it seems likely that CWD tympanoplasty with soft-wall reconstruction results in a low incidence of recurrent cholesteatoma and deep retraction pocket,9 similar to results with the CWD and open procedures.

The reason the incidence of residua in our patients’ ears was not lower than that with CWU tympanoplasty might be that the sinus tympani is still hidden from surgical view under the microscope after the CWD procedure.16 The results of our retrospective videotape analy-
sis of the first-stage operation suggest that greater effort must be made to avert leaving residual cholesteatoma matrix in the sinus tympani assisted with endoscopic observation. Insofar as other factors that may increase the risk of residua, Gristwood and Venables\textsuperscript{11} reported that ears with infiltration of the matrix to the pneumatized mastoid cavity, ears in which the middle ear mucosa was replaced by matrix, or ears in which the mucosa had become polypoidal had a greater chance of residual disease compared with ears in which the mucosa was normal. In such cases, the matrix should be removed completely in the first-stage operation and a second-stage tympanoplasty should be considered.

The combination of the CWD procedure and soft-wall reconstruction is useful. As advantages of this method, Smith et al\textsuperscript{7} listed early postoperative wound healing, technical ease, and little additional operating time compared with the CWD and open procedures. Moreover, Hosoi and Murata\textsuperscript{8} mentioned the low incidence of retraction pockets and recurrent cholesteatoma after surgery using this method. This technique is characterized by almost complete preservation of the shape of the EAC in ears with positive mastoid cavity aeration after surgery, whereas a retracted posterior EAC wall, like a radical mastoid cavity, is observed in ears without gas exchange function in the mastoid cavity.\textsuperscript{7} Takahashi et al\textsuperscript{9} stated that with the soft-wall reconstruction method, the mastoid cavity itself determines whether the posterior EAC wall is retracted after surgery according to its residual gas exchange function.\textsuperscript{9} Regarding this point, further analysis of the postoperative hearing outcome is needed.

Retrospective videotape analysis was extremely useful in determining the technical faults that led to residual cholesteatomas. The videotapes of the first-stage operations identified the manipulations that must be performed with great care to decrease cholesteatoma residua. For example, when removing the matrix from the bony wall of the epitympanum, sufficient opening of the attic is needed. Additional opening of the EAC wall and endoscopic observation are necessary when the cholesteatoma extends into the sinus tympani. In addition, bony defects of the middle cranial fossa or facial canal can hide unexpected residual cholesteatomas. More conscientious maneuvering and observation are essential to eliminate such lesions. Whether other cases demonstrate a lower rate of residua must be determined by further surgical analysis in the near future.

CONCLUSIONS

Canal wall down tympanoplasty with soft-wall reconstruction has no advantage in terms of the incidence of recurrent cholesteatoma compared with CWU tympanoplasty in patients with extensive cholesteatomas who undergo CWD tympanoplasty with soft-wall reconstruction in the first-stage operation, as with CWU tympanoplasty. The existence of residual cholesteatomas, not only in the antrum and tympanic cavity but also in the mastoid cavity, should be explored at a second-stage tympanoplasty. Another reason for a planned 2-stage tympanoplasty with CWD and soft-wall reconstruction is that the length of the columella might be easier to determine at a second-stage than a first-stage tympanoplasty because the shape of the EAC or the distance between the TM and the stapes are fixed by 1 year after the first-stage operation using CWD tympanoplasty with soft-wall reconstruction. The mastoid cavity determines whether the posterior EAC wall is retracted after surgery according to its residual gas exchange function.\textsuperscript{9} Regarding this point, further analysis of the postoperative hearing outcome is needed.
noplasty or CWD and open tympanoplasty. Regarding their localization, CWD tympanoplasty with soft-wall reconstruction does not prevent the possibility of residua in the antrum, mastoid cavity, or tympanic cavity, similar to CWU tympanoplasty. These results suggest that in patients with extensive cholesteatomas, CWD tympanoplasty with soft-wall reconstruction should be followed by later second-stage surgery so as not to miss residual cholesteatomas not only in the tympanic cavity but also in the antrum and mastoid cavity. Furthermore, on the basis of our retrospective videotape analysis of surgical procedures with residual cholesteatomas, several lessons must be seriously considered: (1) do not remove the cholesteatoma matrix under an indirect surgical view; (2) search carefully for residua when the matrix is being removed from the cranial fossa or facial canal with bony defects; and (3) avoid unsuitable keratinizing epithelium rolling during TM and EAC skin reconstruction with soft tissue or soft-wall reconstruction. Further prospective studies are required to confirm these instructive results on reducing cholesteatoma residua and to confirm whether the CWD and soft-wall reconstruction has an advantage over CWU and the CWD and open tympanoplasty in terms of recurrent cholesteatoma and hearing outcome.

Submitted for Publication: May 7, 2007; final revision received October 11, 2007; accepted October 14, 2007. Correspondence: Shin-Ichi Haginomori, MD, Department of Otolaryngology, Osaka Medical College, 2-7 Daigakumachi, Takatsuki, Osaka 569-8686, Japan (hagi@@poh.osaka-med.ac.jp). Author Contributions: Dr Haginomori had full access to all the data in the study and takes responsibility for the integrity of the data and the accuracy of the data analysis. Study concept and design: Haginomori and Takenaka. Acquisition of data: Haginomori, Takamaki, and Nonaka. Analysis and interpretation of data: Haginomori, Takamaki, and Nonaka. Drafting of the manuscript: Haginomori and Takamaki. Critical revision of the manuscript for important intellectual content: Nonaka and Takenaka. Administrative, technical, and material support: Haginomori, Takamaki, and Nonaka. Study supervision: Takenaka.

Financial Disclosure: None reported.

REFERENCES