Autograft Ossiculoplasty in Cholesteatoma Surgery: Is It Feasible?

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**Objective:** To investigate whether autologous ossicles can be safely used in ossicular reconstruction in cholesteatoma surgery after attempting cholesteatoma removal under the operating microscope. **Study Design:** A prospective fine-section histological study of formalin-stored ossicles, harvested from cholesteatomatous ears, to evaluate for existence of residual cholesteatoma after surface disease clearance under the operating microscope. **Methods:** One hundred four ossicles were harvested from 76 patients with cholesteatoma for the study. These malleus heads and incudes were categorized into three groups: group 1, ossicles with retained shape and useful bulk, treated by microscopic stripping alone; group 2, ossicles with retained shape and useful bulk, treated by microscopic stripping and drilling; and group 3, badly eroded ossicles, treated by microscopic stripping alone. These treated ossicles were then subjected to 4-μm histopathological study. **Results:** Residual disease was identified in 6 of the 104 ossicles. Residual disease was found only in badly eroded ossicles that are not suitable for reconstruction. All the usable ossicles were free of disease. **Conclusions:** Autologous ossicles that have retained body and bulk are safe to use for reconstruction after surface stripping under the operating microscope. Additional burring probably adds a further margin of safety. **Key Words:** Autologous ossicles, cholesteatoma, ossiculoplasty.

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**INTRODUCTION**

Autograft ossiculoplasty was first reported by Hall and Rytzner1 in 1957. Autologous ossicles soon became the workhorse for tympanoplasty because of their easy availability, low cost of preparation, and, most of all, biocompatibility.2–4 However, their use in cholesteatomatous ears has been stemmed by the possibility of harboring residual disease. Much attention has also been drawn to the prevalence of microscopic osteitic changes of these ossicles, which may result in late relapse of the inflammatory process leading to malfunctioning of the transmission apparatus.5 Sade6 described the presence of intraosseous mucus-producing cells in the ossicles from 50 patients with cholesteatoma. He postulated that keratin-producing cells could find their way into deep vascular spaces in the same unknown fashion, which might account for some of the recurrences of cholesteatoma. This postulation implies that the autologous ossicle may still be unsafe to use even if the surface is completely cleared of disease. However, such a postulation has not been substantiated by convincing evidence. In contrast, in a similar study in which 113 ossicles were subjected to histopathological evaluation, residual cholesteatoma was found in only one-third of the specimens and all were superficially located even in the presence of gross ossicular destruction.7 Therefore, the authors held the opinion that autologous ossicles should not necessarily be rejected for reconstruction in cholesteatomatous ears because the otologist should be able to remove the superficial disease if present. However, further evidence on this issue is scanty and conflicting.8–10 The aim of the present study was to investigate whether autologous ossicles can be safely employed in ossicular reconstruction in cholesteatoma surgery after attempting cholesteatoma removal under the operating microscope.

**MATERIALS AND METHODS**

Malleus heads and incudes were removed from cholesteatomatous ears during canal wall down mastoidectomies. These ossicles were collected by the authors and stored in formalin. The authors would then attempt to remove possible cholesteatoma associated with these ossicles. The attempted removal was performed using a Hughes stapes mobilizer under the surgical microscope (Carl Zeiss OPMI 9 FC) at a magnification of 12.5 × 7.8 (microscopic stripping). A group of ossicles was subjected to stripping and burring using a fine diamond burr with the help of an ossicle holding clamp to further enhance clearance. The malleus heads and (body of) incudes were each categorized as follows: group 1, ossicles with retained shape and useful bulk, treated by microscopic stripping alone; group 2, ossicles with retained shape and useful bulk, treated by microscopic stripping and drilling; and group 3, badly eroded ossicles, treated by microscopic stripping alone.

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All treated ossicles were decalcified and embedded in paraffin wax. The specimens were serially sectioned at 4 μm and stained with H&E. The planes of section are shown in Figure 1. The long process of incus, if it was present, would be divided from the body and be sectioned at a different plane from the rest of the ossicle. These planes of section were chosen to minimize tangential section of the ossicle, which may give rise to erroneous estimate of depth of the disease invasion as illustrated in Figure 2. The malleus heads would be sectioned superoinferiorly (referring to their anatomical position). The histological slides were then presented to a separate pathologist. Batches of 10 consecutive sections were examined at 10-section intervals.

RESULTS

From March 1998 to February 2002, 104 ossicles were harvested from 76 patients for the study, which included 35 malleus heads and 69 incudes. There were 47 male and 29 female patients. Their ages ranged from 4 to 88 years with a mean age of 36.9 years. The results are shown in Table I.

Residual disease was identified in 1 of the 35 malleus heads and 5 of the 69 incudes. All ossicles with residual disease were from group 3 (i.e., badly eroded ossicles that are not suitable for reconstruction). All the other 62 ossicles, the groups 1 and 2 malleus heads and incudes, were free of disease. The diseased ossicles accounted for 10% of group 3 malleus heads and 15.6% of group 3 incudes. The residual disease on these ossicles was found to be superficial, and no intraosseous cholesteatoma was evident (Figs. 3 and 4).

DISCUSSION

The benefit of reconstructing the ossicular chain is well documented in both canal wall up and canal wall down tympanomastoidectomies. Autograft ossicles are ideal for this procedure, provided that they are disease free.

No randomized controlled study has been performed to show the theoretical adverse consequences of autograft ossiculoplasty regarding cholesteatoma recurrence and possible impact on hearing. The present histological study of the ossicles from patients with cholesteatoma provides more information relating to the use of autologous ossicles. The three main reported methods of clearing cholesteatoma residue from ossicles include microscopic stripping, burring over the ossicular surface, and autoclaving performed either alone or in combination. Undoubtedly, autoclaving the ossicles would provide safe autografts because all the living cells would be killed. However, this extreme measure is inconvenient, costly, and time-consuming. Furthermore, in addition to the uncertainty surrounding its long-term viability, the benefit of immediate use of an autograft is lost. For the other two methods of cleaning the ossicles, the available information...
to date is limited. The two studies that reported no residual disease using methods other than autoclaving were too small (10 specimens in both series) to be conclusive. In one of these studies, the histological examination was probably suboptimal because only 15 slides were examined from each sectioned ossicle. In the present study, histological sections were at 4 μm through the entire ossicle, which meant 800 or more sections for a single minimally eroded incus. The thin sections and meticulous examination virtually eliminate the sampling error.

The choice of sectioning plane is important because an inappropriate planar angle may give rise to an erroneous estimate of the depth of disease invasion as illustrated in Figure 2. Hence, we standardized the sectioning plane as previously mentioned (Fig. 1) to avoid this possible error.

Among the 104 ossicles, cholesteatoma residues could be found only in the badly eroded bones. Even so, the residues were all superficial. Because these bones were so deformed and flimsy, stripping was technically more difficult. Thus, residual disease residing in some of the numerous pits of these bones were relatively easily missed. Another possible reason for failure to achieve complete disease clearance in these fragile bones is the omission of burring, with the intention to avoid their disintegration. Because none of these bones could be used for reconstruction, such findings should not necessarily refute the safe use of autograft ossicles. The remaining 62 ossicles, which were potentially usable for ossicular reconstruction, were all free of cholesteatoma. The majority of bones seem to have been effectively cleaned by microscopic stripping alone. Interestingly, this is in contrast to the results of Dornhoffer et al., who found residues in 7 of 11 specimens treated by microscopic stripping alone. Such a discrepancy can be explained in part by the difference in stripping maneuvers used. Dornhoffer used a round knife (personal communication, April 2002) to clear the disease, which probably missed disease contained in small pits. This can be better avoided by using finer instruments such as the Hughes stapes mobilizer that we have been using. It could be that the disease might have been more easily removed from formalin-stored ossicles than from fresh ossicles in the study of Dornhoffer et al. Nonetheless, in our scrutiny, deep pockets of cholesteatoma were not present in any ossicle. According to our findings, microscopic stripping and additional burring, in theory adding a safe margin, should render the autografts safe for reimplantation. The additional burring potentially supplements microscopic stripping in two ways. First, cholesteatoma residues can be directly scraped away. Second, the heat generated during the drilling might destroy nearby living epithelial cells. In the retrospective clinical study of Seifi and Fouda of 14 cases of cholesteatoma in which nonautoclaved drilled autologous ossicles were used for reconstruction, there was no macroscopic cholesteatoma recurrence from the reimplanted autografts over a period of 3 to 7 years. Further information can be sought in a retrospective review made by Vartiainen and Karjalainen. That study reviewed 315 one-stage tympanoplasties using autologous ossicles or cortical bones with a mean follow-up of 5.8 years. One hundred ninety-six of them were performed in cholesteatomatous ears with simultaneous cavity obliteration. The authors reported a low cholesteatoma recurrence rate of only 4%. Nevertheless, their study did not elaborate on the relative proportions of autologous ossicles and cortical bones used.

Regarding the issue of osteitis, it is more likely to be a secondary phenomenon to the neighboring cholesteatoma rather than a self-perpetuating process. Sadé and Berco remarked that the stagnant keratin in the cholesteatoma serves as an ideal medium for bacterial growth, which would sustain inflammation and result in bone erosion. It would make sense that complete removal of the cholesteatoma and replacement of the ossicle in a favorable environment may reverse the inflammatory process. This concept is consistent with the findings of Wake et al. In their study, ossicle remnants, which were removed during closed cavity mastoidectomy, were stored in the mastoid cavity after thorough

![Fig. 3. Residual cholesteatoma on malleus head (arrow) (H&E stain, original magnification ×100).](image-url)
cleaning. All these ossicle remnants, when removed 12 months later in a ‘second-look’ operation, were found to have remained viable. New bone growth and revascularization were clearly noted, being consistent with healthy sustained survival.

CONCLUSION

Based on our study results and the available evidence, it is feasible to use autologous ossicles for ossicular chain reconstruction in cholesteatoma surgery provided they are microscopically stripped of all suspect tissue. Burring, in addition to stripping, would probably add a further safe margin.

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Fig. 4. Residual cholesteatoma on incudes (arrow). All residual diseases are superficial (H&E stain, original magnification ×100).