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Original Article

Quantitative Study of Bone Removal Region in Transcanal Endoscopic Approach to the Attic and Antrum Using a 70° Endoscope

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BACKGROUND: Transcanal endoscopic ear surgery enables surgeons to operate with few blind areas, and using an angled endoscope expands its usefulness. We have previously reported the usefulness of a 70° endoscope in transcanal endoscopic ear surgery, but no quantitative study has been performed. We quantitatively clarified the difference between a microscope and various endoscopes in the bone removal region, especially a 70° endoscope, in the transcanal approach.

METHODS: A temporal bone model for ear surgery training was used to compare the use of a microscope, a 0° endoscope, a 30° endoscope, a 45° endoscope, and a 70° endoscope. The drilled mass during atticotomy or atticoantrostomy and the size of the reconstructed graft were measured when the formed pseudo-lesion was removed.

RESULTS: The amount of bone excision was 57% and the size of the reconstructed graft was 32% when using a 70° endoscope compared with the case of using a microscope, both of which were the smallest of the various endoscopes.

CONCLUSION: It was quantitatively shown that using a 70° endoscope in transcanal endoscopic ear surgery reduced the bone removal region. We believe that a 70° endoscope is a useful tool for performing a minimally invasive and reliable surgery.

KEY WORDS: Middle ear surgery, minimal invasive surgery, transcanal endoscopic ear surgery, 70° endoscope, cholesteatoma

INTRODUCTION

An exclusive endoscopic tympanoplasty for cholesteatoma was first described by Tarabichi,[1] and endoscopic techniques have improved treatment outcomes, especially in terms of residual disease.[2] The use of angled endoscopes reduces blind areas, which is beneficial in reducing the incidence of residual disease in such cases. Endoscopes with angles of 30° and 45° are commonly used, but there are few reports about the use of 70° endoscopes for ear surgery. We have always used 70° endoscopes for endoscopic sinus surgery with reference to previous reports;[3] therefore, we decided to apply this approach to ear surgery. We previously reported the usefulness of using a 70° endoscope in transcanal endoscopic ear surgery (TEES),[4] but no quantitative study has been performed. In this study, we quantitatively clarified the difference between a microscope and various endoscopes, especially the 70° endoscope, in the transcanal approach, in the amount of removed bone and the size of the material needed to reconstruct the defect.

MATERIALS AND METHODS

Temporal bone models for ear surgery training (NB504 Schmidt right ear with ossicles) were used for both the microscope and endoscopes. A microscope (Carl Zeiss, Jena, Germany) and rigid endoscopes with angles of 0°, 30°, 45°, or 70° (length: 14 cm, outer diameter: 2.7 mm; Stryker, Kalamazoo, Minn, USA) were used. They were connected to a camera head (Stryker) and a high-definition monitor positioned in front of the operator.

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The procedure was performed as follows.

1. The mastoid antrum was exposed with transcortical mastoidectomy using a bone-drilling device (VISAO; Medtronic, Dublin, Ireland).
2. An oral care sponge cut into a 2 mm × 2 mm square was placed at the apex of the lateral semicircular canal and cranial side of the anterior end of the lateral semicircular canal as pseudo-lesions (Figure 1A).
3. After elevating the tympanic membrane (Figure 1B), the posterosuperior wall of the external canal was removed using the VISAO curved burr in the transcanal approach (Figure 1C). During the procedure, the incus and head of the malleus were removed (Figure 1D). Up to this point, a 0° endoscope was used. Drillings were then performed using a microscope and each endoscope.
4. The drilling was stopped every few seconds after the lesions came into view and when the user attempted to remove them. The drilled mass (DM) was measured when the 2 lesions were sufficiently removed (Figure 1E), which was defined as when the sponge could be removed without completely losing sight of the sponge.
5. The defect of the canal wall was reconstructed using molded thick-copy paper (160 g/m^2) (Figure 1F).
6. The mass of the reconstructed graft (AR) was measured, and the area was calculated.
7. Measurements were made using a microscope and 0°, 30°, 45°, and 70° endoscopes.

RESULTS

The DM weighed 0.37 g when using a microscope, 0.33 g with a 0° endoscope, 0.29 g with a 30° endoscope, 0.26 g with a 45° endoscope, and 0.22 g with a 70° endoscope. The area of the reconstructed graft (AR) was 72.5 mm^2 with a microscope, 48.13 mm^2 with a 0° endoscope, 36.25 mm^2 with a 30° endoscope, 31.25 mm^2 with a 45° endoscope, and 23.75 mm^2 with a 70° endoscope (Table 1). The DM and AR were the smallest when using a 70° endoscope. The DM and AR of the 70° endoscope were 57% and 32% of those measured by the microscope (Figures 2A, B), respectively. The DM and AR of the 70° endoscope were 73% and 61% of those measured by the 30° endoscope, respectively. The DM and AR of the 70° endoscope were 81% and 71% of those measured by the 45° endoscope, respectively. The difference in AR was larger than that of the DM. When we checked the model with various endoscopes, in which lesions were seen only when using a 70° endoscope, we found that the larger the angle, the deeper the lesion could be seen (Figure 3). Lesions could not be seen at all with 0° or 30° endoscopes, and only a part of the pseudo-lesion could be seen with a 45° endoscope. The difference in AR was also obvious to the unaided eye (Figure 4).

Table 1. Results for the Drilled Mass (DM) and Area of the Reconstructed Graft (AR) in the Microscope (MS) and Each Endoscope

	MS	0°	30°	45°	70°
DM (g)	0.37	0.33	0.29	0.26	0.22
AR (mm^2)	72.5	48.13	36.25	31.25	23.75

DISCUSSION

An increasing number of reports have described the use of endoscopic ear surgery to treat cholesteatoma, and the results of such procedures have improved. The use of angled endoscopes reduces blind areas,[4] and we believe that is why the incidence of residual disease reduces. Both 30° and 45° endoscopes are commonly used, but there are few reports about the use of 70° endoscopes for ear surgery. We believe that a 70° endoscope is also useful in such surgeries, and we have used it for attic-to-antrum lesions and sinus tympani (ST). According to a previous report on the ST using human temporal bone specimens,[5] it is easier to approach the ST using a

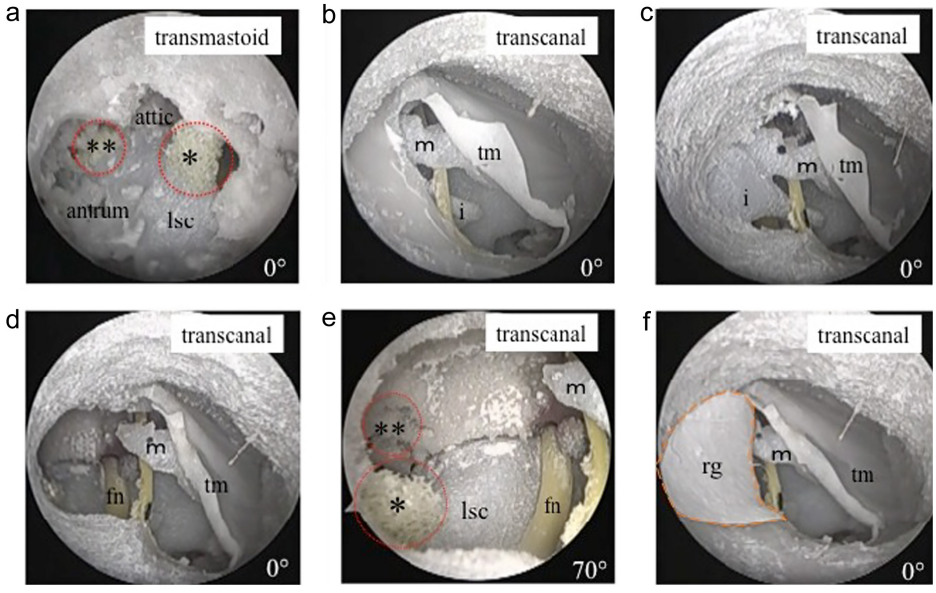

Figure 1. Endoscopic images showing the procedure (right ear). (A) Transmastoid endoscopic image after mastoidectomy and placement of pseudo-lesions. (B-F) Transcanal endoscopic images (B) after elevating tympanic membrane, (C) after atticotomy using curved burr, (D) after removing the incus and the head of the malleus, (E) 70° endoscopic image when the 2 lesions were sufficiently removed; (F) after attic reconstruction. lsc, lateral semicircular canal; tm, tympanic membrane; m, malleus, i, incus, rg, reconstructed graft; red dotted circles, locations of pseudo-lesions; *pseudo-lesion at the apex of the lateral semicircular canal; **pseudo-lesion at the cranial side of the anterior end of the lateral semicircular canal; orange dotted circle, lesion of reconstructed graft.

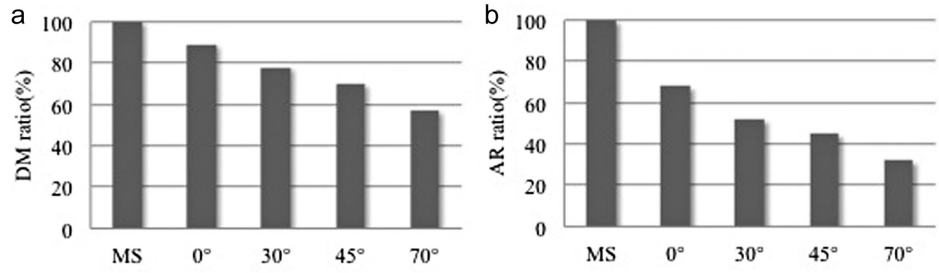

Figure 2. Results for ratio of the drilled mass (DM) and area of the reconstructed graft (AR) in the microscope (MS) and each endoscope. (A) DM ratio between MS and each endoscope. (B) AR ratio between MS and each endoscope. DM, drilled mass; AR, area of reconstructed graft; MS, microscope.

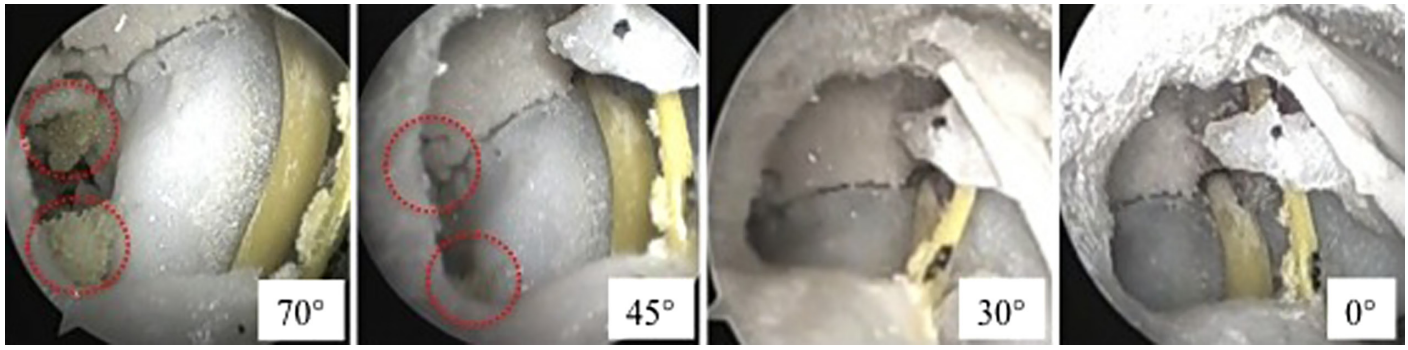

Figure 3. Images taken by each different endoscope for lesions visible only by 70° endoscope. Dotted circles indicate pseudo-lesions.

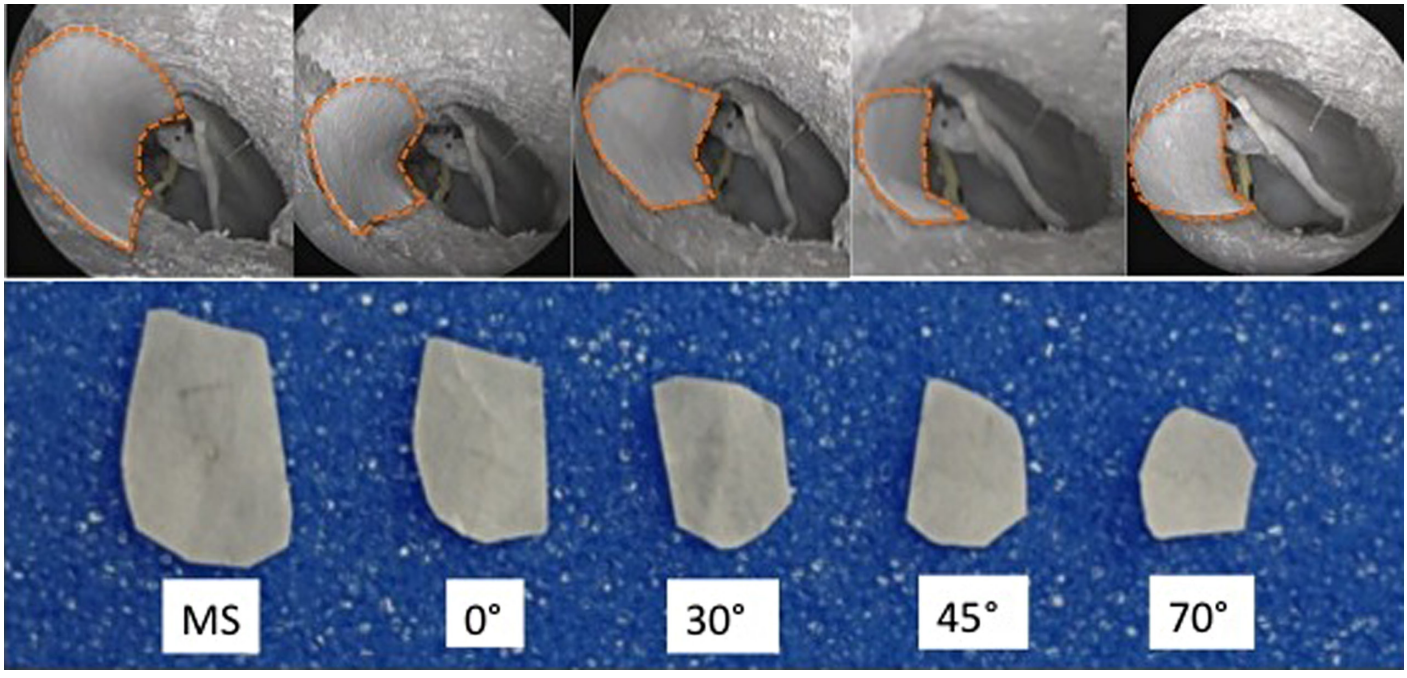

Figure 4. Images of lesions after reconstruction and areas of reconstructed graft used. (A-E) Endoscopic images after attic reconstruction. (A) Microscope (MS), (B) 0°, (C) 30°, (D) 45°, (E) 70°, (F) differences in reconstructed graft used. Orange dotted circles, reconstructed grafts.

70° endoscope, but it is difficult to approach deep ST type-C retrotympanic recesses (posterior and medial to the facial nerve).[6] We previously presented a video of a surgical case and reported the usefulness of a 70° endoscope when approaching an attic-to-antrum lesion.[4] Specifically, using a 70° endoscope makes it possible to perform surgery that minimizes the removal of the external auditory canal. However, no quantitative study has been conducted, and so we quantitatively examined the difference between a microscope and various endoscopes using the transcanal approach in the bone removal region. As a result, the DM and AR were the smallest when using a 70° endoscope.

The limitations in this study are that we used only one type of model and only one surgeon was involved. We considered using multiple cadavers or multiple surgeons. However, in the case of using

cadavers, the mass difference of the cadaver becomes large and the mass difference of the reconstructed graft also becomes large. Therefore, we used identical, commercially available temporal bone models. The reason why a single surgeon performed these procedures in this study was that there was little difference in outcomes compared to several surgeons at the same institution performing similar procedures.

We think that the transcanal endoscopic approach has 2 disadvantages. First, it can often only be performed one-handed, especially when transcanal atticotomy is performed using a bone-drilling device. Second, it is difficult to collect sufficient reconstruction material without performing a retroauricular incision. Surgery for cholesteatoma extending to the attic or antrum often requires a more extensive atticotomy or atticoantrostomy[7] and more reconstruction materials compared to a surgery for other middle ear diseases. An ear surgeon will also know that the larger the defect area, the more difficult it is to reconstruct. This is because the curved ear canal must be reliably reconstructed using nearly flat cartilage. Incomplete reconstruction increases the risk of recurrence, although there is more than one factor involved in recurrence. In addition, endoscopic ear surgery is said to be minimally invasive, but one of the requirements for minimally invasive surgery is to firmly retain the normal structure that does not need to be destroyed. Therefore, it is of great significance to concretely show that the reconstruction with a small graft is possible by using a 70° endoscope.

In previous reports using cadavers,[8] the volume of ear canal removal was smaller in endoscopic surgery than in microscopic surgery, with the same intention as ours. Compared to the study, the strength of our study was the use of angled endoscopes and the evaluation of the size of the graft required for reconstruction. Our study quantitatively showed that the attic and antrum can be approached with a small amount of drilling using a 70° endoscope. Moreover, the difference in AR was larger than the difference in DM, and the use of a 70° endoscope when approaching the attic and antrum makes it easier to reconstruct the attic.

CONCLUSION

The difference between a microscope and various endoscopes in the amount and range of bone excision was quantitatively examined using the transcanal approach for the attic and antrum using a temporal bone model. We believe that a 70° endoscope is a useful tool for performing minimally invasive and reliable surgery.

Ethics Committee Approval: Ethical committee approval was received from the Ethics Committee of Jikei University School of Medicine University (approval no: 32-205 10286).

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

Peer Review: Externally peer-reviewed.

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Declaration of Interests: The authors have no conflict of interest to declare.

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REFERENCES

1. Tarabichi M. Endoscopic management of cholesteatoma: long-term results. *Otolaryngol Head Neck Surg*. 2000;122(6):874-881. [CrossRef]
2. Alicandri-Ciufelli M, Marchioni D, Kakehata S, Presutti L, Villari D. Endoscopic management of attic cholesteatoma: long-term results. *Otolaryngol Clin North Am*. 2016;49(5):1265-1270. [CrossRef]
3. Moriyama H. The technique of endoscopic surgery and diagnosis of frontal recess and sinus disease under local anesthesia. *J Otolaryngol*. 1991;20(6):382-384.
4. Takahashi M, Yamamoto Y, Kojima H. Transcanal endoscopic approach for pars flaccida cholesteatoma using a 70-degree angled endoscope. *Eur Arch Otorhinolaryngol*. 2021;278(4):1283-1288. [CrossRef]
5. Bonali M, Fermi M, Alicandri-Ciufelli M, et al. Correlation of radiologic versus endoscopic visualization of the middle ear: implications for endoscopic ear surgery. *Otol Neurotol*. 2020;41(9):e1122-e1127. [CrossRef]
6. Marchioni D, Valerini S, Mattioli F, Alicandri-Ciufelli M, Presutti L. Radiological assessment of the sinus tympani: temporal bone HRCT analyses and surgically related findings. *Surg Radiol Anat*. 2015;37(4):385-392. [CrossRef]
7. Imai T, Nishiike S, Oshima K, Tanaka H, Tsuruta Y, Tomiyama Y. The resected area of the posterior wall of the external auditory canal during transcanal endoscopic ear surgery for cholesteatoma. *Auris Nasus Larynx*. 2017;44(2):141-146. [CrossRef]
8. Baazil AHA, Dobbe JGG, van Spronsen E, et al. A volumetric three-dimensional evaluation of invasiveness of an endoscopic and microscopic approach for transmeatal visualisation of the middle ear. *J Laryngol Otol*. 2021;135(5):410-414. [CrossRef]