Otology & Neurotology
35:e140–e145 © 2014, Otology & Neurotology, Inc.

Feasibility and Advantages of Transcanal Endoscopic Myringoplasty

Takatoshi Furukawa, Tomoo Watanabe, Tsukasa Ito, Toshinori Kubota, and Seiji Kakehata

Department of Otolaryngology, Head and Neck Surgery, Yamagata University Faculty of Medicine, Yamagata, Japan

Objective: When performing transcanal myringoplasty under a microscope, the total circumference of the perforation can be difficult to confirm in patients where the external ear canal is narrow and/or protruded. In such patients, a retroauricular incision approach is usually used. However, we have developed a transcanal endoscopic myringoplasty procedure, and the microscopic and endoscopic views are compared herein for the first time. The feasibility and advantages of transcanal endoscopic myringoplasty were examined.
Study Design: A prospective case series.
Setting: Tertiary referral center.
Patients: Transcanal endoscopic myringoplasty was performed on 25 ears in 21 patients with chronic otitis media between September 2011 and December 2012.
Intervention: Microscopic and endoscopic views were compared for each patient. The 2 fields of views were both recorded and evaluated to determine the advantages and disadvantages of microscopes and endoscopes. Myringoplasty was performed using an endoscopic technique while comparing views as necessary.
Results: Endoscopic views revealed the entire tympanic membrane in a single field with clear visualization of the perforation edges even when the ear canal was curved. This clear visualization facilitated reliable refreshing of the perforation edges and grafting. The anterior edge of the perforation was not visible under microscopy in 5 of 25 ears. Under an endoscopic wide view, the tympanic cavity was observable through the perforation, and the orifice of the tube, ossicular chain, and tympanic isthmus were visible especially with large perforations. Transcanal endoscopic myringoplasty was successfully performed with a simple underlay technique or with an intracanal incision in cases of marginal perforation.
Conclusion: Comparison of microscopic and endoscopic views revealed superior visualization and operability of the endoscopic approach as opposed to transcanal simple underlay myringoplasty. Transcanal endoscopic myringoplasty does not require surgical exposure such as a retroauricular skin incision to get an anterior view. Our results demonstrated that transcanal endoscopic myringoplasty can be performed, regardless of the perforation size and the narrowness and/or protrusion of external ear canal.
Key Words: Endoscopy—Myringoplasty—Perforation—Tympanic membrane.

Otol Neurotol **35:**e140–e145, 2014.

The introduction of the operating microscope has significantly enhanced the outcome of myringoplasty by improving the accuracy of the technique. A simple underlay myringoplasty (SUM) using fibrin glue was introduced in 1992 by Yuasa et al. (1) (Fig. 1). Long-term follow-up showed that the success rate with this method is comparable to conventional microscopic retroauricular techniques. SUM is used to simultaneously treat binaural perforated chronic otitis media because of the low risk of postoperative inner ear disturbance (2,3). One example of the problems encountered when performing transcanal myringoplasty under a microscope is the difficulty of confirming the entire circumference of the perforation in some patients whose external ear canal is narrow and/or protruded (Fig. 2A). A retroauricular approach is usually used with such patients.

Minimally invasive surgery is becoming standard in many fields. The endoscope is a useful tool and has been incorporated into otologic surgery (4–6). Middle ear endoscopy was first introduced by Mer et al. in 1967, but endoscopes have mainly been used for diagnostic and photographic rather than surgical purposes until the last decade (7). Middle ear surgeries, which were traditionally performed under a microscope, are now increasingly

Address correspondence and reprint requests to Seiji Kakehata, M.D., Ph.D., Department of Otolaryngology, Head and Neck Surgery, Yamagata University Faculty of Medicine, 2-2-2 Iida-Nishi, Yamagata 990-9585, Japan; E-mail: kakehata@med.id.yamagata-u.ac.jp
The authors disclose no conflicts of interest.

Copyright © 2014 Otology & Neurotology, Inc. Unauthorized reproduction of this article is prohibited.

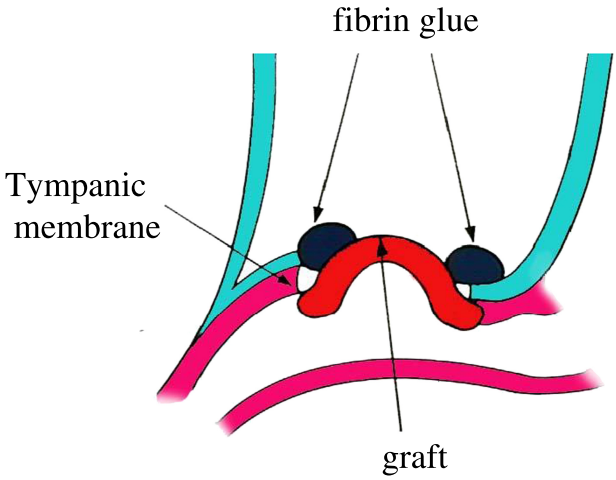

FIG. 1. Schematic drawing of SUM. A graft obtained from the retroauricular region is underlayed and fixed with a few drops of fibrin glue. Figure modified from Sakagami et al. (2).

being done endoscopically (8). El-Guindy has contended that the otoendoscope could replace the operation microscope (9). An endoscope provides visibility to the tympanic membrane in patients with a narrow and/or protruded ear canal (Fig. 2B). In a transcanal approach using a microscope without an elevating flap, the medial wall of the tympanic membrane cannot be visualized, which prevents confirmation of the absence of epithelial ingrowth. An endoscope, in contrast, enables visualization of the medial wall of the tympanic cavity and status of the ossicles (10,11).

We have developed a transcanal endoscopic myringoplasty with a simple underlay technique or with intracanal incision. This procedure has been our first choice of treatment for perforation of the tympanic membrane since September 2011. The feasibility and advantages of transcanal endoscopic myringoplasty are examined in this study, and microscopic and endoscopic views obtained via a transcanal approach are compared herein for the first time. Transcanal endoscopic myringoplasty was determined to be an excellent surgical procedure, which produced good results because of greatly enhanced surgical views without blind pockets obtained by the use of an endoscope.

PATIENTS AND METHODS

The present study was conducted in the Department of Otolaryngology, Head and Neck Surgery, Yamagata University Faculty of Medicine, Japan. Before surgery, all subjects underwent a CT scan to evaluate the status of the tympanic cavity and the mastoid cavity. Mean hearing levels and air-bone gap (ABG) for each patient were determined by averaging the hearing thresholds at 0.5, 1, 2, and 3 kHz, yielding a 4-tone average based on the criteria of AAO-HNS. Paper patch tests were also performed to ascertain the improvement of patient hearing. We used 0-, 30- or 70-degree angled rigid endoscopes with 2.7-mm outer diameter (Karl Storz) together with a high-definition video system (6). Surgery was performed with the endoscope held in one hand and the surgical instruments in the other hand. We primarily used the 0-degree angled endoscope with the 30- or 70-degree angled endoscopes used to more precisely observe the ossicular chain and tympanic cavity through the perforation of the tympanic membrane, taking care to avoid trauma to the ear canal or middle ear structures.

Surgical Procedures

We performed two types of transcanal endoscopic myringoplasty: with an intracanal incision and without an intracanal incision.

Endoscopic Simple Underlay Myringoplasty

The edge of the perforation was incised with a fine pick and circumferentially freshened to remove the epidermis and promote local bleeding. Calcification of the tympanic membrane was removed. When the perforation was large, care was taken to avoid damaging the chorda tympani or incudostapedial joint located in the posterior-superior part of the perforation. A subcutaneous connective tissue graft was harvested from the posterior part of the ear (with a <2-cm incision) and stretched with a press. This graft was then placed medially to the tympanic membrane. A few drops of fibrin glue were applied to the contact area. No meatal packing was necessary with this technique, and hearing improvement could be obtained just after surgery. A representative case of endoscopic SUM is shown in Figure 3.

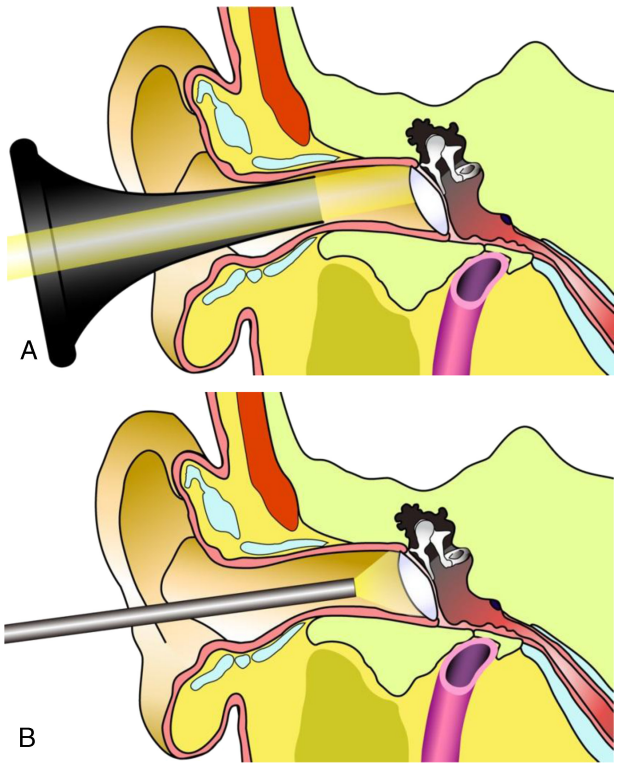

FIG. 2. Schema showing comparison of views provided by a microscope (*A*) or an endoscope (*B*). An endoscopic view provides a whole image of the tympanic membrane in one field, whereas a microscopic view provides a view of only part of the tympanic membrane.

Copyright © 2014 Otology & Neurotology, Inc. Unauthorized reproduction of this article is prohibited.

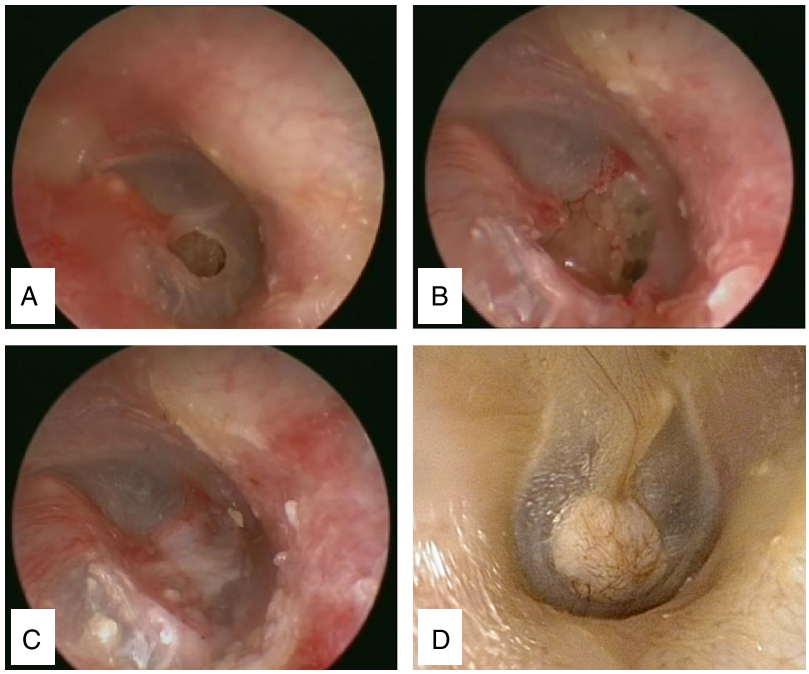

FIG. 3. (Patient 15 of Table 1) Endoscopic SUM. *A*, A perforation existed in the inferior part of the right tympanic membrane. *B*, The edge of the perforation was incised circumferentially with a fine pick to remove the epidermis and promote local bleeding. After cutting the margin, the perforation size was enlarged. *C*, A subcutaneous connective tissue graft was lodged medially to the tympanic membrane and a few drops of fibrin glue were applied to the contact area. *D*, The closed perforation at 6 months postoperatively.

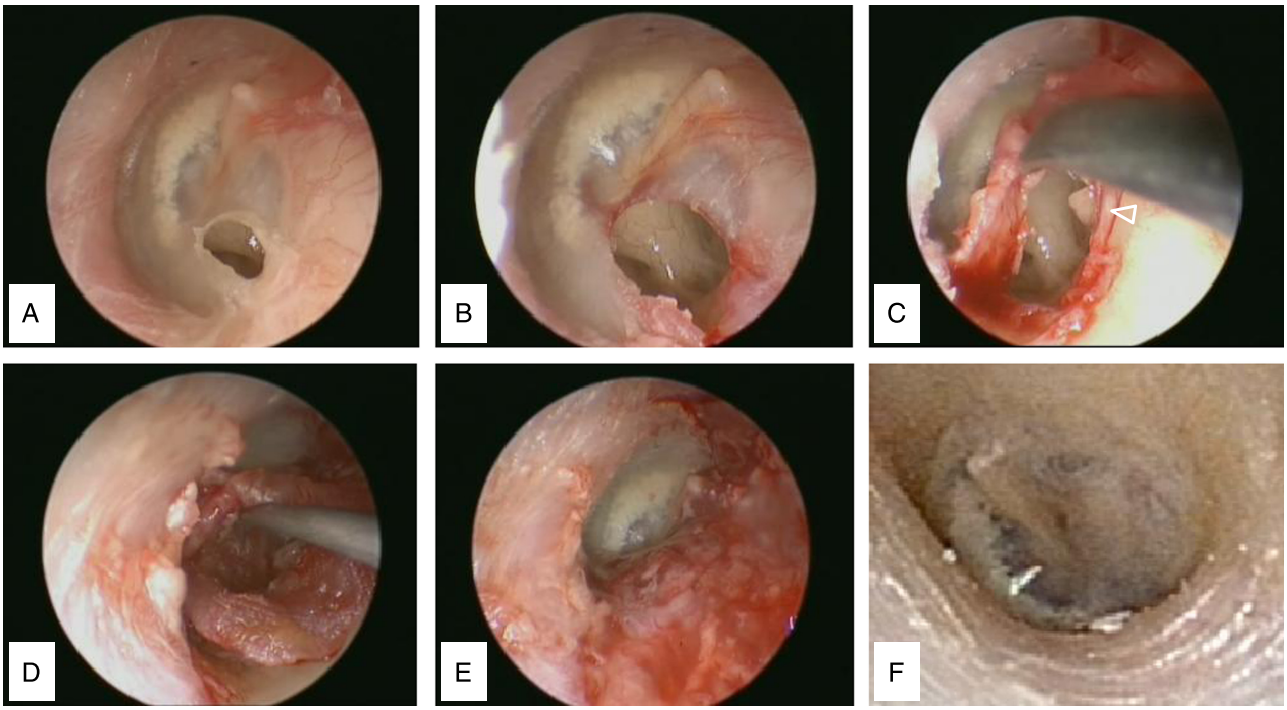

FIG. 4. (Patient 10 of Table 1) Transcanal endoscopic myringoplasty with intracanal incision. *A*, A marginal perforation existed in the posterior part of the left tympanic membrane. *B*, The edge of the perforation was circumferentially cut. The distance between the posterior limbus of the tympanic membrane and perforation edge was narrow. *C*, A tympanomeatal flap was elevated. The I-S joint was visible (Δ). *D*, A subcutaneous connective tissue graft was inserted into the tympanic cavity and underlayed. *E*, The meatal skin flap was replaced. *F*, An endoscopic view at 8 months postoperatively.

Copyright © 2014 Otology & Neurotology, Inc. Unauthorized reproduction of this article is prohibited.

Transcanal Endoscopic Myringoplasty With Intracanal Incision

When the area was inadequate between the posterior limb of the tympanic membrane and perforation edge, we elevated a tympanomeatal flap with intracanal incision and attached the graft using the underlay technique. A representative case of transcanal endoscopic myringoplasty with intracanal incision is shown in Figure 4.

Patients

Eleven right ears and 14 left ears (total n = 25) with persistent perforations present for at least 3 months underwent transcanal endoscopic myringoplasty in our hospital from September 2011 to December 2012. The perforations were caused by chronic suppurative otitis media (76.0%), perforation remaining after tube insertion (20.0%), and trauma (4.0%). Bilateral myringoplasty was performed in 4 patients. No canalplasty was performed. The mean age of the patients was 51.8 years with a range of 8 to 82 years. All operations were conducted under general anesthesia. The patients were instructed to avoid nose blowing and sniffing postoperatively. After surgery, the patients were regularly assessed at our outpatient clinic. The mean follow-up period was 9.8 months (5–18 mo).

RESULTS

Comparison of Endoscopic and Microscopic Views

The endoscopic and microscopic views were compared for each patient. The 2 fields of view were recorded to evaluate the advantages and disadvantages of each instrument. The anterior edge of the perforation was not visible under microscopy in 3 ears preoperatively and in 2 ears after refreshing of the perforation out of 25 ears (Table 1). Endoscopic views, however, revealed the entire image of the tympanic membrane in one field and clear visualization of the perforation edges even when the ear canal was narrow and/or protruded (Fig. 5). Endoscopes facilitated reliable refreshing of the perforation edges and grafting procedures. The tympanic cavity could also be observed through the perforation in the endoscopic wide view. Fine structures were also visible through large perforations such as the incudostapedial joint, orifice of the tube, round-window niche, ossicular chain, and tympanic isthmus. Endoscopy revealed no pathology of the tympanic cavity in this study. Calcification of the tympanic membrane was present in 19 ears (76.0%) (Table 1). A tympanomeatal flap was elevated in 4 ears (16.0%) (Table 1). Little pain or bleeding was observed in any of the patients postoperatively.

Perforation Closure

The overall success rate for perforations was 84.0% (21/25) (Table 1). A small perforation recurred in 4 ears (16.0%). Three of 4 unsuccessfully treated ears had subtotal perforation and calcification in the tympanic membrane preoperatively. The success rate was 84.2% (16/19) for calcified membranes and 83.3% (5/6) for noncalcified membranes (Table 1). No superficial iatrogenic cholesteatomas or ossicular chain–related complications were found during follow-up.

Hearing Results

All patients expressed an overall satisfaction with the treatment. The mean preoperative ABG was 15.6 dB (5.0–27.5 dB). Reduced air bone gaps were seen in all ears, and the mean air bone gap was 5.3 dB (0–12.5 dB)

TABLE 1. *Summary of patients who underwent transcanal endoscopic myringoplasty from September 2011 to December 2012*

Patient no.	Age	Side	Visibility under microscopy	Calcification	Tympano-meatal flap	Results	Air-bone gap (dB)	
							Preoperative	Postoperative
1	43	L	Visible	+	−	Successful	15.0	5.0
2	59	L	Visible	−	−	Successful	18.3	1.7
3	69	L	Visible	+	−	Successful	8.3	0
4	55	L	Visible	+	−	Successful	13.1	5.0
5	63	L	Visible	+	−	Successful	15.0	6.7
6	64	R	Visible	+	−	Successful	7.5	0
		L	Visible	+	−	Successful	11.9	3.1
7	58	L	Visible	+	+	Successful	25.0	3.3
8	61	R	Visible	−	−	Successful	26.9	11.9
		L	Visible	−	−	Successful	21.9	12.5
9	68	R	Visible	+	−	Small reperforation	12.5	0
10	54	L	Visible	+	+	Successful	5.0	0
11	76	L	Not visible	−	+	Successful	35.0	15.0
		R	Not visible	+	−	Successful	27.5	8.8
12	8	L	Visible	+	−	Successful	11.7	6.7
		R	Visible	+	−	Successful	8.3	3.3
13	8	L	Not visible	+	+	Small reperforation	21.9	6.9
14	63	L	Visible	+	−	Reperforation	13.8	10.0
15	58	R	Visible	−	−	Successful	14.4	5.6
16	41	R	Not visible	−	−	Small reperforation	23.1	6.3
17	82	R	Visible	+	−	Successful	6.6	1.7
18	63	R	Visible	+	−	Successful	11.9	0.6
19	12	L	Visible	+	−	Successful	15.6	7.5
20	10	R	Visible	+	−	Successful	5.0	1.7
21	73	R	Not visible	+	−	Successful	14.4	9.4

Copyright © 2014 Otology & Neurotology, Inc. Unauthorized reproduction of this article is prohibited.

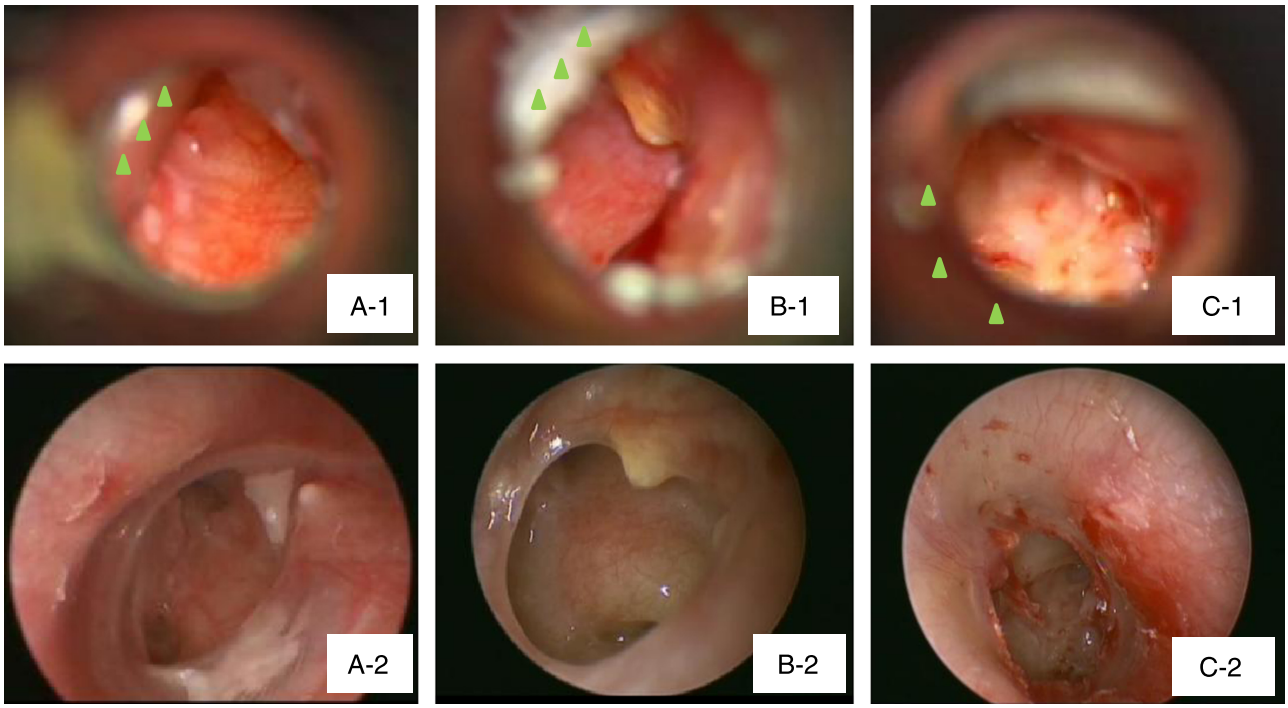

FIG. 5. (Patients 11, 21, and 13 of Table 1) Comparison of microscopic and endoscopic views. *A-1* and *B-1*, An anterior protrusion (Δ) of the left external auditory canal hampered visualization of the anterior edge of the perforation under microscopy preoperatively. *A-2* and *B-2*, Endoscopy provided visibility of the tympanic membrane. *C-1*, After cutting the perforation, the anterior edge of the perforation was not visible because of the anterior protrusion (Δ) of the left external auditory canal under microscopy. *C-2*, An endoscope provided visibility to the tympanic membrane.

postoperatively. The ABG was within 10 dB in 88.0% of the ears and within 20 dB in 100% of the ears.

DISCUSSION

Myringoplasty is one of the most common surgeries in otology. The main advantages of the retroauricular microscopic approach are bimanual surgical handling and 3D images, while a shortcoming of microscopy is that the field of view has to be frequently changed. Therefore, the patient's head has to be manipulated or the microscope has to be repeatedly moved. Endoscopic surgery, in contrast, is based on 2D images. These 2D images make depth perception difficult (12), and thus, the surgeon has to carefully ascertain whether the graft has been sufficiently lifted to make contact with the edge of the perforation. However, advances in full HD camera systems provide much clearer and contrasted endoscopic views and has greatly minimized the drawbacks of 2D images. One of the main shortcomings with an endoscopic approach is the need for ''one-handed'' surgery. The operator has to use one hand to hold the endoscope and the other hand to perform the actual surgery. However, one-handed surgery does not really constitute a shortcoming in transcanal endoscopic myringoplasty. A simple procedure such as myringoplasty can be easily performed using a one-handed procedure without any increased risk or difficulties. Moreover, microscopic simple underlay myringoplasty is also technically ''one-handed'' surgery: the operator has to use one hand to hold the aural speculum and the other hand to perform the actual surgery.

Another shortcoming of endoscopic surgery is that hematomas can result if the endoscope makes contact with the external auditory canal. However, the endoscope's wide field of view allows observation of the entire circumference of the perforation and approaching the edge of the perforation reveals the under surface of the tympanic membrane. Some reports described the importance of investigation of the under surface of the tympanic membrane, where 30% of mucoepithelial junctions were in the under surface (13,14). Yadav et al. have emphasized that endoscopic examination of the tympanum allows one to repair the perforation without any possibility of an iatrogenic cholesteatoma, in contrast to the conventional myringoplasty (14). Moreover, endoscopic surgery is a better procedure for demonstrating the surgical steps, and it also enables viewing of the anatomic structures in the same field, resulting in a better appreciation of their relationship.

This report represents the first comparison of microscopic and endoscopic views. The circumference of the perforation could not be confirmed with a microscope before freshening in 12.0% of the cases in this study. Furthermore, the entire perforation was not visible in 20.0% after refreshing the edges. Indeed, Harugop et al. reported that the tympanic annulus was not completely

Copyright © 2014 Otology & Neurotology, Inc. Unauthorized reproduction of this article is prohibited.

visualized with a microscope in 20% of patients, and these patients required canalplasty (8). Transcanal endoscopic myringoplasty extends the indications of SUM. Endoscopy also allows obtaining information on the incudostapedial joint, the orifice of the tube, and the round-window niche, which are usually difficult to observe under the operating microscope. We think that these results show that all myringoplasty can be done using transcanal endoscopic myringoplasty, regardless of the perforation size or presence of a narrow and/or protruded external ear canal, which cannot be reached via the transcanal microscopic approach.

Sakagami et al. reported on 29 myringoplasty patients treated with microscopic transcanal simple underlay myringoplasty with a follow-up time of 6 months. The rate of perforation closure was 76% and improvement in ABG after surgery was 11.8 dB (2). Usami et al. reported on 22 myringoplasty patients treated with endoscopic assistance with a follow-up time of 24.5 months. The rate of perforation closure was 81.8% and improvement in ABG after surgery was 14.8 dB (15). Karhketo et al. reviewed the records of 29 myringoplasty patients treated with the aid of rigid otoendoscopes with a follow-up time of one year. The rate of perforation closure was 80%, and improvement in ABG after surgery was 7 dB (16). The perforation closure rate with endoscopes is almost the same as in past reports using a traditional underlay temporal fascia technique (9,17–19). Transcanal endoscopic myringoplasty has been successfully achieved, and a sufficient rate of perforation closure (84.0%) was obtained in our study. Hearing also showed satisfactory results with improvement in ABG after surgery using this technique (10.3 dB).

Transcanal endoscopic myringoplasty is a minimally invasive technique. Transcanal endoscopic myringoplasty offers a number of advantages in comparison to the retroauricular microscopic approach including less invasiveness (no skin incision and no canalplasty), superior visualization, and no hair loss. Unfortunately, the anterior margin can sometimes be difficult to reach via the microscopic transcanal and endaural approach. Thus, a retroauricular approach with bone cutting is required in such cases. However, the endoscope allows for better visualization and reconstruction of anterior tympanic membrane perforations. In addition, postoperative bleeding and pain are reduced and cosmetic results are better as opposed to a retroauricular microscopic approach. This endoscopic procedure could be performed as ambulatory surgery (20). According to the principles of minimally invasive surgery, minimal trauma of healthy tissue is produced with the result of minimizing local and general postoperative adverse reactions (21).

CONCLUSION

Comparison of microscopic and endoscopic views revealed superior visualization and operability of endoscopic approach as opposed to transcanal simple underlay myringoplasty. Transcanal endoscopic myringoplasty does not require surgical exposure such as a retroauricular skin incision to obtain an anterior view. Our results demonstrated that transcanal endoscopic myringoplasty can be performed, regardless of the perforation size or the presence of a narrow and/or protruded external ear canal.

REFERENCES

1. Yuasa R, Suetake M, Kaneko Y, Kambayashi J. *A New Simple Myringoplasty with the Use of Fibrin Glue. Cholesteatoma and Mastoid Surgery Fourth International Conference*. Niigata, Japan, 1992:603–6.
2. Sakagami M, Mishiro Y, Tsuzuki K, Seo T, Sone M. Bilateral same day surgery for bilateral perforated chronic otitis media. *Auris Nasus Larynx*. 2000;27:35–8.
3. Sakagami M, Yuasa R, Yuasa Y. Simple underlay myringoplasty. *J Laryngol Otol* 2007;121:840–44.
4. Thomassin JM, Korchia D, Doris JM. Endoscopic-guided otosurgery in the prevention of residual cholesteatomas. *Laryngoscope* 1993; 103:939–43.
5. Tarabichi M. Endoscopic management of acquired cholesteatoma. *Am J Otol* 1997;18:544–9.
6. Kakehata S, Watanabe T, Ito T, Kubota T, Furukawa T. Extension of indications for transcanal endoscopic ear surgery using an ultrasonic bone curette for cholesteatomas. *Otol Neurotol* 2014; 35:101–7.
7. Glasscock and Shambaugh. ''Tympanoplasty,'' in Glasscock and Shambaugh, *Surgery of the Ear*. 5th ed. Chapter 16. 2003: 350–70.
8. Harugop AS, Mudhol RS, Godhi RA. A comparative study of endoscope assisted myringoplasty and micrsoscope assisted myringoplasty. *Indian J Otolaryngol Head Neck Surg* 2008;60:298–302.
9. El-Guindy A. Endoscopic transcanal myringoplasty. *J Laryngol Otol* 1992;106:493–5.
10. Karhuketo TS, Laippala PJ, Puhakka HJ, Sipilä MM. Endoscopy and otomicroscopy in the estimation of middle ear structures. *Acta Otolaryngol* 1997;117:585–9.
11. Karhuketo TS, Puhakka HJ, Laippala PJ. Endoscopy of the middle ear structures. *Acta Otolaryngol Suppl* 1997;529:34–9.
12. Mohindra S, Panda NK. Ear surgery without microscope; is it possible. *Indian J Otolaryngol Head Neck Surg* 2010;62: 138–41.
13. Somers TH, Houben V, Goovaerts G, Govaerts PJ, Offeciers FE. Histology of the perforated tympanic membrane and its mucoepithelial junction. *Clin Otolaryngol Allied Sci* 1997;22:162–6.
14. Yadav SP, Aggarwal N, Julaha M, Goel A. Endoscope-assisted myringoplasty. *Singapore Med J* 2009;50:510–2.
15. Usami S, Iijima N, Fujita S, Takumi Y. Endoscopic-assisted myringoplasty. *ORL J Otorhinolaryngol Relat Spec* 2001;63:287–90.
16. Karhketo TS, llomäki JH, Puhakka HJ. Tympanoscope-assisted myringoplasty. *ORL J Otorhinolaryngol Relat Spec* 2001;63: 353–8.
17. Naganuma H, Okamoto M, Shitara T, Tokumasu K. Myringoplasty in the outpatient clinic. *Acta Otorhinolaryngol Belg* 1994;48:59–65.
18. Black JH, Wormald PJ. Myringoplasty—effects on hearing and contributing factors. *S Afr Med J* 1995;48:41–3.
19. Gersdorff M, Garin P, Decat M, Juantegui M. Myringoplasty: long-term results in adults and children. *Am J Otol* 1995;16:532–5.
20. Ayache S. Cartilaginous myringoplasty: the endoscopic transcanal procedure. *Eur Arch Otorhinolaryngol* 2013;270:853–60.
21. Plinkert P, Löwenheim H. Trends and perspectives in minimally invasive surgery in otorhinolaryngology–head and neck surgery. *Laryngoscope* 1997;107:1483–9.

Copyright © 2014 Otology & Neurotology, Inc. Unauthorized reproduction of this article is prohibited.