Use of Endoscopic Cartilage Graft Myringoplasty Without Tympanomeatal Flap Elevation to Repair Posterior Marginal Perforations

Zhengcai Lou, MD

Abstract

Objective: We evaluated the graft success rate and hearing outcomes of endoscopic cartilage graft myringoplasty without tympanomeatal flap elevation used to repair posterior marginal perforations. Study Design: A prospective case series. Materials and Methods: A total of 31 patients with posterior marginal perforations who underwent endoscopic cartilage graft myringoplasty were included. The outcomes were the hearing gain and graft success rate at 6 and 24 months. Results: The graft success rate was 96.7% (30/31) at 6 months and 90.3% (28/31) at 24 months; 1 patient exhibited composite graft extrusion and lateralization in the region of the anterior annulus; a residual perforation was apparent. Reperforation occurred in 2 patients. The mean preoperative air-bone gap (ABG; 28.61 ± 3.14 dB) was significantly greater than the mean postoperative ABG (12.15 ± 3.98 dB; P < .05) at 6 months; however, there was no statistically significant difference between the post-6 months and post-24 months with regard to ABG values (P = .871), ABG gain (P = .648), or functional success rate (P = .472). No significant graft blunting or atelectasis was noted during follow-up. The free perichondrium became fully integrated with the skin of the external auditory canal; the perichondrium could not be clearly distinguished endoscopically 4 to 8 weeks postoperatively. Computed tomography revealed well-pneumatized middle ear and mastoid cavity at postoperative 24 months. Conclusion: Endoscopic cartilage graft myringoplasty without tympanomeatal flap elevation reliably repairs posterior marginal perforations. The short- and long-term graft success rate is high, and the hearing results are satisfactory; the technique is minimally invasive.

Keywords
endoscopy, myringoplasty, push-through technique, cartilage graft

Introduction

Underlay or overlay myringoplasty is used to repair perforations associated with mucosal chronic otitis media (COM) and an intact ossicular chain. Generally, the underlay technique is associated with a higher risk of graft failure because the residual native tympanic membrane (TM) does not support marginal perforations.1,2 The overlay technique is technically more difficult and occasionally complicated by graft lateralization, anterior blunting, and epithelial pearl production.1,2 Several surgical techniques have been developed to improve the graft success rate; these include sandwich graft tympanoplasty,3 over-under tympanoplasty,4 mediolateral graft tympanoplasty,5 the “window shade” technique,6 “hammock” tympanoplasty,7 and loop underlay tympanoplasty.1 However, all require the elevation and restoration of differently sized tympanomeatal flaps to strengthen the grafting of marginal perforations. Such flap manipulations prolong the operation time. Although butterfly cartilage myringoplasty does not require tympanomeatal flap elevation, it is not easy to ensure that the cartilage graft groove accurately follows the perforation margins.8-10 Here, we use cartilage–perichondrium composite graft myringoplasty to repair posterior marginal perforations; tympanomeatal flap elevation is unnecessary because the perichondrium graft is placed lateral to the posterior bony annulus and the posterior external auditory canal (EAC).
We present our preliminary data on the graft success rate and hearing gain.

Materials and Methods

Ethical Considerations

The study protocol was approved by the institutional ethical review board of Yiwu Central Hospital. Informed consent was obtained from all participants.

Patients and Methods

This prospective case series ran from January 1, 2016, to December 31, 2017. The inclusion criteria included a posterior marginal perforation, COM, an intact ossicular chain without a cholesteatoma, and a need for TM repair. Patients exhibiting ossicular chain disruption and revision cases were excluded. Temporal bone computed tomography/magnetic resonance imaging was performed to exclude a middle ear cholesteatoma. Patients exhibiting a marginal perforation, COM, an intact ossicular chain without a cholesteatoma, and a need for TM repair. Patients exhibiting ossicular chain disruption and revision cases were excluded. Pure-tone audiometry was performed preoperatively and 6 and 24 months postoperatively at the standard frequencies of 0.5, 1, 2, and 3 kHz. The air-bone gap (ABG) was the average difference between air and bone conduction at 0.5, 1, 2, and 3 kHz. Each TM perforation was classified as small (<50% of the eardrum) or large (≥50%).

Surgical Procedure

A 0°, 4 mm × 18 cm rigid endoscope and a high-definition monitor were used. The left hand was used to hold the endoscope and the right to perform surgery. The monitor was placed on the side of the patient where the surgeon did not stand. All patients were under general anesthesia. A composite tragal cartilage–perichondrium graft (with the perichondrium stripped from one side) was harvested and a 1 to 1.5 mm skin incision created on the medial side of the ipsilateral tragus. The composite graft was at least 2 mm wider than the diameter of the annulus but was not thinned. The perichondrium on one side of the composite graft was peeled over at least 2 mm to form free perichondrium and uncover cartilage; the perichondrium on the other side remained attached to cartilage. The cartilage lacking perichondrium was partially removed to ensure that the cartilage graft was at least 2 mm wider than the perforation edges. A notch was made in cartilage from which perichondrium had been removed to accommodate the handle of the malleus. The perforation edges were de-epithelialized using an angled pick. If the perforation involved the malleus, the epithelium was removed from the distal malleus handle. The cartilage–perichondrium graft was pushed through the perforation. Cartilage covered by perichondrium was placed medial to the remnant TM and the anterior annulus in an underlay manner; cartilage lacking perichondrium was placed medial to the posterior bony annulus; the notch in the cartilage graft received the handle of the malleus. The free perichondrium was placed lateral to the handle of the malleus, the posterior bony annulus, and the posterior EAC over a distance of at least 2 mm without elevation of a tympanomeatal flap (Figure 1). Biodegradable NasoPore soaked in antibiotic ointment was used to support the graft medially and laterally. The EAC was packed with gauze soaked in antibiotic ointment up to the tragus incision, which was not sutured.

Postoperative Follow-Up

The packing gauze was removed from the EAC 14 days after surgery and biodegradable NasoPore fragments were aspirated from the EAC 3 to 4 weeks after surgery, then the graft could be visualized. All patients were followed up in the outpatient department at 2 weeks. At 1, 3, 6, and 24 months after surgery, endoscopic otological examinations were performed. At the end of the 6th and 24th postoperative month, graft take-up was evaluated endoscopically and the ABGs were examined audiometrically. Any intra- or postoperative complications were recorded. Functional success was defined as an ABG ≤20 dB, and grafting success was an intact graft lacking perforation, retraction, lateralization, significant blunting, and medialization.

Statistical Analyses

Statistical analyses were performed using SPSS ver. 20 software (IBM Inc). The data are expressed as means (SDs) or percentages (%). We compared the pre- and postoperative ABGs using the Wilcoxon signed-rank test. A P value <.05 was considered to indicate statistical significance.

Results

Patient Demographics

We included 31 patients (31; 12 right and 19 left ears; 22 females and 9 males; average age, 47.3 ± 11.8 years) with unilateral, posterior marginal perforations associated with COM. In all, 25 perforations were large and 6 were small; the average perforation duration was 15.7 ± 8.3 years. The tragal incisions healed by postoperative week 2 in all patients. The mean operative time (from the start of surgery after anesthesia induction to EAC packing) was 42.8 ± 11.6 minutes.

Graft Take Rate and Hearing Gain

All patients had follow-up longer than 24 months, with a mean follow-up of 27.9 months (range: 24.2-36.4 months). The graft success rate was 96.7% (30/31) at 6 months and 90.3% (28/31) at 24 months (Figure 2); 1 patient exhibited composite graft extrusion and lateralization near the anterior annulus and a residual perforation (Figure 3). Two patients developed mild otorrhea, which resolved following application of topical ofloxacin otic solution and oral antibiotics. The reperforation occurred in 2 patients at 24 months.

The Wilcoxon signed-rank test revealed that the mean pre-operative ABG (28.61 ± 3.14 dB) was significantly greater than the mean postoperative ABG (12.15 ± 3.98 dB; P < .05).
Figure 1. Diagram of surgical procedure. The perichondrium on one side of the composite graft was peeled (A). The cartilage lacking perichondrium was partially removed (B). Preoperative perforation (C). Freshened perforation edges (D). The free perichondrium was placed lateral to the posterior bony annulus and EAC (E). CA, cartilage; CAP, cartilage with single-side perichondrium; EAC, external auditory canal; MA, malleus; PE, perichondrium; TMP, tympanic membrane perforation.

Figure 2. Photographs of the perforation preoperatively (A), at 4 weeks postoperatively (B), at 6 weeks (C), at 7 weeks (D), and at 8 weeks (E). The irregular curve indicates the free perichondrium.

Figure 3. Photographs of the perforation preoperatively (A), at 5 weeks postoperatively (B), at 12 months (C), and at 13 months (D). The irregular curve indicates the free perichondrium. Arrows indicate partial extrusion of the cartilage graft and the residual perforation.
Of the 31 patients, 17 (54.8%) exhibited ABG closures of 0 to 10 dB, 13 (41.9%) had closures of 11 to 20 dB, and 1 (3.2%) had a closure of 21 to 30 dB (Table 1). However, there was no statistically significant difference between the post-6 months and post-24 months with regard to ABG values ($P = .871$), ABG gain ($P = .648$), or functional success rate ($P = .472$; Table 1).

No complications (iatrogenic sensorineural hearing loss, altered taste, facial nerve palsy, vertigo, or tinnitus) were observed during follow-up. No significant graft blunting or atelectasis was noted. The free perichondrium became fully integrated with the skin of the EAC; the perichondrium could not be clearly distinguished endoscopically by 4 to 8 weeks postoperatively (Figure 2). Computed tomography revealed well-pneumatized middle ear at postoperative 24 months in 31 patients (Figure 4).

### Discussion

Recently, some scholars have modified the myringoplastic repair of large marginal perforations; the graft success rates have been low and the complication rates have been high.

Barake et al. reported that loop underlay tympanoplasty afforded a closure rate of 99.3%. Panchal et al. reported a 95% success rate using over-underlay myringoplasty. Other scholars have reported graft success rates of 95%, 90%, and 97.9% using different double-layer graft techniques. Other studies have reported graft take rates of 96.7% and 97.1% after overlay tympanoplasty. However, in these 3 latter studies, although the various techniques indeed enhanced the graft success rate, elevation of posterior EAC skin was mandatory. Our graft success rate was 96.7% (30/31) at 6 months and 90.3% (28/31) at 24 months. In addition, the mean preoperative ABG (28.61 ± 3.14 dB) was significantly greater than the mean postoperative ABG (12.15 ± 3.98 dB; $P < .05$) at 6 months; 96.7% of patients achieved ABG closures of 0 to 20 dB. However, there was no statistically significant difference between the post-6 months and post-24 months with regard to ABG values, ABG gain, or functional success rate. Thus, our findings are comparable to those of previous studies.

We did not elevate a posterior tympanomeatal flap; free perichondrium was placed lateral to the handle of the malleus, the posterior bony annulus, and the posterior EAC. Although some scholars have developed endoscopic, cartilage tympanoplasty methods employing minimal tympanomeatal flaps, flap elevation is still required. The absence of tympanomeatal flap elevation reduces the operation time (to a mean of 42.8 ± 11.6 minutes in the present study). We placed the cartilage graft medial to the remnant TM and annulus in an underlay manner; this completely closed the perforation. Free perichondrium that was still attached to the cartilage graft was placed lateral to the posterior EAC. Biodegradable NasoPore packing of the middle ear and EAC supported and strengthened the graft. Theoretically, the EAC perichondrium may tauten the cartilage graft, thus preventing collapse by maintaining intimate contact between the cartilage, the posterior bony annulus, and the remnant TM. We used the largest possible perichondrial flap to cover the EAC. This large flap is in contact with the EAC and the undersurface of the TM and thus nourishes the cartilage graft, enhancing cartilage viability. Some scholars have reported high graft success rates using butterfly cartilage myringoplasty without tympanomeatal flap elevation. A groove

### Table 1. Comparison of Hearing Gains and Success Rates Between the Postoperative 6 and 24 Months.

|                        | ABG (mean, dB) | Gain (mean, dB) | 0-10 | 11-20 | 21-30 | Graft success, n (%) |
|------------------------|----------------|-----------------|------|-------|-------|---------------------|
| Postoperative 6 months | 12.15 ± 3.98   | 16.14 ± 5.83    | 17 (54.8) | 13 (41.9) | 1 (3.2) | 30 (96.7) |
| Postoperative 24 months| 10.26 ± 5.34   | 17.36 ± 4.89    | 22 (71.0) | 8 (25.8)  | 1 (3.2)  | 28 (90.3) |
| $P$ value              | .871           | .648            | .293 | .283  | .472  | .605                |

Figure 4. At 36 months postoperatively (A), computed tomography revealed well-pneumatized middle ear (B), pure-tone audiogram at 36 months (C). Please note, this is the same patient as in Figure 2.
1 to 2 mm deep created in the cartilage graft is used to anchor the graft to the bony annulus. By contrast, we increased the tension imparted to the free perichondrium of the cartilage graft. Precise creation of the graft groove (which must accurately fit the perforation margins) is time-consuming.

During follow-up, we encountered no complications (further hearing deterioration, a taste change, facial nerve paralysis, vertigo, tinnitus, EAC stenosis, graft medialization, or significant blunting). However, cartilage graft lateralization and extrusion into the anterior annulus were observed in one patient. We may have placed an oversized graft. Our principal concerns were the clinical prognosis and whether the EAC surface perichondrium would develop a cholesteatoma. We in fact found that the perichondrium became fully integrated with the EAC skin to the extent that the “border” was difficult to identify endoscopically. Computed tomography revealed well-pneumatized middle ear and mastoid cavity at postoperative 24 months. We found no cholesteatoma pearls, but further longer-term observation is still needed.

**Conclusion**

Endoscopic cartilage graft myringoplasty without tympanomeatal flap elevation reliably repairs posterior marginal perforations. The short- and long-term graft success rate is high and the hearing results are satisfactory; the technique is minimally invasive.

**Author’s Note**

The English in this document has been checked by at least 2 professional editors, both native speakers of English. For a certificate, please see: http://www.textcheck.com/certificate/fnHxcx.

**Declaration of Conflicting Interests**

The author(s) declared no potential conflicts of interest with respect to the research, authorship, and/or publication of this article.

**Funding**

The author(s) disclosed receipt of the following financial support for the research, authorship, and/or publication of this article: This study was supported by the Science and Technology Agency of Yiwu city, China (Grants#2018-3-76).

**ORCID iD**

Zhengcai Lou https://orcid.org/0000-0002-1085-9033

**References**

1. Barake R, El Natout T, Bassim M, El Natout MA. Loop underlay tympanoplasty for anterior, subtotal and total tympanic membrane perforations: a retrospective review. *J Otolaryng Head Neck Surg*. 2019;48(1):12.

2. Panchal V, Gulia JS, Yadav SP, Hernot S, Kathuria B, Kaintura M. To evaluate and compare the results of over-underlay graft technique with conventional underlay myringoplasty. *In J Otol*. 2015;21(4):274-279.

3. Farrior JB. Sandwich graft tympanoplasty: experience, results, and complications. *Laryngoscope*. 1989;99(2):213-217.

4. Kartush JM, Michaelides EM, Becvarovski Z, LaRouere MJ. Over-under tympanoplasty. *Laryngoscope*. 2002;112(5):802-807.

5. Jung TT, Park SK. Mediolateral graft tympanoplasty for anterior or subtotal tympanic membrane perforation. *Otolaryng Head Neck Surg*. 2005;132(4):532-536.

6. Bluher AE, Mannino EA, Strasnick B. Longitudinal analysis of “window shade” tympanoplasty outcomes for anterior marginal tympanic membrane perforations. *Otol Neurotol*. 2019;40(3):e173-177.

7. Peng R, Lalwani AK. Efficacy of “hammock” tympanoplasty in the treatment of anterior perforations. *Laryngoscope*. 2013;123(5):1236-1240.

8. Eren SB, Tugrul S, Ozucer B, Dogan R, Ozturan O. A randomized prospective trial of a novel device for measuring perforation size during intlay ‘butterfly’ myringoplasty. *Am J Otolaryngol*. 2014;35(3):305-308.

9. Demir E, Coskun ZO, Celiker M, et al. Endoscopic butterfly inlay myringoplasty for large perforations. *Eur Arch Otorhinolaryngol*. 2019;276(10):2791-2795.

10. Karataş M, Kaskalan E. Simultaneous bilateral butterfly tympanoplasty using tragal cartilage from one ear. *Auris Nasus Larynx*. 2019;46(3):324-329.

11. Olarieta Soto FJ, Antoli-Candela Cano F, Harguindeguy Antoli-Candela A. Double medial and lateral graft in myringoplasty [in English, Spanish]. *Acta Otorrinolaringol Esp*. 2019;70(3):123-130.

12. Bedri EH, Korra B, Redleaf M, Worku A. Double-layer tympanic membrane graft in type I tympanoplasty. *Ann Otol Rhino Laryngol*. 2019;128(9):795-801.

13. Nemade SV, Shinde KJ, Sampate PB. Comparison between clinical and audiological results of tympanoplasty with double layer graft (modified sandwich fascia) technique and single layer graft (underlay fascia and underlay cartilage) technique. *Auris Nasus Larynx*. 2018;45(3):440-446.

14. Plodpai Y, Paje N. The outcomes of overlay myringoplasty: endoscopic versus microscopic approach. *Am J Otolaryngol*. 2017;38(5):542-546.

15. Plodpai Y. Endoscopic vs. microscopic overlay tympanoplasty for correcting large tympanic membrane perforations: a randomized clinical trial. *Otolaryng Head Neck Surg*. 2018;159(5):879-886.

16. Özdamar K, Sen A. Comparison of temporal muscle fascia and tragal cartilage perichondrium in endoscopic type 1 tympanoplasty with limited elevation of tympanomeatal flap. *Braz J Otorhinolaryngol*. 2019. pii: S1808-8694(19)30083-7.

17. Şen A, Özdamar K. Endoscopic tympanoplasty with limited tympanomeatal flap elevation in pediatric cases: comparison of anatomic and audiological results of grafts. *Eur Arch Otorhinolaryngol*. 2019;276(9):2427-2432.

18. Kaya I, Turhal G, Ozturk A, Gode S, Bilgen C, Kirazli T. Results of endoscopic cartilage tympanoplasty procedure with limited tympanomeatal flap incision. *Acta Otorhinolaryngol*. 2017;137(11):1174-1177.

19. Yamamoto E, Iwanaga M, Fukumoto M. Histologic study of homograft cartilages implanted in the middle ear. *Otolaryng Head Neck Surg*. 1988;98(6):546-551.

20. Hamed M, Samir M, El Bigermy M. Fate of cartilage material used in middle ear surgery: a light and electron microscopy study. *Auris Nasus Larynx*. 1999;26(3):257-262.