

Extra Perichondrium Patch to Enhance Cartilage Graft during Endoscopic Cartilage Myringoplasty

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Abstract

Abstract Objectives The aim of this study was to evaluate whether adding an extra perichondrium patch to enhance the cartilage graft during endoscopic myringoplasty can improve the healing rate and post-operative hearing of patients with poor prognostic factors (eustachian tube dysfunction, large perforations, subtotal perforations and marginal perforations). **Methods** This retrospective study analyzed a total of 80 patients (40 females and 40 males, median age of 40.55 years) who had received an extra patch during endoscopic cartilage myringoplasty. Patients were followed up for six months. Healing rates, complications, preoperative and postoperative pure-tone average (PTA) and air-bone gap (ABG) were analyzed. **Results** At six months follow-up, the healing rate of tympanic membrane was 100% (80/80). The mean preoperative pure-tone average (PTA) (43.18 ± 14.57 dB HL) significantly decreased (27.08 ± 9.36 dB HL) six months after the operation ($P = 0.002$). Similarly, the mean preoperative ABG (19.05 ± 5.72 dB HL) reduced to (9.36 ± 3.75 dB HL) ($P = 0.0019$) at sixth month. Major complications were not observed during follow-up. **Conclusions** The usage of an extra patch during endoscopic cartilage myringoplasty for large, subtotal and marginal tympanic membrane perforations achieved a high healing rate and a statistically significant hearing gain with low incidence of complications.

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The usage of an extra patch during endoscopic cartilage myringoplasty for large, subtotal and marginal tympanic membrane perforations achieved a high healing rate and a statistically significant hearing gain with low incidence of complications.

Key words: Endoscopic myringoplasty; Tympanic membrane perforation; Cartilage graft; Extra patch

Key Points

- Endoscopic myringoplasty with cartilage perichondrium complex has been considered an effective and well-developed surgery method to repair tympanic membrane perforation.
- Patients with eustachian tube dysfunction, large perforations, sub-total or marginal perforations still suffer from lower healing rate than patients without these poor prognostic factors.
- We further enhanced the contact between graft and tympanic membrane remnant by adding an extra perichondrium patch anterior-inferior to a graft made of tragal cartilage perichondrium complex.
- At six months follow-up, all 80 patients exhibited good healing and significant hearing improvement without major complications.
- An extra patch during endoscopic cartilage myringoplasty has been proven to have promising potential to benefit patients with eustachian tube dysfunction, large perforations, sub-total or marginal perforations.

INTRODUCTION

Perforation closure plays an important role in Chronic suppurative otitis media (CSOM) treatment to restore the anatomy and function of the tympanic membrane and prevent repeated infection. Endoscopic myringoplasty with cartilage perichondrium complex has been considered an effective and well-developed surgery method, especially for patients with eustachian tube dysfunction, large perforations, sub-total or marginal perforations (1, 2).

The effectiveness of myringoplasty is evaluated by the healing rate of tympanic membrane. Multiple factors affect the healing rate of tympanic membrane, including surgical approaches, location and size of perforations, graft choice and preparation, use of antibiotics, repair technology and status of tympanum and mastoid, etc. (3). Among all of these factors, Carr (4) found that the location of perforation is the most important, with subtotal perforations and anterior marginal perforations subject to the lowest healing rates. Similarly, a multicenter retrospective study of 523 patients undergoing cartilage myringoplasty (5) also showed the lowest healing rates in subtotal perforations (89%) and anterior perforations (92.4%) three months after surgery, while the healing rates of inferior and posterior perforations were higher at 94.9% and 95.6%, respectively. New surgery techniques have been explored by otologists to improve the healing rate of large perforations and marginal perforations, such as skin flap method((6) ,anterior wall skin flap(7) , butterfly cartilage myringoplasty(8) and inside out elevation of a tympanomeatal flap (9).The healing rate of anterior marginal perforations and large perforations remains significantly lower than that of small, inferior and posterior perforations, and should be further improved. In this study we modified the classic endoscopic cartilage myringoplasty by adding an extra perichondrium patch to strengthen the anterior-inferior tympanic membrane. The new method was applied to three types of patients with: (1) large perforations where the grafts could not tightly fit tympanic membrane remnant during operation; (2) marginal perforations without residual tympanic membrane to support the graft; or (3) preoperative eustachian tube dysfunction. Using this newly developed method, we performed endoscopic myringoplasty on 80 patients and statistically analyzed the healing rate and hearing improvement.

METHOD

Design

In this retrospective study, we reviewed medical records of 80 CSOM patients who underwent endoscopic myringoplasty between August 2019 and April 2021 with an extra perichondrium patch to strengthen the traditional cartilage graft. The demographics and characteristics of patients are shown in Table 1. The trial has been approved by the ethics committee of XX hospital.

Patients were enrolled using the following inclusion criteria and exclusion criteria. Inclusion criteria: (1) CSOM patients with large (diameter $\geq$ 5mm), subtotal or anterior marginal perforations; (2) patients who had received an extra perichondrium patch during the procedure of endoscopic cartilage myringoplasty; (3) patients without pathological changes in tympanum, attic or the ossicular chain and who underwent myringoplasty only; (4) patients who had provided informed consent. Exclusion criteria: (1) patients who cannot tolerate general anesthesia due to serious diseases; (2) patients with severe EAC stenosis or EAC malformation; (3) patients with small perforation (diameter less than 5 mm).

Preoperative Evaluation

All patients underwent the following preoperative procedures, including endoscopic examination, thin-slice CT scan of temporal bone, hearing loss assessment by pure-tone audiometry (500 Hz, 1000 Hz, 2000 Hz and 4000 Hz), auditory brainstem response (ABR) and tests of eustachian tube function.

Preoperative Preparation

Cerumen and secretion of EAC were cleaned under otoscope before operation. If permitted, external canal hair was depilated to reduce lens contamination.

Surgical Procedures

(1) Anesthesia: all patients were subjected to both general anesthesia and local infiltration anesthesia. (2) Preparation of graft: an arc incision was made on the tragus 3 mm from the free margin. The subcutaneous tissue was dissected to cut a piece of tragus cartilage-perichondrium complex of suitable size. (3) Preparation of graft bed: annulus fibrocartilaginous in the vicinity of the perforation was removed using a cachet hook. (4) Elevation of tympanomeatal flap: an arc-shaped incision (3/4 circle of the EAC) was made from 6 o'clock to 2 o'clock position clockwise on the right ear (or 10 o'clock to 6 o'clock position clockwise on the left ear) at the junction of the skin and mucosa, and then tympanomeatal flap was dissected and elevated up to the annulus. (5) Exploration: the ossicular chain was confirmed to be intact and mobile, and the orifice of the eustachian tube was unobstructed. (6) Placement of grafts: perichondrium on the parotid side was harvested for later use (Step 7). The cartilage-perichondrium complex was trimmed to an appropriate size, with the perichondrium slightly wider than the cartilage, and a wedge-shaped notch to accommodate the malleus handle. The graft was then placed on the inner side of the residual tympanic membrane. The tympanomeatal flap was repositioned back once the graft tightly fit the tympanic membrane. (7) Extra patching: if the graft did not tightly fit the residual tympanic membrane or if the marginal perforation had no tympanic remnant to support the graft, an extra perichondrium patch was used to strengthen the anterior-inferior tympanic membrane. We trimmed the perichondrium (prepared in Step 6) into a wide and long strip, laid it at the fissure with a crochet hook and folded it inward to make it in good contact with both the residual tympanic membrane /annulus and the graft. After that, we confirmed that the extra patch was firmly stabilized and tucked (Figure 1 and 2 for the extra patch). (8) Filling of the external auditory canal with gelatin sponge. (9) Suture of the tragus incision.

Main outcome measure

Patients were closely monitored for complications such as tinnitus, vertigo, facial paralysis, abnormal sense of taste and hearing loss. Within the first week after operation, each patient received two to three levofloxacin ear drops per day in the ear subject to surgery. All patients were examined at the first month, third month and sixth month after operation. At each follow-up visit, the operator checked the external auditory meatus, the healing of tympanic membrane and performed pure tone audiometry (PTA, at 500 Hz, 1000 Hz, 2000 Hz and 4000 Hz) to evaluate the level of hearing recovery.

Statistical Analysis

Data were analyzed using SPSS25.0 software. Qualitative data were described as number of cases and percentage. Quantitative data were described as mean $\pm$ SD. Quantitative data were analyzed using *t*-test. $P < 0.05$ was considered as statistically significant.

RESULTS

Demographic Data

A total of 80 CSOM patients (40 males and 40 females) with unilateral tympanic membrane perforations were included in this study, with a median age of 40.55 years. Myringoplasty was performed on 42 left ears and 38 right ears. All patients had a history of recurrent purulent discharge. Among all the patients, three reported tinnitus and four experienced dizziness. Seventy (87.5%) operations were performed on dry ears while ten operations were performed on wet ears (12.5%). Twenty-two (27.5%) patients had perforations in the anterior inferior quadrant and 58 (72.5%) patients had sub-total or total perforations. The demographics and characteristics of patients are shown in Table 1.

Post-operative Complications

Cord tympani nerve was well protected in all patients. Complications like facial paralysis, ear purulent discharge and tympanic perforations were not observed. No patients needed a reoperation. Two cases of otitis externa were well managed by secretion removal and local application of Triamcinolone acetonide for one week. Out of four patients with aural fullness one had symptoms after flying, and the other three were relieved by treatment of eustachian tube dysfunction with eustachian catheterization and eustachian tube exercise. One patient experienced taste disturbance and the taste recovered at six-month follow-up visit.

Healing of Tympanomeatal Flap and Tympanic Membrane

At first-month follow-up visit, we found that the tympanomeatal flaps of all 80 patients exhibited good healing, and observed no defects, hyperplasia or granulation. Six months after the operation, all tympanic membranes healed very well, without fissure, perforation or invagination. The area where the extra patch was added healed well, as illustrated by Figure 3.

Within the first two months after operation, some patients exhibited tympanic membrane redness and swelling. In month three the situation was improved with excellent vascularization of the grafts, as shown in Figure 4.

Hearing Evaluation

Hearing evaluation indicates that the endoscopic myringoplasty significantly decreased the mean preoperative pure-tone average (PTA) from 43.18 $\pm$ 14.57 dB HL to 27.08 $\pm$ 9.36 dB HL six months after the operation ($P = 0.002$). Similarly, the mean preoperative ABG was measured to reduce from 19.05 $\pm$ 5.72 dB HL to 9.36 $\pm$ 3.75 dB HL ($P = 0.0019$) at the six-month follow-up, as shown in Table 2.

DISCUSSION

All patients in this study underwent endoscopic myringoplasty without canaloplasty. Two cases were treated with sleeve resection of the EAC skin due to EAC stenosis. In addition to traditional endoscopic cartilage myringoplasty, an extra patch of perichondrium was used to enhance the anterior-inferior tympanic membrane if preoperative evaluation revealed dysfunction of eustachian tube or the graft did not tightly fit the residual tympanic membrane during operation. At sixth month follow-up, all the tympanic membranes healed well without fissure-like perforation or obtuse-angle healing, leading to a 100% healing rate of tympanic membrane. Although some patients had hypertrophy and swelling at the site of the extra patch, the symptoms improved during follow-up.

The audiological evaluation at month six post-operation showed significant decrease in ABG, compared with preoperative values. All patients had external auditory meatus healed smoothly and epithelized well, without bone exposure or granulation. Only a few minor complications were observed and all of these complications had resolved by the end of follow-up. These results and observation demonstrate that it is an effective and safe procedure to add an extra patch anterior to the graft and enhance the tympanic membrane.

Endoscopic myringoplasty has become popular in recent decades and its effectiveness and safety have been ascertained by multiple studies. Our previous study of endoscopic cartilage myringoplasty performed on

CSOM patients achieved a healing rate of 97.4% in dry ear group and 96.9% in wet ear group (10). However, the small tympanic membrane residue of large perforation and anterior-inferior perforation provides less or no support to the graft and makes it difficult for the graft to tightly fit the tympanic membrane. A national multicenter study showed that the healing rate of large perforations was only 89.2%, much lower than those of small and medium perforations (100.0% and 93.7%, respectively). In terms of location, anterior perforations had the lowest healing rate of 92.4%, compared to 94.9% of inferior perforations and 95.6% of the posterior perforations (5).

In order to improve the healing rate of large, sub-total and anterior-inferior perforations, some scholars used the tympanic epithelial flap to repair marginal perforations and achieved a healing rate of 96.3% (6). However, this method only improves the healing rate of perforations no larger than 4 mm and critically depends on operators' skills. Anterior wall flap separating were also applied to repair the marginal perforations and reported 100% heal of perforations, but it is only applicable for anterior (7). Different studies using butterfly cartilage reported healing rates of 96% (11) and 88% (8). This method improves the healing rate, but the high healing rate also heavily relies on surgeons' skills. Due to the lack of precise measuring tools for tympanic perforation, the perforation size can only be roughly estimated by the operator, leading to inappropriate size of trimmed butterfly cartilage. Another drawback of butterfly cartilage method is the high risks in induced tympanitis, with reported incidence varying from 5% to 14% (12).

In order to improve the surgical outcome of patients with poor prognostic factors, we further enhanced the contact between graft and tympanic membrane remnant by adding an extra perichondrium patch anterior-inferior to a graft made of tragal cartilage perichondrium complex. We performed this procedure on patients with preoperative eustachian tube dysfunction, and patients with large or anterior-inferior marginal perforations whose grafts did not tightly fit the tympanic membrane during operation. This patch can be easily obtained by stripping perichondrium and cartilage on the parotid gland side of the well-prepared cartilage. Once the surgeon develops graft placement skills, this extra patching procedure can be completed within 1-3 minutes, without prolonging the operation or increasing patient financial burden. Patients in our study exhibited significant improvement in hearing after surgery, with both of the average PTA and the ABG significantly reduced six months after operation.

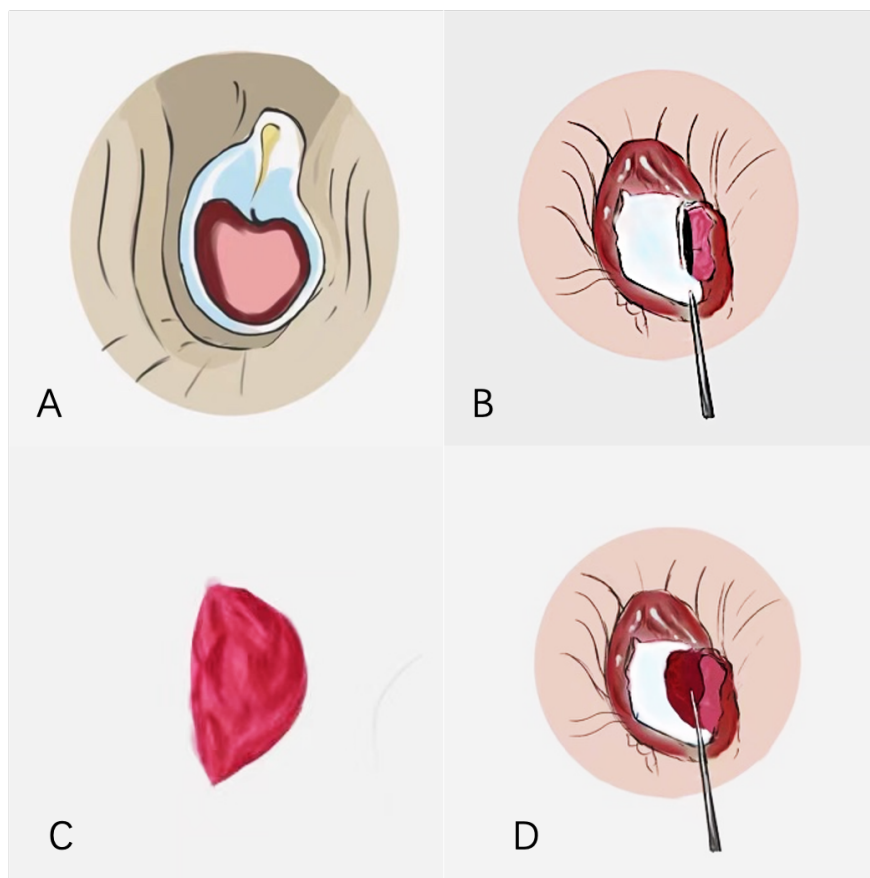
Although our method of adding an extra patch is easy to operate, surgeons' skill is still critical. Improper operation may affect patch survival and a bulky patch may block the pharyngeal orifice of eustachian tube. There are some tips of adding an extra patch to reinforce the graft: (1) The perichondrium strip should be trimmed to 2-3 mm in width. (2) The prepared patch should be delivered to anterior-inferior area of the graft using forceps, and then a crochet hook should be used to fold the patch inward between the graft and the residual tympanic membrane to make the patch fit tightly with the graft surface, the anterior-inferior edge of the graft and the residual tympanic membrane. (3) If the fissure along the graft edge is large, a cartilage patch can be placed at the fissure firstly, before placing the perichondrium patch. Once the patching procedure is completed, gelatin sponge can be used to remove surface secretions. Operators can slightly press the gelatin sponge to smooth the patch and graft surface, and further check hidden fissures underneath.

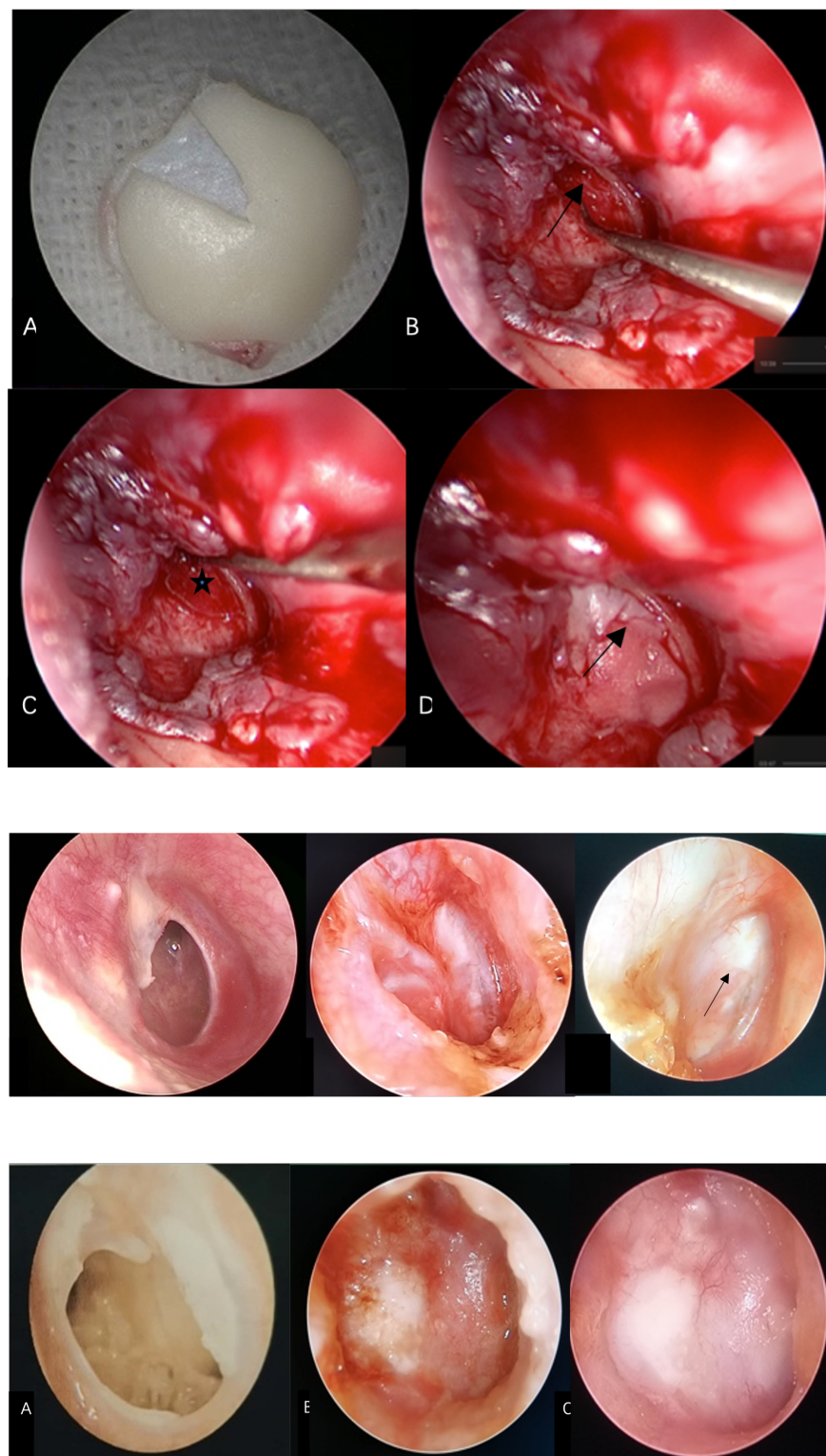
This method benefits patients in the following situations. Firstly, patients who have eustachian tube dysfunction will benefit, because they are more prone to anterior-inferior fissures due to possible negative middle ear pressure. Secondly, this method will improve healing rates in patients who have no residual tympanic membrane to support the graft, or those whose tympanic membrane remnant does not closely fit the graft due to various reasons such as too small graft, graft of poor shape, or impossibility to retake a graft. In this case, an extra patch can be easily obtained by trimming the parotid perichondrium or the remaining cartilage. Thirdly, some patients have tympanic chamber left empty, and the grafts without anterior-inferior support could not closely fit the tympanic membrane. An extra patch offers additional support to the graft. Fourthly, for low-income patients who cannot afford biological materials or a secondary surgery, this method provides an affordable alternative.

CONCLUSION

In order to improve the healing rate of large perforations, sub-total perforations and marginal perforations in the anterior inferior quadrant, we modified the traditional endoscopic cartilage myringoplasty by adding an extra perichondrium or cartilage patch to the anterior inferior edge of the perforation to enhance the contact between graft and tympanic membrane remnant. The using of an extra patch achieved a high healing rate and a statistically significant hearing gain. No major complications were observed during follow-up period. While this method improves the outcome of patients whose grafts did not well fit tympanic membrane during operation, it does not significantly prolong the operation time or increase the financial burden of patients, promoting its potential to be popularized in clinical practice. The clinical effectiveness and feasibility of this method can be further demonstrated by expanding the sample size and prolonging the follow-up time.

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