Primary cartilage tympanoplasty: our technique and results☆
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Abstract
Cartilage has shown to be a promising graft material to close tympanic membrane perforations. However, due to its rigid quality, doubts are raised regarding its sound conduction properties. It has been suggested that acoustic benefit may be obtained by thinning the cartilage. We describe our innovative method for harvesting tragal cartilage from the same endaural incision and also describe preparation of the graft by slicing it. We present our 3-year experience of shield cartilage type 1 tympanoplasty using sliced tragal cartilage–perichondrium composite graft.

Aim: The aim of this study was to prove the success rate of our technique of shield cartilage tympanoplasty using sliced tragal cartilage graft in terms of functional and anatomic results.
Study design: Retrospective analysis of type 1 cartilage tympanoplasties using sliced tragal cartilage was carried out in MIMER Medical College and Sushrut ENT Hospital during May 2005 to January 2008 with a minimum follow-up of 2 years.
Method and materials: A total of 223 ears were operated by our technique.
Results: The overall success rate of our technique was 98.20% in terms of perforation closure and air bone gap closure within 7.06 ± 3.39 dB. The success rates in the various age group are as follows: 11 to 20 years, 97.67%; 21 to 40 years, 99.12%; and 41 to 60 years, 96.96%.
Conclusion: Our technique of type 1 cartilage tympanoplasty achieves good anatomic and functional results.
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1. Introduction

Temporalis fascia remains the most frequently used graft material with closure of the tympanic membrane in 70% to 90% of primary tympanoplasties in different hands. However, in some situations such as advanced middle ear pathology, retraction pockets, and atelectatic ears, temporalis fascia tends to undergo atrophy in the subsequent postoperative period regardless of placement techniques [1]. Our dissatisfaction with the temporalis fascia with a higher incidence of recurrent perforations compelled us to use a tougher material that would not only prevent reperforation but also prevent retractions. Cartilage has shown to be a promising graft material to close perforations in the tympanic membrane. Although it is similar to temporalis fascia, its more rigid quality tends to resist resorption, retraction, and reperforation, even in the milieu of continuous eustachian tube dysfunction [2].

Of the 23 well-defined cartilage tympanoplasty methods, Tos [3] has classified them into 6 groups:

1. Underlay palisade method of Heermann
2. Onlay palisade method
3. Method of broad palisades
4. Method of underlay stripes
5. Method of onlay stripes
6. Dornhoffer mosaic cartilage tympanoplasty

The tragal cartilage is yellow fibroelastic cartilage. The cartilage is a relatively avascular tissue. The presence of cartilage canals through which blood vessels may enter
cartilage is well documented. Each canal contains a small artery surrounded by numerous venules and capillaries. Cartilage cells receive their nutrition by diffusions from vessels. Cartilage cells–chondrocytes lie in spaces (lacunae) present in matrix. Ground substance is made of complex molecules containing proteins and carbohydrates (proteoglycans). These molecules form a meshwork that is filled by water and dissolved salts. The carbohydrates are chemically glycosaminoglycans including chondroitin sulfate, keratan sulfate, and hyaluronic acid. The core protein is aggrecan. The proteoglycan molecules are tightly bound. Along with the water content, these molecules form a firm gel that gives cartilage its firm consistency [4].

This rigidity of the cartilage that prevents perforations is, however, considered to interfere with the sound conduction properties of the tympanic membrane. We describe our innovative method for harvesting tragal cartilage from the same endaural incision and also describe the preparation of the graft by slicing it so as to obtain acoustic benefits.

2. Materials and methods

A retrospective study of type 1 cartilage tympanoplasties operated by both the authors in MIMER Medical College and Sushrut ENT Hospital from May 2005 to January 2008 was carried out.

2.1. Study population

All cases of Safe Chronic Suppurative Otitis Media were included in the study. The patients in the study group ranged
from 11 to 57 years. Only cases in which ossicular chain was intact and no mastoid surgery was performed were included in the study. The number of ears operated was 268. However, 15 patients failed to follow up after 3 months, 16 failed to follow up after 6 months, and 14 failed to follow up after 1 year and hence were excluded from the study. Hence, the number of ears included in the study was 223.

In all patients, a detailed history was taken. A thorough clinical examination of ear, nose, and throat was done with special reference to the ear. Otomicroscopic examination was done in all cases. Hearing was assessed with Tuning Fork. Preoperative and postoperative pure tone audiogram was done in all patients. Preoperative investigations included hemogram, bleeding and clotting time, urine for routine, and microscopy, HIV testing and hepatitis B surface antigen test. In patients older than 40 years, electrocardiogram and chest x-ray were done. All details of the patients including name, age, sex, address, mobile number, preoperative findings, and pure tone audiogram were entered in case sheets. In all patients, preoperative and postoperative video-otoendoscopic recording was done for documentation. All patients were assessed preoperatively by an anesthesiologist and were fit for surgery in American Society of Anesthesiologist (ASA) grade I or II. All patients were explained about the operative procedures failure rates along with the postoperative care to be taken. Written consent was taken in all patients.

2.2. Anaesthesia

All patients were operated under local anesthesia with adequate sedation except children who were operated under general anesthesia. Premedication included pentazocine lactate injection Indian Pharmacopoeia (IP) 30 mg/midazolam injection British Pharmacopoeia (BP) 1 mg/mL.
2.3. Infiltration

Two percent lidocaine with 1:200 000 adrenaline was used.

2.4. Procedure of sliced shield cartilage tympanoplasty

With proper aseptic precautions, Lempert’s endaural incision is taken. Tragal cartilage graft is harvested via the same incision, that is, by sharp dissection into vertical limb of Lempert’s incision (Fig. 1). The cartilage with its attached perichondrium is dissected from overlying skin and soft tissue by a pair of sharp scissors in a plane that is easily developed superficial to the perichondrium on both sides (Fig. 2). It is necessary to make an inferior cut as low as possible to maximize the length of the harvested cartilage graft (Fig. 3). The superior cut is made leaving 5-mm strip of cartilage in the dome of the tragus for cosmesis (Fig. 4). The cartilage is then grasped with plain forceps and retracted, and final cut is given on the fourth side (first side being the free edge along the incisura terminalis), which delivers a piece of cartilage measuring approximately 15 × 15 mm (Fig. 5).

The thickness of the tragal cartilage is approximately 1 mm, and it has been suggested that thinning the cartilage to 0.5 mm could attain acoustic benefit. The thickness of the normal tympanic membrane is 0.1 mm. Hence, to achieve this acoustic benefit, we thin the cartilage with the help of a Cartilage Splitter (Kalelkar Surgical, Mumbai, India). The cartilage splitter is an assembly consisting of blade fixation instrument and other for cartilage stabilization (Fig. 6). The peculiarity of the Cartilage Splitter is that it can produce cartilage slices of varied thickness ranging from 0.1 to

![Fig. 9. Tragal cartilage firmly held in cartilage splitter.](image9)

![Fig. 11. Sliced cartilage-perichondrium shield graft.](image11)

![Fig. 10. Cartilage is sliced by cartilage knife.](image10)

![Fig. 12. Sliced cartilage kept as underlay graft.](image12)
Edges of the perforation in the pars tensa are freshened with the help of a sickle knife (Fig. 7). Tympanomeatal flap is elevated after giving 6 o’clock and 12 o’clock incision. This can be extended up to 2 o’clock on anterior canal wall (considering right ear) leaving 6-mm canal skin from annulus tympanicus laterally. The whole elevated tympanomeatal flap is parked in attic area superiorly (Fig. 8). Ossicular mobility and continuity are assessed. The handle of malleus is denuded. The tragal cartilage is firmly held with the help of cartilage splitter (Fig. 9). The tragal cartilage is sliced with the help of cartilage splitter knife (Fig. 10). The composite sliced cartilage-perichondrium shield graft of 0.5-mm thickness (Fig. 11) is now placed by underlay technique in a meticulous manner after filling the middle ear with gel foam (Fig. 12). Tympanomeatal flap is reposited back. Gel foam is placed over the graft. Meatal pack is placed. Endaural incision is sutured. Mastoid bandage is tied.

2.5. Postoperative monitoring

Patient is monitored closely for a minimum of 4 hours and is encouraged to eat by lunchtime. Patient is usually discharged within 6 hours of surgery if the vital signs are stable and adequate control of pain with oral analgesics (ibuprofen + paracetamol). All patients are put on prophylactic broad-spectrum antibiotics (amoxicillin + clavulanic acid) and analgesics (ibuprofen + paracetamol) and Antihistaminics (fexofenadine) for 7 days postoperatively.

2.6. Follow-up protocol

First postoperative visit is after 48 hours for meatal pack and mastoid bandage removal. Patient is advised about ear care and use of topical antibiotic—steroid ear drops (neomycin + polymyxin B + hydrocortisone). Subsequent postoperative visits are at weekly intervals for 1 month and thereafter monthly for 6 months. At the end of 3 months, pure tone audiometry (average threshold at 500, 1000, 2000, and 3000 Hz) is done to evaluate air bone gap (ABG) closure. Patients are evaluated functionally at the end of 6 months, 1 year, and 2 years.

3. Results

The data of the operated patients are tabulated in Tables 1, 2, and Table 3.

4. Discussion

It has been shown in both experimental and clinical studies that cartilage is well tolerated by middle ear, and long-term survival is the norm [5-8]. The greatest advantage of the cartilage graft has been thought to be its very low metabolic rate. However, in addition, it can receive its nutrients by diffusion; it is very easy to work with because it is pliable and resists deformation from pressure variations and becomes well incorporated in the tympanic membrane [9]. Human and animal studies [10,11] have found that although some softening occurs with time, the matrix of the cartilage remains intact, but with empty lacunae, showing degeneration of the chondrocytes [2]. In our study group, a

<table>
<thead>
<tr>
<th>Age group (y)</th>
<th>Male</th>
<th>Female</th>
<th>Total</th>
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<td>43</td>
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<tr>
<td>21–40</td>
<td>70</td>
<td>44</td>
<td>114</td>
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<tr>
<td>41–60</td>
<td>34</td>
<td>32</td>
<td>66</td>
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<tr>
<td>Total</td>
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<td>94</td>
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<table>
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<tr>
<td>21–40</td>
<td>1 [M]</td>
<td>–</td>
<td>1</td>
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<tr>
<td>41–60</td>
<td>1 [F]</td>
<td>1 [M]</td>
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</tr>
<tr>
<td>Total</td>
<td>2</td>
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<td>4</td>
</tr>
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M indicates male; F, female.
total number of 223 ears underwent type 1 cartilage tympanoplasty using shield sliced tragal cartilage-perichondrium composite graft.

### 4.1. Age–sex distribution

In our study, patients ranged from 11- to 57-year age group. The total number of males is 129, and for females, it was 94. The success rate in terms of perforation closure in 11- to 20-year age group was 97.67%; 21- to 40-year age group, 99.12%, and 41- to 60-year age group, 96.96%. We had comparable success rates in all the age groups, which is in contradiction to the study by Raine and Singh [12], who demonstrated a significant higher rate of failures in 8- to 12-year age group in a retrospective analysis of 114 tympanoplasties. They advocated deferring surgery till 12 years for achieving better results, whereas Strahan and Ward [13] documented that incidence of graft failure was higher in older age group.

### 4.2. Anatomic closure of the perforations

In our study, graft uptake was in 219 patients, recurrent perforations (Fig. 13) in 2 years follow-up was in 2 patients, and residual perforation (Fig. 14) in 2 patients, of a total number of 223 ears operated. The success rate with our technique was 98.20% in terms of perforation closure. The number of residual perforations is 2 and that of recurrent perforations is 2. The success rate would be higher, if the incidence of residual perforations had to be nil. There was no postoperative retraction in the study group. In our study group, we did not encounter any complications (eg, perichondritis, otitis externa, or cosmetic deformity of tragus).

### 4.3. Air Bone Gap (ABG) closure

In our study of 223 ears, the average (SD) ABG closure postoperatively was $7.06 \pm 3.39$ dB. The average ABG closure of 7 dB is indicative of the effective sound conduction by the sliced cartilage graft. Hence, slicing cartilage has offset the disadvantage of the thicker cartilage interfering with the sound conduction. With reference to the study reported by Ben Gamra et al [1], the average ACG (Air Conduction Gain) was $21 \pm 11$ dB, and residual perforation was observed in 2.2% in the cartilage group, with an average follow-up of 2 years. According to the study by Dornhoffer [14], tympanic membrane closure was achieved in all 22 patients, with preoperative and postoperative pure tone average ABG of 21.1 and 6.8 dB, respectively.

The advantages of our innovative technique of cartilage tympanoplasty are as follows:

1. No extra incision for cartilage harvesting because it is available at operative site
2. Improved results with closure of the tympanic membrane perforations in 98.20%
3. Low recurrence in 2-year follow-up
4. Resistant to repeated infection due to rigidity
5. No retraction and adhesion of tympanic membrane in postoperative follow-up of 2 years
6. Residual perforations can be reduced with meticulous technique

### 5. Conclusion

Our technique of type 1 cartilage tympanoplasty gives good anatomic and functional results. The highlight of our technique is the harvesting of the graft via the same endaural incision. By slicing the cartilage, desired acoustic benefit is obtained. We recommend using sliced cartilage as a first choice for tympanic membrane reconstruction.

### References


