

Reinforcement of Sliced Tragal Cartilage Perichondrium Composite Graft with Temporalis Fascia in Type I Tympanoplasty: Our Techniques and Results

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Abstract: In our otological practice, we prefer sliced tragal cartilage-perichondrium grafting for reconstruction of the tympanic membrane perforations. In an attempt to reduce residual and recurrent perforations in our series of cartilage tympanoplasty using sliced tragal cartilage perichondrium composite graft, we reinforce tragal cartilage with temporalis fascia in large perforations.

Aim: The purpose of this study is to evaluate anatomical and audiological results after primary cartilage tympanoplasty using sliced tragal cartilage reinforced with temporalis fascia in large perforations.

Methods and Materials: We carried a prospective study of 28 patients operated from March 2010 to January 2011 in M.I.M.E.R Medical College and Sushrut ENT Hospital using sliced tragal cartilage reinforced with temporalis fascia. The surgical technique is described in detail.

Results: Successful closure of the tympanic membrane was achieved in all patients at 2 years of follow up. The average postoperative Air Bone Gap was 9.6429+/-2.6557 dB.

Conclusion: Reinforcement of temporalis fascia with sliced tragal cartilage is a reliable technique for tympanoplasty, especially in large perforations.

To our knowledge, this is the first study involving the reinforcement of sliced tragal cartilage with temporalis fascia in type I tympanoplasty.

Keywords: Sliced tragal Cartilage, Temporalis fascia, Functional results, Tympanoplasty.

INTRODUCTION

The goal of tympanoplasty is to reconstruct the tympanic membrane and the sound-conducting mechanism in a long-lasting way [1]. Since the introduction of this procedure in the 1950s by Zoellner [1, 2] and Wullstein [1, 3] numerous graft materials and placement techniques have been described to reconstruct the tympanic membrane [4]. Cartilage has been successfully used in middle ear procedures for 40 years, and has been shown to be well tolerated with minimal resorption over time [5]. Initially used for ossicular chain reconstruction, cartilage is now used for a wide range of procedures. Cartilage-perichondrium grafts are frequently the material of choice for reconstruction of the atelectatic tympanic membrane and recurrent perforations. The greatest advantage of cartilage perichondrium composite grafts has been thought to be their very low metabolic rate. However, this tissue can receive its nutrition by diffusion, and it is easy to work with because it is pliable and can resist deformation from pressure variations. The major advantage of cartilage-perichondrium composite grafts is their stiffness and bradytrophic metabolism

summarized in detail by Tos [6] and Yung [7]. Our personal experience in 223 patients operated with sliced tragal cartilage perichondrium composite graft technique has been very good with a success rate of 98.20% with 2 residual and 2 recurrent perforations [8]. The present study describes our subsequent experience of modifying this technique in patients with large perforations (when perforation is > 50% of total tympanic membrane diameter) by reinforcing the temporalis fascia over the sliced tragal cartilage perichondrium composite graft so as to minimize the rate of residual and recurrent perforations and thus improve success rates.

METHODS AND MATERIALS

A prospective study of all type I tympanoplasties performed on patients with large perforations of pars tensa from March 2010 to January 2011 using sliced tragal cartilage perichondrium composite graft reinforced with temporalis fascia was carried out in M.I.M.E.R Medical College and Sushrut ENT Hospital, Talegaon-Dabhade, Pune, India.

Study Population

The current study included ears with large perforations, an intact ossicular chain, a dry ear for at

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least one month, and normal middle-ear mucosa. The patients ranged from 8 to 54 years of age with a mean age of 26.5 years with standard deviation of 13.48. Only primary cases in which the ossicular chain was intact and no mastoid surgery was performed were included. The number of ears operated using sliced tragal cartilage perichondrium composite graft reinforced with temporalis fascia was 28. The total number of males in our study group were 15 and females were 13.

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 Rinne and Weber tests. Pre and Postoperative pure tone audiogram was done in all patients. In all patients, pre and post operative video- otoendoscopic recording was done for documentation. All patients were assessed preoperatively by an anesthesiologist. All patients were explained about the operative procedure, failure rate along with the postoperative care to be taken. Written consent was taken in all patients. Institutional Review Board approval and patients' consent were obtained.

Anaesthesia

All patients were operated under local anesthesia with adequate sedation except children who were operated under general anesthesia. Pre medication included Pentazocine lactate injection IP (Indian Pharmacopoeia) 30 mg / ml and Midazolam injection BP (British Pharmacopoeia) 1mg per ml.

Infiltration

2% lidocaine with 1: 2, 00,000 Adrenaline was used.

Procedure

Procedure of Sliced Shield Cartilage Reinforced with Temporalis Fascia Tympanoplasty

This procedure is a modification of our technique of sliced tragal cartilage tympanoplasty [8] in large perforations

With proper aseptic precautions Lempert's endaural incision is taken. Tragal cartilage (Figure 1) graft (measuring approximately 15mm x 15mm) along with temporalis fascia is harvested *via* the same endaural incision (Figure 2). In order to overcome the disadvantage of a thick cartilage graft interfering with the sound conduction, we prefer slicing the tragal

cartilage (Precise Cartilage Splitter, Germany) (Figure 3). Edges of the perforation in the pars tensa is freshened with the help of a sickle knife. Tympanomeatal flap is elevated after giving 6'o clock through 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 folded and placed in attic area superiorly. Ossicular mobility and continuity is assessed. The handle of malleus is denuded. The sliced cartilage perichondrium composite shield graft of 0.5mm thickness is now placed by underlay technique in a meticulous manner after filling the middle ear with Gel foam. Temporalis fascia is placed lateral to the sliced tragal cartilage by underlay technique (Figure 4). Tympanomeatal flap is re-positioned. Gel foam is placed over the graft. Meatal pack is placed. Endaural incision is sutured. Mastoid bandage is tied.



Figure 1: Tragal cartilage harvest from endaural incision.



Figure 2: Temporalis fascia harvest from endaural incision.



Figure 3: Tragal cartilage sliced with Precise Cartilage Splitter.



(a)



(b)

Figure 4: (a) Sliced tragal cartilage perichondrium composite graft reinforced with temporalis fascia and placed as underlay graft. (b) Temporalis fascia reinforced over sliced tragal cartilage.

Postoperative Monitoring

Patient is monitored closely for minimum 4 hours and is encouraged to eat by lunchtime. Patient is usually discharged within six 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 (amoxicilin + clavulanic acid) and analgesics (Ibuprofen + Paracetamol) and Antihistaminics (Fexofenadine) for 7 days postoperatively.

Follow up Protocol

First post operative 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 + Polymixin B + Hydrocortisone). Subsequent post operative visits are at weekly intervals for 1 month and thereafter 1monthly for 6 months. At the end of 3 months, pure tone audiometry (average threshold at 500, 1000, 2000 and 4000 Hz) is done to evaluate Air Bone Gap Closure. Patients are evaluated functionally at the end of 6 months, 1 year and 2 years. Otoendoscopic recording of all the patients was done postoperatively.

RESULTS

Our study consisted of a total of 28 patients (with large perforation Figure 5), 15 males and 13 females operated using tragal cartilage perichondrium composite graft reinforced with temporalis fascia in type I tympanoplasty. The patients ranged from 8 to 54 years of age.

Out of 28 patients, 3 patients developed Acute Otitis Media (Figure 6), of which 2 patients responded to medical treatment with resolution of AOM (Figure 7). However, one patient developed a small perforation which healed at 4 weeks. In our study population, we had no occurrence of residual perforations.

Table 1 shows the pre air bone gaps of 32.464+/- 5.0220dB and postoperative air bone gap of 9.2131+/- 3.2823 dB at 6 months, 10.3246+/-4.5427 dB at one year and 9.6429+/-2.6557 dB at 2 years of follow up. The pre and the post-operative difference in the Air Bone Gap were statistically significant ($p < 0.05$).

DISCUSSION

Cartilage was first introduced in middle ear surgery in 1959 by Utech [9]. The technique was then promoted

Table 1: Pre-Operative and Post-Operative Air Bone Gap of the Study Group

Pre Op AB GAP in dB	Post Op AB gap in dB at 6months	Post Op AB gap in dB at one year	Post Op AB gap in dB at two years
32.464 +/- 5.0220	9.2131+/-3.2823	10.3246+/-4.5427	9.6429+/-2.6557

by Prof. Heermann J. from Essen, Germany, who used "the cartilage palisade technique" for the reconstruction of the tympanic membrane and the auditory canal wall [10, 11]. Saraç *et al.* [12] were the first to use cartilage to prevent temporal muscle fascia detachment anteriorly, with the aim of increasing the success rates in large and subtotal perforations. It is known that central large and subtotal perforations have low success rates. Failure of these cases is based on graft detachment anteriorly. The main causes of this detachment [13] are as follows. (1) Gelfoam placed anteriorly switch towards the eustachian tube and this reduces the graft support medially. (2) If the external ear canal wall is prominent, visualization of the anterior quadrant may be difficult. (3) After the graft has been placed under the remnant membrane anteriorly, when the surgeon manipulates it, the posterior area of the graft may slide backwards.

In the quest to improve tympanoplasty success rates, research has focussed on the eradication of disease and the creation of a healthy, well aerated middle-ear cleft with an intact tympanic membrane [14]. Clinical studies of tympanic membrane reconstruction with fascia, perichondrium and cartilage have obtained differing results. These results may have been influenced by confounding variables such as revision surgery, variable perforation size and location, perforation drainage during surgery, and bilateral perforation. The current study included primary tympanoplasty cases with large perforations, an intact ossicular chain, a dry ear for at least one month, and normal middle-ear mucosa.

In our study group, a total number of 28 ears underwent type I cartilage tympanoplasty using sliced tragal cartilage-perichondrium composite graft reinforced with temporalis fascia in large perforations.

In this study, success was evaluated as

- 1) Anatomical Intactness of tympanic membrane
- 2) Hearing improvement by postoperative Air Bone Gap closure

Intactness of the Tympanic Membrane

The success criterion in the anatomical evaluation of the tympanic membrane is the occurrence of the re-perforations. Out of 28 patients, 3 patients developed Acute Otitis Media, of which 2 patients responded to medical treatment with resolution of AOM. However, one patient developed a small perforation which healed

at 4 weeks. Hence, at the end of 2 years, the tympanic membrane was intact in all 28 patients; the graft take up percentage was 100 % (Figure 8).



Figure 5: Large Perforation.

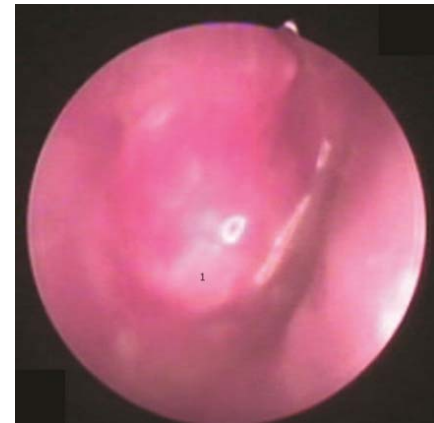


Figure 6: Post tympanoplasty acute otitis media.



Figure 7: Healed Otitis media post tympanoplasty.

Air Bone Gap Closure

The pre-operative air bone gap was 32.464+/- 5.0220dB and postoperative air bone gap was



Figure 8: Well-functioning Sliced tragal cartilage reinforced with fascia after postoperative 2 years.

9.2131+/-3.2823 dB at 6 months, 10.3246+/-4.5427 dB at one year and 9.6429+/-2.6557 dB at 2 years of follow up. The pre and the post-operative difference in the Air Bone Gap were statistically significant ($p < 0.05$).

Table 2 tabulates the success rates of the studies using different graft materials and techniques in tympanoplasty.

In a study by Ozbec C *et al.* involving type I tympanoplasty it was concluded that tympanoplasty with the palisade cartilage technique resulted in a significantly higher graft acceptance rate (100%) than with the fascia technique (70.2%; $p = 0.008$). Speech reception threshold levels, pure-tone average, and air-bone gaps improved significantly with surgery in both the palisade and fascia groups ($p < 0.001$). Comparison of audiologic results between the groups did not reveal any statistically significant difference ($p > 0.05$) [15].

In a study by Kazikdas KC on Palisade cartilage tympanoplasty, graft take was achieved in 22 patients (95.7%) in palisade cartilage group and in 21 patients (75%) in temporalis fascia group ($P = 0.059$). Mean speech reception threshold, air-bone gap and pure-tone average scores comparing the gain between both techniques showed no significant changes in the threshold ($P > 0.05$). However the functional success was achieved with the palisade cartilage technique postoperatively, regarding to mean air-bone gap and speech reception threshold changes [16].

In a study comparing cartilage and temporal fascia, Yu *et al.* observed a 92.4% success rate for 66 cartilage tympanoplasty patients and 80% for 60 temporal fascia tympanoplasty patients [17].

In the study by Celil Uslu *et al.*, a 78.3% success rate for tympanic membrane healing was reported. They had 17 patients whose perforation was $> 75\%$ of total membrane diameter preoperatively and 15 of them healed with no perforation; 1 of them had a perforation $< 25\%$ of total membrane diameter and 1 of them had a perforation between 50% and 75% of total membrane diameter. These results show that the cartilage reinforcement technique had a great success rate in subtotal or total perforations. With this technique cartilage reinforces and supports the temporal fascia graft and prevents the detachment of the fascial graft anteriorly [13].

In a systematic literature review by Iacovou E, Vlastarakos PV *et al.*, total number of treated patients was 1,286. Cartilage reconstruction was used in 536, Temporalis fascia in 750 cases. The mean graft integration rate was 92.4 % in the cartilage group and

Table 2: Success Rates of the Graft Materials in Tympanoplasty

Study	Graft Materials	Success Rate
Khan, Parab [8]	Sliced Tragal Cartilage	98.20 %
Ozbec C <i>et al.</i> [15]	palisade cartilage technique	100%
	Temporalis Fascia	70.2 %
Kazikdas KC[16]	Palisade cartilage	95.7%
	Temporalis Fascia	75%
Yu <i>et al.</i> [17]	Cartilage	92.4%
	Temporalis Fascia	80 %
Celil Uslu <i>et al.</i> [13]	Temporalis Fascia reinforced with cartilage	78.3 %
Iacovou E, Vlastarakos PV <i>et al.</i> [18]	Cartilage	92.4 %
	Temporalis Fascia	84.3%

84.3 % in the TMF group ($p < 0.05$). The rates of re-perforations were 7.6 and 15.5 %, respectively ($p < 0.05$). The graft integration rate in myringoplasty is higher after using cartilage, in comparison with fascia reconstructions (grade C strength of recommendation), and the rate of re-perforation is significantly lower [18].

Limitations of the Study

The sample size of the study group being only 28, a larger data and a longer follow up is needed to prove the functional and anatomical results of the reinforcement of temporalis fascia with sliced tragal cartilage graft in tympanoplasty.

CONCLUSION

We conclude that reinforcement of temporalis fascia with sliced tragal cartilage is a reliable technique for tympanoplasty, especially in large perforations. In this study we found our technique greatly increases the rate of tympanic membrane closure without affecting audiometric results.

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