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Results of cartilage shield tympanoplasty in revision cases of myringoplasty

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ABSTRACT

Background: Cartilage shield tympanoplasty (CST) is seen as a good option for revision surgery in cases of myringoplasty failure. Cartilage serves as rigid material which resists retraction. However, there have been concerns regarding hearing outcome and surveillance in follow up period.

Methods: A prospective study was conducted at our tertiary institute. 25 patients of either sex in age group of 18-50 years with one or more failed tympanoplasties underwent CST. Pre-operative and post-operative audiograms were obtained, and patients were regularly followed up to calculate graft uptake and hearing outcome. Quantitative data was analyzed by using Student t-test and for qualitative data chi square test was used.

Results: The mean pre-operative pure tone air-bone gap was 25.09±8.10 dB while the mean postoperative pure tone air-bone gap was 13.47±5.18 dB, one case (4%) presented with failure as there was a residual perforation anteroinferiorly. Since it was a small residual perforation, it was planned for closure by fat myringoplasty. No complications were recorded. We obtained graft take rate of 96% and mean postoperative gain of 11.62±7.11 dB in PTA-ABG.

Conclusions: We recommend CST for revision cases of tympanoplasty.

Keywords: Cartilage shield tympanoplasty, Revision tympanoplasty, Failure of myringoplasty

INTRODUCTION

Although temporalis fascia and perichondrium are the commonly used grafts in tympanoplasty and the reported results are excellent, they both have the potential to atrophy resulting in failure, especially in high risk ears as those with atelectasis, cholesteatoma, and prior surgery. Although cartilage is similar to fascia in that it is mesenchymal tissue, its more rigid quality tends to resist resorption and retraction, even in the milieu of continuous Eustachian tube dysfunction leading to negative middle ear pressure. Long term survival is achieved since cartilage graft is nourished largely by diffusion and not by neovascularization. It maintains its rigid quality and resists resorption and retraction. This

grafting material is easy to harvest from conchal bowl or tragus and is well tolerated in middle ear.⁴ The concha cymba cartilage is within the operative field, has an average thickness of 0.8 mm and its concave contour resembles the conical shape of normal tympanic membrane and it is thinner than tragal cartilage (1.016 mm).⁵ However, cartilage material has been criticized because of concerns regarding hearing results and postoperative middle ear surveillance in cholesteatoma cases. Due to its characteristic rigidity and thickness, there has been controversy regarding audiological aspect.⁴ The present study evaluates the results of cartilage shield tympanoplasty (CST) in revision cases of myringoplasty.

Aim and objectives

The aim and objectives of the study were to evaluate results of CST in revision cases of myringoplasty, to assess the hearing outcome of CST in revision cases of myringoplasty and to assess graft uptake of CST in revision cases of myringoplasty.

METHODS

Study design

This was a prospective study. Study was conducted after ethical approval from Post Graduate Board of Studies, Pt B D Sharma PGIMS Rohtak.

Inclusion criteria

Patients in age group of 18-50 years with tympanic membrane perforation who had already undergone myringoplasty in the past for the same ear and whose ear was dry over a period of at least 6 weeks without the use of topical or systemic antibiotics were included in the study, after obtaining their written informed consent.

Exclusion criteria

Patients having cholesteatoma and/or granulation tissue, patients having marginal perforation, patients with sensorineural or mixed hearing loss, patients with tympanosclerosis involving ossicular chain, patients with ossicular erosion or fixation, patients with only one hearing ear, patients with hearing loss out of proportion to the size of perforation, patients with underlying diseases such as diabetes or poor immune system and patients with marked deviated nasal septum and active infection in nose, throat and paranasal sinuses were excluded from the study.

Study procedure

25 patients of either sex in age group of 18-50 years having chronic otitis media presenting in ENT Department of PGIMS Rohtak between June 2017 to January 2019.

All the patients who met inclusion and exclusion criteria underwent a detailed evaluation based on history, general physical examination as well as complete ear, nose and throat examination. All the cases were subjected to an otoscopic examination pre-operatively to identify the size and type of perforation, the condition of middle ear mucosa, the condition of malleus handle, the condition of the drum remnant, whether adherent to the middle ear mucosa or not. The condition of the opposite ear was also noted. Examination under microscope was done to confirm the findings of otoscopy. Tuning fork tests were done in all the patients. These tests included the Rinne's test, Weber's test and the absolute bone conduction test. Pure tone audiometry (PTA) was done to confirm the

degree and type of hearing loss and to assess hearing status of opposite ear. PTA was done for frequencies ranging between 0.5 KHz and 8 KHz. A written informed consent was taken from the patients explaining the advantages, disadvantages and complications of the treatment being offered, and about being included in present study. Patient were taken up for surgery after the routine investigations. All cases were performed under local anesthesia. Findings were recorded in the proforma.

Pre-operative preparation

Xylocaine sensitivity test was done by injecting 0.2 cc of 2 percent xylocaine intradermally on the volar surface of the forearm on each patient to rule out hypersensitivity.

Ear to be operated was prepared in the ward by shaving the hair over the scalp and the post auricular region for about one inch.

All patients were given tablet alprazolam 0.25 mg at night prior to surgery.

Premedication with pentazocin 30 mg, promethazine 25 mg and atropine 0.3 mg intramuscular was given 45 minutes prior to the operative procedure.

Injection amoxycillin with clavulanic acid 1.2 gm was given.

CST

Surgical technique: Patient was placed supine with the head turned to the opposite side. The area to be operated was cleaned with povidone iodine and spirit. Sterile draping was done. Local anaesthesia (xylocaine 2% with 1:100000 adrenaline) was injected in the pre auricular, post auricular area and at bony cartilaginous junction of external auditoty canal in four quadrants and in temporal region. Vascular strip incisions were made in the ear canal followed by a postauricular incision. Temporalis fascia graft was harvested and it was spread on a slide and dried. Vascular strip was elevated out of the ear canal and kept in position using two self-retaining retractors. Access to the ear canal and tympanic membrane was accomplished via the post auricular approach. A canaloplasty was performed in cases with bulging of the bony anterior canal wall to improve visualization of the anterior sulcus. The edges of the perforation were denuded and areas of tympanoclerosis were completely removed. The middle ear was explored, the status of ossicular chain was determined. A round piece of cartilage, approximately the size of 8 to 10 mm was harvested from the concha cymba area. The perichondrium was stripped from both sides and a wedge of cartilage was excised to accommodate the manubrium. The cartilage graft, with its convex surface medially, was placed underneath the manubrium by lifting it up with a small right-angle hook while gently pushing the graft medially with a 22-gauge suction. Subsequently, the

periphery of the cartilage graft was placed medial to the tympanic membrane remnant or the fibrous annulus. A very small gap (less than 1 mm) was allowed between the cartilage graft and the tympanic sulcus. For patients with medialization of the malleus, the tensor tympani tendon was sectioned to lateralize the manubrium and allow medial placement of the graft. The previously harvested temporal fascia was then placed over the cartilage graft and medial to the tympanic membrane remnant, or fibrous annulus, so that any small gaps are bridged. The vascular strip flap was returned to its original position and the external auditory canal was packed with gelfoam pieces impregnated in the antibiotic ointment. The post auricular incision was sutured in two layers with 3.0 vicryl sutures. Hemostasis was achieved. Mastoid dressing was applied.

Post-operative care: Postoperatively, the patients were given Tablet (Amoxycillin and clavulanic acid) 1 gm BD, tablet levocertizine 5 mg OD, tablet acelofenac 100 mg and paracetamol 500 mg BD was given for 7 days. The patients were discharged after 24 hours of surgery if post-operative period remained uneventful. All the patients at the time of discharge were instructed to take adequate precautions to prevent entry of water into the ear canal. They were advised to avoid blowing of nose and lifting heavy weights. Further follow up was done on out-patient basis.

Post-operative follow-up: All the operated patients were followed up at one week, 6 weeks and 3 months post operatively in outpatient department.

Statistical analysis

At the end of the study, collected data were entered in the MS Excel spreadsheet and coded appropriately. Analysis was carried out using SPSS (Statistical Package for Social Studies) for Windows version 24.0. Data was analyzed by using Student t-test. For qualitative data, chisquare test was used. Normally distributed data were presented as means and standard deviation. All tests were performed at 5% level of significance. Thus, an association was significant if the p value was less than 0.05.

RESULTS

Mostly males were in age group of 18 to 24 years while females were evenly distributed in all three age groups (Table 1).

Size of perforations were divided in three groups of 4, 5 and 6 mm. Maximum number was represented by perforations of sizes 4 mm and 5 mm comprising 56% and 24% respectively. Rest 5 (20%) patients had 6mm sized perforation (Table 2).

Table 1: Age and sex distribution of patients undergoing cartilage myringoplasty.

Age (years)	Males	Females	Total	%
18-24	8	4	12	48
25-34	2	5	7	28
35 and above	1	5	6	24
Total	11	14	25	100

Table 2: Distribution of patients of com with respect to the size of perforation.

Size of perforation (mm)	No of patients (%)
4	14 (56)
5	6 (24)
6	5 (20)
Total	25

Tuning fork tests: Rinne's test was negative in all patients in affected ears and Weber's test was lateralized to the worse ear in all patients pre-operatively.

PTA was used to assess average air-bone gap (ABG) preoperatively and post-operatively (12 weeks) including the failed cases. Hearing levels for frequency 500 Hz, 1 kHz, 2 kHz, 4 kHz and 8 kHz was assessed and an average was taken for these four frequencies.

16 out of 25 patients had hearing threshold of 25-40 dB and 9 patients had 41-55 dB (Table 3).

Table 3: Degree of hearing loss before surgery.

Degree of hearing loss	Hearing threshhold (dB)	Total number of patients
Mild	25-40	16
Moderate	41-55	07
Moderate severe	56-70	02
Severe	71-90	00
Profound	>90	00

Post-operative results

Graft take-up: With regards to tympanic membrane intactness, of the total 25 patients; 24 had an intact tympanic membrane at 12th post-operative week accounting for 96% success rate.

Of the 11 male patients we had success in 11 out of 11 patients i.e., 100% and 13 out of 14 female patients had a successful outcome i.e., 92.86% (Table 4).

All grafts were taken by perforations of size 5 and 6 mm. There was one failure case by the perforation size 4 mm (Table 5).

Table 4: Graft take-up.

Gender	No. of patients	No. of patients with graft taken up	%
Males	11	11	100
Females	14	13	92.86
Total	25	24	96

Table 5: Relationship between graft take up and size of perforation.

Size of perforation	No. of patients	Graft taken up	%
4 mm	14	13	92.86
5 mm	6	6	100
6 mm	5	5	100

There was no correlation between size of perforation and graft take up rate (p>0.05).

There was 100% graft take up in cases of bilateral COM and 94.44% in unilateral COM patients (Table 6). Only one ear was operated for patients with bilateral COM, which matched the criteria for revision surgery for CST.

Table 6: Graft take up in bilateral and unilateral com cases.

Com	No.	Graft take up	%
B/l	7	7	100
U/I	18	17	94.44
Total	25	24	96

Audiometry

Hearing improvement

Hearing levels were assessed at 3 months

Mean gain in hearing threshold

The mean preoperative hearing threshold was 42.02 ± 4.71 dB while the mean postoperative hearing threshold was 28.47 ± 6.49 dB. The mean gain in hearing threshold was 13.55 ± 5.52 dB.

Table 7: Mean gain in hearing threshold

Mean pre-op hearing threshold	Mean post-op hearing threshold	Mean gain
42.02 dB	28.47 dB	13.55 dB

Mean gain in ABG after surgery

The mean preoperative A-B gap was 25.09±8.10 dB while the mean postoperative A-B gap was 13.47±5.18 dB, giving mean postoperative gain of 11.62±7.11 dB.

Table 8: Mean gain in ABG after surgery.

Mean pre-op ABG	Mean post-op ABG	Mean gain
25.09 dB	13.47 dB	11.62 dB

Comparison of pre-operative and post-operative degree of ABG on PTA

6 of the patients had ABG below 20dB prior to surgery. Pre-operatively; 12 patients out of 20 has ABG between 20-30 dB; more than 30 dB ABG was present in 7 patients pre-operatively

Post-operatively; ABG of less than or equal to 10 dB was in 10 patients, 11-19 dB in 14 patients and more than 20dB in one of the patients at 12th week.

Total 25 patients out of 25 had ABG less than or equal to 20 dB post operatively (Table 9).

Table 9: Comparison of pre-operative and postoperative gain in ABG.

ABG (dB)	Pre-operative	Post-operative
≤10	1	10
11-20	5	14
21-30	12	1
>30	7	0

When compared statistically preoperative versus postoperatively AB gap, it was found to be highly significant (p<0.001). There was significant improvement in ABG after surgery.

Improvement in ABG

There was improvement of 0-10 dB in 13 patients. Improvement of 11-20 dB in ABG was seen in 9 patients. Improvement of 21-30 dB was seen in 3 patients (Table 10).

Table 10: Improvement in ABG.

Improvement in ABG (dB)	No. of patients
0-10	12
11-20	10
21-30	3

When compared statistically, it was found to be significant. So, there was significant hearing improvement after surgery. No post-operative complications were recorded.

DISCUSSION

In the present study age ranged from 18 to 50 years. This age group was selected due to its likelihood of their

proper and regular follow up as well as to rule out failure of graft acceptance, due to repeated upper respiratory tract infections as is commonly observed in children. In the elderly patients presbycusis tends to blur the auditory functions. Maximum number of patients were in the age group of 18 to 24 years i.e., 48%. This is explained by the fact that many patients are inclined towards joining armed forces from this part of the country, where chronic otitis media is very common causes of medical rejection to join army. Hence patients in the age group of 18 to 24 years regularly attend the clinics to get the surgery done. Mean age was 28.32±10.61 years. Yung et al had mean age of 42 years in their study, Cabra et al had 39 years as mean age in their study, Yetiser et al 26.6 years and Aidonis et al 32 years. 6-9 Amongst these 44% were males and 56% females. Kulkarni et al also observed males as 43.4% and females 56.6% in their study. 10 Khan et al also found males 57.85% and females 42.15% in their study. 11 Kyrodimos et al found males 50% and females 50%, Boone males 55.79% and females 44.21%. 12,13

Presence of ear discharge

All the ears were dry at the time of surgery though there was history of ear discharge in the past. A six weeks period of dry ear was ensured prior to surgery as it is generally believed that wet ear has a direct bearing on the graft take up rate, with a dry period resulting in better graft take rates. One study reported that middle ear infection had strong lethal effects on chondrocytes and that cartilage grafts survive better in dry ears. ¹⁴ However, others are of the opinion that there is no clinically significant difference in the success rate of myringoplasty in patients whose ear are wet or dry at the time of surgery.

Size of perforation

Perforations size was measured and categorized into 4mm to 6mm. In our study, maximum number of patients 14 (56%) had size 4 mm perforations, 6 (24%) had size 5mm perforations, 5 (20%) had 6 mm size perforations. No correlation was found between size of perforation and result of surgery.

Condition of contralateral ear

In the present study bilateral ear involvement was present in 7 (28%) cases. However, no correlation was observed between bilateral ear involvement and successful outcome of myringoplasty. This is in accordance with the study done by Smyth et al.¹⁵

Hearing improvement

The use of cartilage in type I tympanoplasty (myringoplasty) to fill a membranous void appears inherently non-physiologic and innately unrelated to the principles of physics. Cartilage may be seen as a mass impeding vibration of the tympanic membrane. The mass

effect of the cartilage must necessarily favour the lower frequencies.¹⁶ However, in our study, all patients had hearing improvement, assessed by decrease in ABG on pure tone audiometry at 3 months' follow up. Majority of patients i.e., 12 (48%) had a gain in the range of 0 to 10 dB while 10 patients (40%) had gain of 11 to 20 dB and 3 (12%) patients had 21 to 30 dB. When compared statistically preoperative versus postoperatively ABG, it was found to be highly significant (p<0.001). Results were in accordance with the study by Ahmad et al.¹⁷ who also observed better hearing results with cartilage graft. They observed ABG mean value reduced from 26.1±10.8 dB to 13±7.1 dB post-operatively (p<0.05). They observed ABG closure less than or equal to 10 dB in 7 (15.2%), 11 to 25 dB in 34 (73.9%) and more than 25 dB in 5 (10.9%) patients in their study. Simsek et al reported decrease in ABG from pre-operative mean value of 23.18±11.36 dB to post-operative value of 12.37±8.28 dB (p<0.05). 18 Aidonis et al observed mean improvement of 8.4 dB in 98.4% cases. Human and animal studies have found that although some softening occurs with time, the matrix of the cartilage remains intact, but with empty lacunae, showing degeneration of chondrocytes. 19,20 In an experimental study, Zahnert et al compared the acoustic transfer characteristics of cartilage of varying thickness and its mechanical deformation when exposed to fluctuations of atmospheric pressure.²¹ When tragal and conchal cartilages were compared, there was no statistical difference between the two. A cartilage thickness of 500 micrometer or less resulted in acceptable acoustic transfer loss compared with the normal tympanic membrane. Hence, in our study, to achieve a thinner graft we stripped perichondrium from both sides of graft. Temporalis fascia graft was placed lateral to it.

Graft take

We had 96% graft take in our study. Other authors have also reported excellent graft take with cartilage shield. Kyrodimos et al performed cartilage tympanoplasty in 52 patients and reported that graft take was successful in all patients. 12 Khan et al did primary cartilage tympanoplasty in 223 ears. The overall success rate was 98.20% in terms of perforation closure.¹¹ Moore reported 100% graft take. Cartilage, perichondrium, and fascia are derived from mesenchymal tissue.²² Histologically, on healing, they are incorporated in the middle layer of the tympanic membrane providing the lamina propria. Cartilage is easier to tailor, manipulate, and position than fascia and supplies both the scaffolding necessary during healing subsequent support (epithelialization) and recurrence of perforations.^{23,24} During healing, the cartilage scaffolding stabilizes and fixes perichondrium, thus preventing it from herniating into the middle ear cavity and contributing to a failure. Shrinking of the perichondrium is also minimized by its attachment to the cartilage.²⁵ In our study, perichondrium was stripped on both sides and cartilage prevented retraction of laterally placed temporalis fascia graft.

Graft take in revision cases

Patients undergoing revision surgery, those with atelectatic middle ears and total tympanic membrane perforation with a history of chronic eustachian tube dysfunction have high risk of failure with temporalis fascia grafts. Boone et al did revision cartilage tympanoplasty in 95 patients and reported that successful closure without perforation was obtained in 94.7% of patients.¹³ Sismanis et al performed CST using cymba concha cartilage in revision cases.²⁶ Graft take was 93.5%. Our study suggests that CST is a satisfactory technique in such cases. Cartilage is a rigid material which can resist retraction. Its medial to handle of malleus placement and its intrinsic firmness prevents graft failure and medialization of graft. The concha cymba cartilage is easy to harvest, has an average thickness of 0.8 mm and its concave contour resembles that of tympanic membrane.²⁷ In none of the cases, we encountered graft lateralization or collapse into middle ear space. Hence, cartilage may be put without creating a groove in bony annulus for graft stabilization as reported by Moore.²² Besides, the same cartilage shield used as tympanic membrane can also be used for ossicular reconstruction. For example, in patient where malleus, incus and stapes suprastructure does not exist, conchal cartilage directly placed over footplate of stapes will act as ossicular as well as tympanic membrane graft.²⁷ There have been concerns regarding hearing outcome as thickness of cartilage may reduce middle ear space. However, we had encouraging hearing results in our patients. One theoretical 'disadvantage' of cartilage is that it creates an opaque tympanic membrane at repair site, which could potentially hide disease recidivism.

In our study, CST has been very effective in previous failures because of severe atelectasis, isolated tympanic membrane perforations, and lateralization of neotympanic membranes. The 96% graft take in our patients is comparable to other studies. In one failure case there was a small residual perforation anteroinferiorly, which was planned for fat myringoplasty. However, this failure case also presented with a post-operative PTA-ABG of 14.33 dB against pre-operative PTA-ABG of 23.33 dB. Except for sizing and shaping the cartilage graft, this surgical technique is similar to other underlay tympanoplasties. Initially remodelling the cartilage graft consumes time but with experience this procedure can be accomplished in same time as other underlay tympanoplasties. The post-operative pain was minimal. The donor site healed without any complication and any residual deformity. The patients were able to experience the hearing improvement right on the table. There were no post-operative complications.

CONCLUSION

CST is an excellent technique for revision cases and for those at higher risk of graft failure. These results are consistent with other published series on cartilage tympanoplasty. Graft take is excellent, hearing results are comparable to other cartilage tympanoplasties as well as temporalis fascia graft tympanoplasty and complications are minimal.

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Institutional Ethics Committee

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