

# A Comparative Study of Type-I Underlay Tympanoplasty with Temporalis Fascia Graft Alone and with Conchal Cartilage

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**Abstract** Tympanoplasty which is the repair of the tympanic membrane using temporalis fascia, has been done worldwide and has stood the test of time. However in cases of reperforation or large/subtotal perforations, we are often left in need of some sturdy material for grafting. To compare the graft uptake and hearing improvement in patients undergoing type I tympanoplasty using temporalis fascia alone and temporalis fascia along with conchal cartilage. The current research is a prospective study of 60 patients with chronic suppurative otitis media (Tubo tympanic type), undergoing type I tympanoplasty, using temporalis fascia alone and temporalis fascia along with conchal cartilage. The graft uptake and hearing improvement was much better using temporalis fascia along with conchal cartilage graft as compared to cartilage alone. The use of temporalis fascia along with conchal cartilage graft is beneficial for patients with chronic suppurative otitis media (tubotympanic type) undergoing type I tympanoplasty than using temporalis fascia alone.

**Keywords** Tympanoplasty · Temporalis fascia · Conchal cartilage graft · Perforations · Hearing

## Introduction

Tympanoplasty has been defined as “eradication of disease from the middle ear with or without reconstruction of the hearing mechanism, with or without tympanic membrane grafting, used in the treatment of chronic suppurative otitis media tubotympanic disease” [1]. Tympanoplasty has been modified by many authors in terms of approach, technique and materials used for grafting the tympanic membrane [1–3]. Different types of graft materials have been used to reconstruct the tympanic membrane, which 2 include temporalis fascia, periostia, perichondria, cartilage, vein and fat. Each has its merits and demerits, but whichever is the graft material used, subtotal perforations have always posed a challenge to otologists [4].

Temporalis fascia has been the most commonly used material for tympanic membrane reconstruction, with a variable success rate in the closure of perforations and the improvement in conductive hearing loss. However, during the last decade there has been encouraging results when cartilage has been used along with the temporalis fascia graft, in cases where there is a high risk of graft failure, such as subtotal perforations, adhesive otitis media, and residual perforations after primary tympanoplasty surgery and is superior to the use of temporalis fascia alone as a graft material both in the closure of perforations as well as in hearing improvement. Subtotal perforations with very small anterior remnant of tympanic membrane and anterior bony overhang are reported to be more prone to failure after tympanoplasty [5]. Though various materials have been used as grafts in tympanoplasty for subtotal perforations, still failure of perforation closure is reported seen in 10% of cases [5, 6].

Various reasons for residual perforations reported are poor adaptations of the graft, displacement of the graft

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which may sink medially or may shift posteriorly or may shrink. Further, the perforation fails to heal in large number of cases, when the graft is supported medially only by gelfoam [5].

To overcome this problem, use of a small semilunar shaped piece of conchal cartilage is suggested to be placed medial to the narrow anterior rim in case of a large or subtotal perforation. The temporalis fascia graft is placed lateral to this cartilage support and medial to the thin anterior rim. This cartilage splays and stays in place and provides firm support to the fascia graft and prevents sinking or shrinking of the graft. Other reported advantages of use of cartilage along with fascia graft are, its low metabolic rate, minimal inflammatory tissue reaction, its viability for long time owing to its nutrition by diffusion. Further it is easy to work with because it is pliable and it can resist deformation from pressure variations [6–8].

Variable results have been reported from different studies. In a recent study, graft uptake of 80%, with 66.7% hearing improvement in patients undergoing type-I tympanoplasty with use of cartilage along with temporalis fascia has been reported [9, 10].

Therefore not many studies are available in literature to report the efficacy of the use of cartilage along with temporalis fascia. Hence the present study is undertaken to assess the advantages of the use of cartilage along with temporalis fascia in perforation closure and hearing improvement as compared with the use of temporalis fascia alone.

### Aims and Objectives

- To compare the graft take up in patients using temporalis fascia alone and using conchal cartilage support along with temporalis fascia graft.
- To compare the improvement in conductive hearing loss, using temporalis fascia alone and using conchal cartilage support along with temporalis fascia graft.

### Materials and Methods

A Prospective study of 60 Patients attending the Otorhinolaryngology Out Patient Department of Goa Medical College which is a tertiary care hospital for the period of one and a half year, between November 2014 to May 2016, diagnosed with tympanic membrane perforations of all sizes which have been dry for 4 weeks, of either sex and all age groups undergoing type-I tympanoplasty will be included in the present study.

Patients found with ossicular chain pathology/ies and with Cholesteatoma will be excluded from the study.

Written informed consent was taken in all patients. Permission from the Institutional Ethical committee was obtained to conduct this study.

After obtaining a detailed history, a thorough clinical examination of ear, nose and throat was done with special reference to the ear in all patients and was recorded in the case proforma. Hearing assessment was done by performing tuning fork tests and a preoperative pure tone audiogram was done.

All patients were subjected to appropriate clinical investigations for anaesthesia fitness and subjected to type-I tympanoplasty by underlay technique. Patients were randomly assigned to Group 1, where only temporalis fascia alone was used as a graft and Group 2, where conchal cartilage was used along with temporalis fascia graft.

Patients were followed up and examined at 8 weeks to assess graft take up and pure tone audiometry was performed to record the improvement in conductive hearing loss.

The hearing assessment in pre and post operative audiograms were calculated by taking the average hearing in dB at the 3 speech frequencies (500 Hz, 1 kHz, 2 kHz).

Results were compiled and analysed statistically using Chi-square test and Student *t* test.

A *P* value of less than 0.05 was considered statistically significant.

### Operative Technique

**Anaesthesia:** All patients were operated under local anaesthesia with adequate sedation. Pre anaesthetic medication included Pethidine 1 mg/kg body weight, Phenagan 0.5 mg/kg body weight and Glycopyrrolate 0.2 ug, all given as intramuscular injections half an hour prior to the surgery. Local infiltration was given with 2% lignocaine with 1 in 2 lakh adrenaline was used.

Antibiotic cover was given half an hour prior to surgery. Under proper aseptic precautions, postaural Wilde's incision is given. Temporalis fascia graft is harvested and prepared. Through the same incision, conchal cartilage graft is harvested from the conchal bowl using skin hooks. Conchal cartilage is ideal as it is thin, has a smooth contour and is very elastic, so when it is placed medial to anterior rim, it splays and stays in place. The conchal cartilage is then cut into thin strips. Incision is then deepened up to periosteum and periosteum is then elevated up to spine of henle. Posterior meatotomy is then done. Pinna is retracted anteriorly and mastoid retractors are applied. Margins of the perforation are freshened with a sickle knife. Tympanomeatal flap is elevated after giving 12 O'clock and 6 O'clock bony canal incisions. Annulus is reached and lifted, middle ear is entered and chorda tympani is visualized. Ossicular mobility and continuity is assessed. Round

window reflex is checked. Temporalis fascia graft is placed medial to handle of malleus by underlay technique. Strips of harvested conchal cartilage is placed over the promontory in a pallisade fashion medial to the fascia graft, supporting the anterior rim margin. The strips extend anterior to the malleus, and into the hypotympanum, making sure that the Eustachian tube opening is not closed. The strips of cartilage are placed in such a way that they don't impede ossicular mobility. Gelfoam is placed in the middle ear, medial to the cartilage strips. Margins of the perforation are well tucked. Tympanomeatal flap is then repositioned. Gelfoam is placed in the canal. Postaural incision is then closed and a tight compression mastoid bandage is given. Post operatively antibiotic cover was given for 1 week and antibiotic ear drops for 3 weeks.

## Observations and Results

### Graft Up Take

The graft up take was assessed 8 weeks following the surgery, in Group 1, out of the total of 30 patients, the graft had taken up in 21 patients, while in 9 patients the graft did not take up as compared to Group 2, among the total of 30 patients, the graft had taken up in 28 patients while in 2 patients the graft did not take up (Table 1).

Graft uptake was assessed 8 weeks post operatively and statistically analysed using the Chi-square test (Table 2).

From the above analysis, graft up take in type 1 tympanoplasty with conchal cartilage graft was found to be statistically significant (Figs. 1, 2).

### Improvement in Hearing

In the present study, the total number of patients were 60 (sample size) of which 30 patients underwent type 1 tympanoplasty without conchal cartilage graft (Group 1) and 30 patients underwent type 1 tympanoplasty with conchal cartilage graft (Group 2).

Among the 30 in Group 1, the average pre operative hearing loss was 38 dB and the average post operative hearing loss was 31 dB. The average improvement in

**Table 2** Showing statistical analysis of graft up take

	Value	Degree of freedom	Significance (2-tailed)
Pearson Chi-square	5.455	1	0.020 <sup>a</sup>

<sup>a</sup>Statistically significant difference

hearing following type 1 tympanoplasty without conchal cartilage graft was 7 dB.

Among the 30 in Group 2, the average pre operative hearing loss was 32 dB and the average post operative hearing loss was 17 dB. The average improvement in hearing following type 1 tympanoplasty with conchal cartilage graft was 15 dB (Fig. 3; Table 3).

### Statistical Analysis

Paired t test was used. From the above analysis, the improvement in pre and post operative hearing was found to be statistically significant in both the study groups (Fig. 4; Table 4).

## Discussion

In the present study out of sixty patients 57% were females and majority of patients (42%) were young adults in the age group of 21–30 years. This may be due to the fact that they are more conscious about the ear discharge and hearing and are also worried about their future job prospects. Major conclusions with respect to sex and age distribution was difficult to arrive at, as the sample size was small.

Various graft materials have been used for tympanic reconstruction in type-I tympanoplasty which include temporalis fascia, periostia, perichondrial, cartilage, vein and fat [4]. With success of graft uptake and improvement in hearing, the temporalis fascia is the most frequently used graft material with closure rate reported up to 90% for primary tympanoplasties [10, 11].

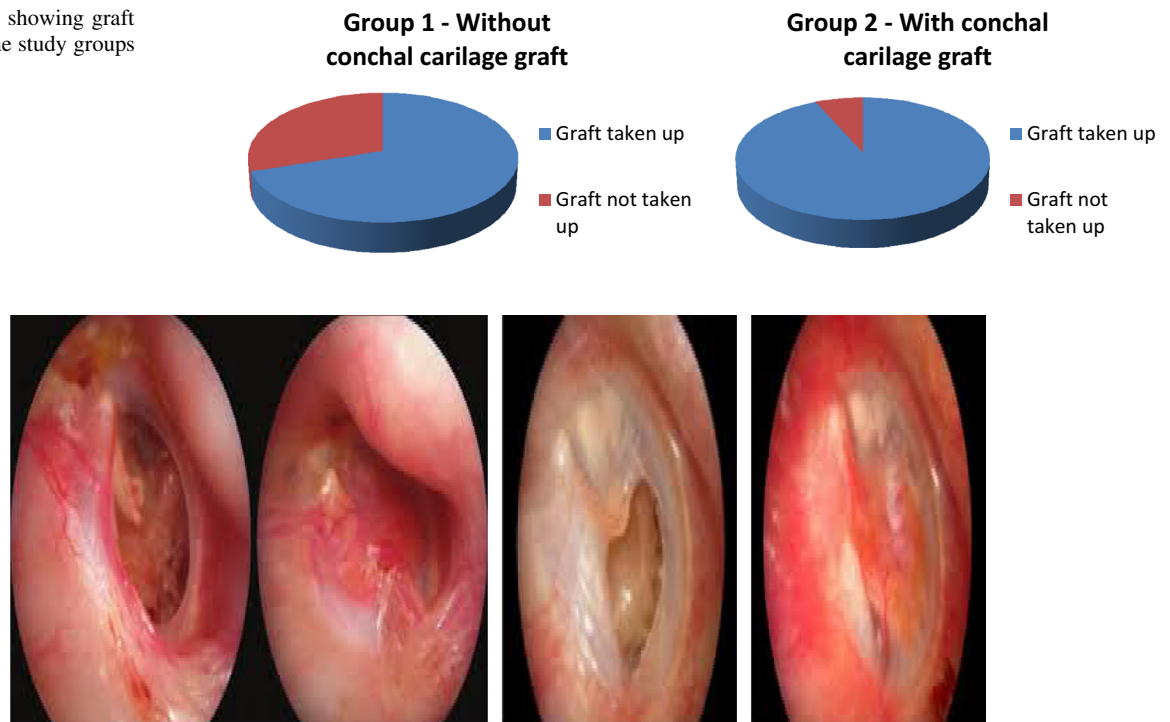
The failure of perforation closure, has been attributed to subtotal perforations, poor adaptations of the graft which

**Table 1** Showing graft up take in both the study groups

Type 1 tympanoplasty	Graft taken up n (%)	Graft not taken up n (%)	Total
Without conchal cartilage graft (Group 1)	21 (70)	9 (30)	30
With conchal cartilage graft (Group 2)	28 (93.33)	2 (6.66)	30

n Is the number of patients

Percentage is shown in brackets

**Fig. 1** Pie charts showing graft up take in both the study groups**Fig. 2** Showing pre op and post op tympanic membrane findings in patients who underwent type 1 tympanoplasty with conchal cartilage graft (Group 2). The graft has taken up well

may sink medially, shift posteriorly or shrink. Other disadvantages of using temporalis fascia for type-I tympanoplasty is that it provides only a stent effect for healing of perforation and does not get incorporated into the thickness of the tympanic membrane. Thus the newly formed tympanic membrane lacks the intermediate layer of elastic fibres, which serves to resist the negative pressure of the tympanum [11]. Therefore repaired tympanic membranes often re-perforate, particularly when the initial perforation is large and the auditory tube is dysfunctional [12]. Furthermore, the blood supply to the central part of the tympanic membrane is usually so poor that re-perforation occurs easily [11]. Temporalis fascia has its own advantages like a common incision, large amount of graft material is available and its basal metabolic rate is low, its thickness is similar to the normal tympanic membrane and embryologically it develops from mesoderm which is same as the normal tympanic membrane [4, 13, 14]. Temporalis fascia can suffer atrophy and vascularization causing posterior shrinkage or sinking in the middle ear, ultimately causing failure of closure of the perforation in such cases [6, 15].

The tympanic membrane reconstruction done with cartilage has been reported very successful [16–18]. Cartilage can also be used in the form of parallel, full thickness strips (palisade technique) or in different sizes and shapes; in the

latter case grafting can be modified using composite cartilage perichondrial grafts [16].

The cartilage palisade technique was first introduced by Heermann in 1962 [13, 19, 20].

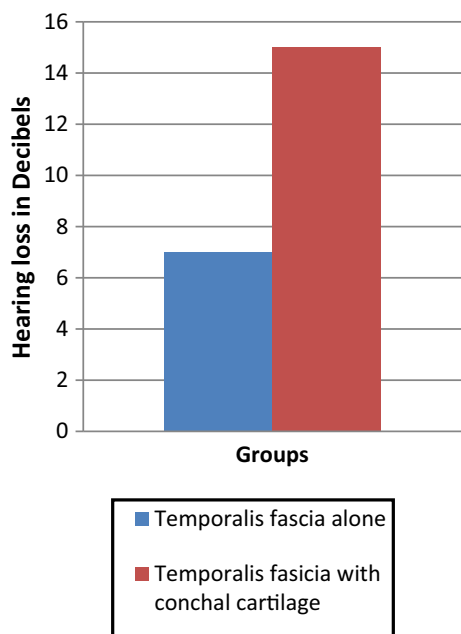
Cartilage is well tolerated by middle ear. As cartilage grafts are nourished largely by diffusion and not by neovascularisation, excellent long term survival has been reported. It maintains its rigidity and resists resorption and retraction [21–23].

The cartilage is a satisfactory grafting material, as it is easily accessible, easy to adapt, stable, elastic, well tolerated by the middle ear, resistant to negative middle ear pressures and resistant to resorption. Theoretically due to its characteristic rigidity and thickness, use of cartilage as a graft, in tympanoplasties is fraught with poor audiological gain, but various studies have reported good audiological results [24–29].

In the present study we have utilized cartilage along with temporalis fascia and compared the result with the use of temporalis fascia alone in type-I tympanoplasty and the results are similar to other studies advocating the use of cartilage.

Following are the success rates of the studies using different graft materials and techniques in tympanoplasty.

1. Ozbek et al. [24] used palisade cartilage technique. Success rate was 100%.



**Fig. 3** Bar diagram showing the average improvement in hearing loss in decibels following surgery in both the groups

**Table 3** Showing average hearing assessment in both the study groups

Study groups (type-1 tympanoplasty)	Pre op hearing in dB	Post op hearing in dB
Group 1 (with temporalis fascia alone)	38	31
Group 2 (temporalis fascia with conchal cartilage graft)	32	17

2. Kazikdas et al. [25] used palisade cartilage, having a success rate of 95.7% and temporalis fascia with a 75% success rate.

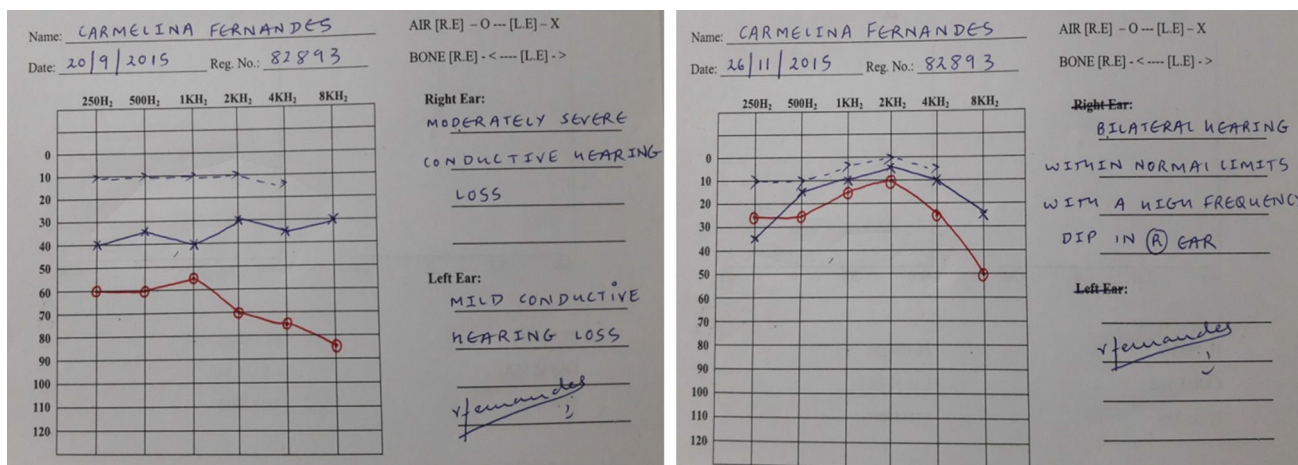
3. Yu et al. [26] used cartilage, with a success rate of 92.4% and temporalis fascia with 80% success rate.
4. Uslu et al. [27] used temporalis fascia reinforced with cartilage and had a success rate of 78.3%.
5. Lacovou et al. [28] used cartilage with a success rate of 92.4% and temporalis fascia with a 84.3% success rate.
6. Khan and Parab [29] used sliced tragal cartilage. Success rate was 98.20%.

The reported success of perforation closure ranges from 78.3 to 100%.

The successful closure of perforation in the present study was 93.33% when cartilage was used along with temporalis fascia as compared to 81.66% with temporalis fascia alone, at 8 weeks post operatively. There was a significant improvement in hearing as suggested by the statistical tests.

A good amount of air–bone–gap closure was seen in all 3 speech frequencies i.e. 500, 1 K, 2 K Hz. The exact reason behind this observation is not understood, but the explanation may be as follows; perichondrium and cartilage share with temporalis fascia, the quality of being mesenchymal tissue, however they are thicker and stiffer. The vibratory pattern of the tympanic membrane is mechanically reduced, contributing to some impairment in the functional results, especially in the higher tones. The tympanic membrane is attached from all over at the annulus and the handle of malleus. Posteriorly there is the ossicular chain and anteriorly there is the eustachian tube opening. In our technique, we are placing the cartilage, supporting the anterior most portion of the tympanic membrane, away from the Eustachian tube opening, so that it does not hamper aeration of the middle ear.

Cartilage has lower compliance than temporalis fascia, so sudden pressure variations may not be well regulated



**Fig. 4** Showing hearing improvement in pre and post operative pure tone audiograms in a patient who underwent right type 1 tympanoplasty with temporalis fascia and conchal cartilage graft

**Table 4** Showing statistical analysis of improvement in pre op and post op hearing loss in both the study groups

Type I tympanoplasty	Sample size (n)	Mean (hearing improvement in dB)	SD	SE mean	95% confidence interval of the difference		Significant <i>P</i> value (2-tailed)
					Lower	upper	
Temporalis fascia alone	30	7.07	6.878	1.256	2.503	11.897	0.003 <sup>a</sup>
Temporalis fascia with conchal cartilage	30	14.27	10.799	1.972	2.521	11.879	0.003 <sup>a</sup>

n—Number of patients

<sup>a</sup>Statistically significant difference

with a more rigid tympanic membrane [4]. The rigidity of the cartilage graft has benefits in reducing retractions of the tympanic membrane; however it is unclear if the rigidity and mass reduces the sound conduction properties of the graft.

The use of cartilage in middle ear surgery is not a new concept [30]. Advantages of the cartilage graft include its very low metabolic rate and its ability to receive nutrients by diffusion. It is also very easy to work with, because it is pliable, resists deformation from pressure variations and incorporates well into the tympanic membrane [31, 32]. Human and animal studies have found that although softening occurs over time, the cartilage matrix remains intact but with empty lacunae showing chondrocyte degeneration [31–34].

Zahnert et al. reported that a tympanic membrane with a large perforation, repaired using a thick cartilage fragment had poor conduction in response to low frequency sounds; this could be improved by reducing cartilage thickness [35, 36].

They also showed that compared with normal tympanic membrane, 0.5 mm thick cartilage maintained mechanical stability and reduced sound energy loss during sound transmission. Hence we prefer to slice conchal cartilage to 0.5 mm thickness.

## Conclusions

The use of strips of conchal cartilage in type-I tympanoplasty results in better closure of perforation and hearing improvement, when used along with temporalis fascia graft than the use of temporalis fascia alone.

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