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Original Research Article

A Prospective Comparative Study of Cartilage Versus Temporalis Fascia Graft in Endoscopic Type-I Tympanoplasty: Anatomical and Audiological Outcomes

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Conflict of interest: Nil

Abstract

Background: Cartilage and temporalis fascia are commonly used grafts in Type-I tympanoplasty, but their relative anatomical and audiological performance in endoscopic surgery remains uncertain.

Methods: This prospective, non-randomized comparative study included 143 patients undergoing endoscopic Type-I tympanoplasty: 75 received cartilage and 68 temporalis fascia grafts. The primary anatomical outcome was 6-month graft uptake, and the primary audiological outcome was change in air–bone gap (ABG). Pure-tone average (PTA), postoperative complications, and adjusted audiological outcomes were also analysed.

Results: Six-month graft uptake was 87.1% with cartilage and 84.1% with temporalis fascia (p=0.620). Both groups showed significant improvement in PTA and ABG. Mean ABG closure was greater with cartilage (13.2 vs 10.3 dB; p<0.001), and cartilage remained associated with a lower postoperative ABG after adjustment (adjusted difference -2.52 dB, 95% CI -3.95 to -1.10). Tympanic membrane retraction occurred less often with cartilage (0% vs 6.3%, p=0.048).

Conclusion: Both grafts achieved satisfactory anatomical outcomes, while cartilage provided greater audiological improvement and less postoperative retraction.

Keywords: Endoscopic Tympanoplasty; Cartilage Graft; Temporalis Fascia; Air–Bone Gap; Graft Uptake.

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Introduction

Chronic middle-ear disease often leads to perforation of the tympanic membrane, which can lead to recurrent otorrhoea and conductive hearing loss. The goal of type-I tympanoplasty is to restore the integrity of the tympanic membrane and to enhance sound conduction in patients with an intact or functionally intact ossicular chain. Various autogenous materials have been employed for reconstruction, including temporalis fascia and cartilage, which are among the most accepted grafts. [1]

Temporalis fascia has traditionally been favoured because it is readily available, easy to harvest and handle, and has acoustic properties similar to those of the native tympanic membrane. Fascia can, however, retract, reperforate, or fail to graft, especially if there are large or subtotal perforations, Eustachian tube dysfunction, or chronic negative middle-ear pressure. The increased stiffness and thickness of cartilage has raised concerns about its potential to negatively impact sound transmission, which has resulted in ongoing research to compare its functional outcomes with temporalis fascia for tympanic membrane reconstruction.[1-3]

The anatomical outcome of the two grafts has been generally shown to be favourable with cartilage.[1,4,5] There have been more recent long-term and pooled analyses that have confirmed the anatomical reliability of cartilage without showing a clinically significant hearing loss, but there remains some variability between studies due to differences in cartilage thickness, graft

configuration, perforation size, surgical technique, and duration of follow-up.[4-6]

With the growing popularity of transcanal endoscopic ear surgery, the concept of Type-I tympanoplasty has also evolved.[7,8] However, the evidence for graft success in exclusively endoscopic Type-I tympanoplasty is still relatively scarce. Different graft materials have been assessed using the endoscopic technique with good anatomical and functional outcomes,[9] but the decision to use cartilage or fascia remains highly dependent on the perforation characteristics and surgeon preference.

The present study was therefore conducted to compare the anatomical and audiological results of cartilage and temporalis fascia grafts in patients undergoing endoscopic Type-I tympanoplasty. The study focused on comparing graft uptake and change in air–bone gap between the two groups and also included a comparison of pure-tone average improvement and graft-related complications.

Materials and Methods

Study design and setting: The study was a prospective, non-randomized, comparative observational study carried out in the Department of Otorhinolaryngology, Chamarajanagar Institute of Medical Sciences, Chamarajanagar, Karnataka, from June 2025 to June 2026. Eligible patients who underwent endoscopic Type-I tympanoplasty were consecutively enrolled and treated with either a cartilage graft or temporalis fascia graft. Graft selection was not random, but rather based on clinical characteristics and the operating surgeon's judgment.

Study eligibility: Patients with chronic tympanic membrane perforation and an intact or functionally preserved ossicular chain were included in the study who underwent primary endoscopic Type-I tympanoplasty. Patients had to be clinically and audiologically evaluated preoperatively and deemed to be appropriate for reconstruction with either cartilage or temporalis fascia.

Patients were excluded if they had cholesteatoma, active extensive middle-ear disease requiring mastoid surgery, ossicular discontinuity requiring major ossiculoplasty, previous unsuccessful tympanoplasty requiring revision surgery, congenital ear abnormalities, sensorineural or mixed hearing loss likely to interfere with the audiological assessment, or inadequate follow-up for evaluation of the primary outcome.

Study participants and baseline assessment: Preoperative demographic and clinical data were recorded and included age, sex, and duration of ear disease, side operated, smoking/tobacco use, diabetes mellitus, hypertension, contralateral ear status, Eustachian tube dysfunction, and previous ear surgery. Otoscopic/endoscopic examination revealed perforation site and size, percentage of involvement of the tympanic membrane (if measurable), middle-ear mucosal status, dry/wet ear status, tympanosclerosis, retraction, and ossicular findings.

Perforations were classified as small, medium, large, or subtotal. Due to non-randomized treatment allocation, baseline characteristics were compared between the graft groups.

Audiological Assessment: Preoperatively and at follow-up (preferably at 3 and 6 months postoperatively), pure-tone audiometry was conducted. Air- and bone-conduction thresholds were obtained at 500, 1000, 2000, and 4000 Hz when available. Pure-tone average (PTA) and air–bone gap (ABG) were kept as continuous variables. PTA improvement was defined as postoperative PTA minus preoperative PTA, while ABG closure was calculated as preoperative ABG minus postoperative ABG, with a positive ABG-closure value indicating hearing improvement.

Surgical procedure and follow-up: Endoscopic Type-I tympanoplasty was performed on all patients with either cartilage or temporalis fascia. Surgical information included graft source and technique, underlay/overlay placement, status of the ossicular chain, operative duration, other ossicular procedures, and intraoperative complications if present. Postoperative evaluations were conducted at about 1, 3, and 6 months. Graft integrity, complete uptake, residual or recurrent perforation, tympanic membrane retraction, lateralization, medialization, postoperative otorrhoea/infection, granulation, and revision surgery were noted. Patients who were lost to follow-up were not considered graft failures.

Outcome Measures: The main anatomical result was successful graft uptake at about 6 months, which was defined as the presence of an intact tympanic membrane with no residual or recurrent perforation. The main audiological result was the change in ABG from baseline to 6 months. Secondary outcomes were change in PTA, residual or recurrent perforation, tympanic membrane retraction, postoperative infection, and revision surgery.

Statistical Analysis: Continuous variables were summarized as mean ± SD or median (IQR), and categorical variables as n (%). Baseline comparisons between graft groups used Welch's independent-samples t test or Mann–Whitney U test for continuous variables and Pearson chi-square or Fisher exact test for categorical variables, as appropriate.

Six-month graft success was compared between groups and reported with the absolute difference and 95% confidence interval; adjusted associations were assessed using multivariable logistic regression. Pre- and postoperative PTA and ABG were compared within groups using paired t tests, while 6-month changes were compared between groups using Welch's independent-samples t test. ANCOVA was used for 6-month postoperative ABG, adjusting for baseline ABG and perforation size. All tests were two-tailed, with $p<0.05$ considered statistically significant.

Results

Study population and baseline characteristics: A total of 143 patients underwent endoscopic Type-I tympanoplasty during the study period; 75 (52.4%) received a cartilage graft and 68 (47.6%) a temporalis fascia graft. The groups were comparable with respect to age, sex, smoking, diabetes, hypertension, ear status, and perforation site. Cartilage was used more frequently for large or subtotal perforations, and the cartilage group had a greater mean perforation size and higher preoperative air–bone gap (Table 1).

Anatomical Outcome: Six-month anatomical assessment was available in 133 (93.0%) patients. Successful graft uptake occurred in 61/70 (87.1%) in the cartilage group and 53/63 (84.1%) in the temporalis fascia group. The absolute difference was 3.0 percentage points (95% CI -9.0 to 15.5) and was not statistically significant (Figure 1; Table 2). After adjustment for perforation size and Eustachian tube dysfunction, cartilage grafting was not independently associated with graft success (aOR 2.08, 95% CI 0.69–6.29, p=0.193).

Audiological Outcome: Six-month audiometry was available in 123 (86.0%) patients. Both groups showed significant improvement in PTA and ABG from baseline to 6 months (all within-group $p<0.001$). Mean ABG closure was 13.2 dB in the cartilage group and 10.3 dB in the temporalis fascia group (between-group difference 2.9 dB, $p<0.001$). In ANCOVA, cartilage grafting was associated with a lower postoperative ABG at 6 months (adjusted difference -2.52 dB, 95% CI -3.95 to -1.10, p=<0.001) after adjustment for baseline ABG and perforation size (Table 3; Figure 2).

Postoperative Complications: Overall postoperative complication rates were similar between groups. Tympanic membrane retraction at 6 months occurred in 0/70 (0.0%) cartilage-graft patients and 4/63 (6.3%) temporalis-fascia patients (Fisher exact p=0.048). Residual and recurrent perforation, graft lateralization or medialization, and revision surgery did not differ significantly between groups (Table 4).

Table 1: Baseline characteristics according to graft type

Characteristic	Cartilage (n=75)	Temporalis fascia (n=68)	Test statistic	p value
Age, years	33.8 ± 11.1	33.5 ± 9.2	t=0.21	0.834
Disease duration, months	41.0 (25.1–57.1)	32.7 (20.6–52.3)	U=2717.0	0.252
Perforation size, %	55.3 ± 20.3	40.8 ± 18.9	t=4.43	<0.001
Preoperative PTA, dB	36.8 ± 7.2	34.5 ± 7.1	t=1.91	0.058
Preoperative ABG, dB	25.9 ± 5.1	22.3 ± 6.0	t=3.82	<0.001
Sex: Male	44 (58.7%)	39 (57.4%)	χ^2=0.03, df=1	0.874
Female	31 (41.3%)	29 (42.6%)		
Perforation size: Small	7 (9.3%)	15 (22.1%)	χ^2=25.03, df=3	<0.001
Medium	18 (24.0%)	36 (52.9%)		
Large	38 (50.7%)	12 (17.6%)		
Subtotal	12 (16.0%)	5 (7.4%)		
Perforation site: Anterior	13 (17.3%)	9 (13.2%)	χ^2=3.63, df=4	0.459
Posterior	12 (16.0%)	11 (16.2%)		
Inferior	7 (9.3%)	8 (11.8%)		
Central	31 (41.3%)	35 (51.5%)		
Subtotal	12 (16.0%)	5 (7.4%)		
Ear status: Dry	59 (78.7%)	60 (88.2%)	χ^2=2.34, df=1	0.126
Wet	16 (21.3%)	8 (11.8%)		
Smoking/tobacco use: No	64 (85.3%)	53 (77.9%)	χ^2=1.31, df=1	0.252
Yes	11 (14.7%)	15 (22.1%)		
Diabetes mellitus: No	72 (96.0%)	66 (97.1%)	Fisher exact	1.000
Yes	3 (4.0%)	2 (2.9%)		
Hypertension: No	70 (93.3%)	61 (89.7%)	χ^2=0.61, df=1	0.435
Yes	5 (6.7%)	7 (10.3%)		
Eustachian tube dysfunction: No	58 (77.3%)	58 (85.3%)	χ^2=1.48, df=1	0.224
Yes	17 (22.7%)	10 (14.7%)		

Continuous data are mean ± SD or median (IQR); categorical data are n (%). Welch's t test, Mann–Whitney U test, Pearson chi-square test, or Fisher exact test was used as appropriate.

Table 2: Anatomical graft outcomes

Time point / outcome	Cartilage	Temporalis fascia	Test statistic	p value
1 month	67/74 (90.5%)	60/67 (89.6%)	χ^2=0.04, df=1	0.845
3 months	65/73 (89.0%)	56/65 (86.2%)	χ^2=0.27, df=1	0.606
6 months	61/70 (87.1%)	53/63 (84.1%)	χ^2=0.25, df=1	0.620
Absolute difference at 6 months	3.0 percentage points	95% CI -9.0 to 15.5	—	—

Primary endpoint: successful graft uptake at approximately 6 months, defined as an intact tympanic membrane without residual or recurrent perforation. Patients lost to follow-up were not classified as graft failures.

Table 3: Audiological outcomes

Group / measure	Paired n	Preoperative	Postoperative	Mean change (95% CI)	Test statistic	p value
Cartilage – PTA	65	37.2 ± 6.9	25.9 ± 6.7	-11.3 (-12.4 to -10.2)	paired t=20.22	<0.001
Cartilage – ABG	65	26.2 ± 5.1	14.7 ± 5.8	11.5 (10.4 to 12.6)	paired t=20.45	<0.001
Temporalis fascia – PTA	61	34.3 ± 7.2	25.2 ± 8.2	-9.1 (-10.2 to -7.9)	paired t=15.82	<0.001
Temporalis fascia – ABG	61	22.4 ± 5.9	13.4 ± 6.8	9.1 (8.0 to 10.1)	paired t=16.85	<0.001
Cartilage – PTA	66	36.8 ± 7.5	23.6 ± 8.0	-13.2 (-14.2 to -12.2)	paired t=26.70	<0.001
Cartilage – ABG	66	25.8 ± 5.2	12.6 ± 5.8	13.3 (12.3 to 14.2)	paired t=27.52	<0.001
Temporalis fascia – PTA	57	34.4 ± 7.2	24.3 ± 7.4	-10.2 (-11.1 to -9.2)	paired t=20.77	<0.001
Temporalis fascia – ABG	57	22.2 ± 6.1	11.8 ± 6.0	10.3 (9.4 to 11.3)	paired t=21.37	<0.001

PTA change is postoperative minus preoperative; negative values indicate improvement. ABG closure is preoperative minus postoperative; positive values indicate improvement.

Table 4:

Primary 6-month comparison	Cartilage	Temporalis fascia	Between-group difference (95% CI)	Test statistic	p value
PTA change (postoperative – preoperative), dB	-13.2 ± 4.0	-10.2 ± 3.7	-3.1 (-4.4 to -1.7)	t=-4.39	<0.001
ABG closure (preoperative – postoperative), dB	13.2 ± 3.9	10.3 ± 3.7	2.9 (1.5 to 4.3)	t=4.25	<0.001

ANCOVA for 6-month postoperative ABG: adjusted cartilage-versus-fascia difference -2.52 dB (95% CI -3.95 to -1.10), t=-3.46, p=<0.001, adjusted for preoperative ABG and large/subtotal perforation.

Table 5. Postoperative complications

Complication	Cartilage	Temporalis fascia	Test statistic	p value
Residual perforation at 6 months	6/70 (8.6%)	5/63 (7.9%)	χ^2=0.02, df=1	0.894
Recurrent perforation at 6 months	3/70 (4.3%)	5/63 (7.9%)	Fisher exact	0.476
Tympanic membrane retraction at 6 months	0/70 (0.0%)	4/63 (6.3%)	Fisher exact	0.048
Lateralization at 6 months	2/70 (2.9%)	0/63 (0.0%)	Fisher exact	0.498
Medialization at 6 months	2/70 (2.9%)	1/63 (1.6%)	Fisher exact	1.000
Revision surgery	3/75 (4.0%)	4/68 (5.9%)	Fisher exact	0.709
Any postoperative complication	21/75 (28.0%)	26/68 (38.2%)	χ^2=1.69, df=1	0.193

Six-month anatomical complication rates are based on patients with an evaluable six-month assessment; other complications are based on the full operated cohort.

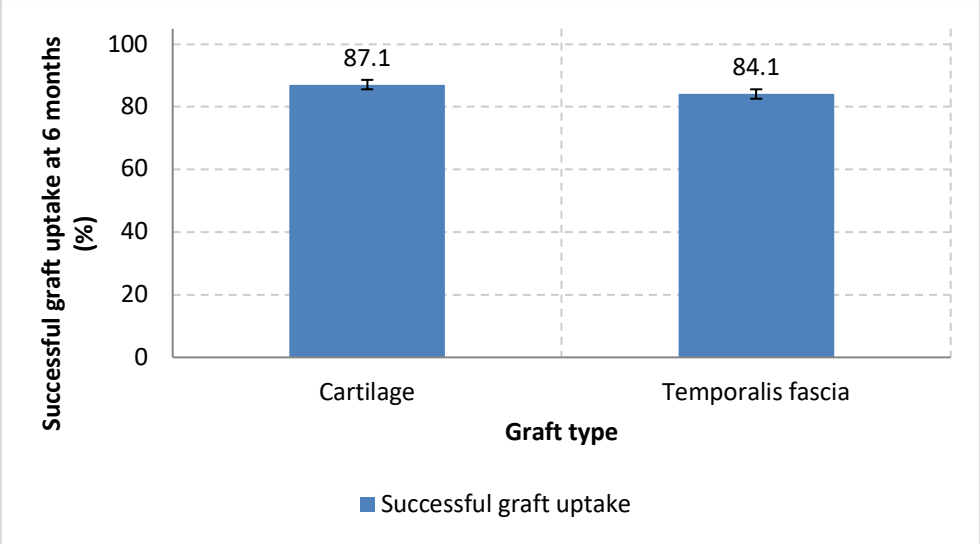

Figure 1: Successful graft uptake at approximately 6 months according to graft type.

Bars show success proportions; error bars represent Wilson 95% confidence intervals.

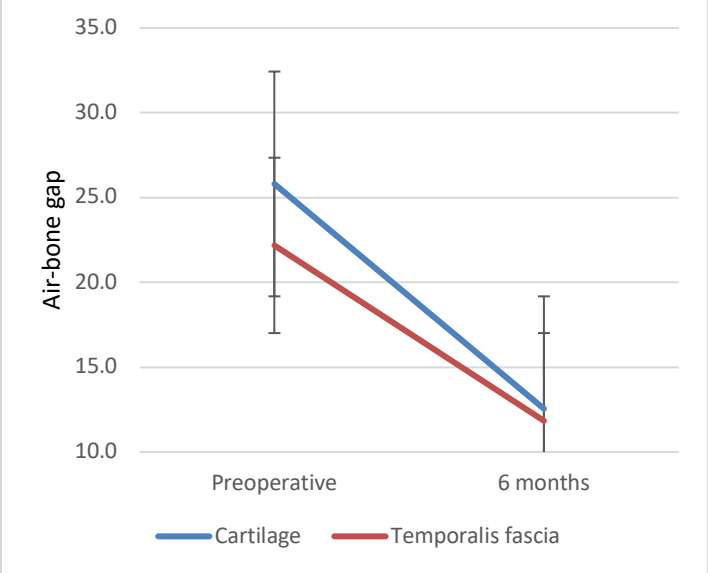

Figure 2: Change in mean air–bone gap from baseline to approximately 6 months according to graft type.

Discussion

In the present study, cartilage and temporalis fascia grafts were compared in patients undergoing endoscopic Type-I tympanoplasty. The success rate of the anatomical results was high in both groups and was not significantly different, with graft uptake rates of 87.1% for cartilage and 84.1% for temporalis fascia. Both techniques resulted in substantial audiological improvement, but cartilage was correlated with higher PTA improvement and ABG closure. This difference remained after adjusting for baseline ABG and perforation size. Of particular interest, cartilage was used more frequently in large and subtotal perforations and in ears with a higher preoperative ABG, indicating that its favourable hearing outcome was not solely due to selection of less severe cases. The incidence of tympanic membrane retraction was also lower with cartilage, and the overall complication rate was similar between the two techniques. Our findings are similar to those of Nagar et al., who performed a prospective comparison of endoscopic cartilage and temporalis fascia tympanoplasty. Their success rate for fascia was 84% and for cartilage was 92%, with hearing gain of 6.71 dB and 5.9 dB, respectively, which is very similar to our results, with a slightly lower success rate for cartilage.[10]

This may be partly due to differences in perforation characteristics, as the cartilage group in our cohort had significantly more large and subtotal perforations. This is further supported by Mohanty et al., who specifically looked at endoscopic reconstruction of anterior-quadrant perforations in 187 ears, with an overall closure rate of 91.95% for cartilage and 79.0% for temporalis fascia, and a

mean ABG improvement of 17.52 ± 3.84 dB with cartilage and 15.26 ± 5.56 dB with fascia.[11] Their population was limited to anterior perforations, but the study is of special interest because it was performed using an endoscopic technique and showed that cartilage can be effective both anatomically and functionally in technically difficult perforations. Similarly, cartilage was chosen more often for larger defects in our study, but the adjusted audiological outcomes were still good. The lack of difference in graft uptake in our cohort does not necessarily mean that the mechanical behaviour of the two materials is the same over time. Ciğer et al., in a prospective randomized comparison of a wheel-shaped composite cartilage graft with temporalis fascia, reported 6-month graft success of 97.7% with cartilage and 82.9% with fascia.[12] Although this is an advantage, there were no significant differences between the groups in terms of postoperative PTA, ABG, PTA gain, or ABG closure, indicating that some differences between cartilage and fascia may become more apparent anatomically with longer observation, but that auditory outcomes are satisfactory with either material.[12]

Longer-term evidence also favours the structural durability of cartilage.[13] This difference between mechanical stability and hearing function is important in our study, as we found that although the uptake of the graft was similar in both groups, there was significantly less tympanic membrane retraction in the cartilage group, which is reflected in the long-term results.

The decreased retraction seen in our study is clinically reasonable, as cartilage is more resistant to deformation under sustained negative middle-ear pressure. No cartilage-grafted patient had developed tympanic membrane retraction at 6 months, whereas 6.3% of patients receiving temporalis fascia had developed it.

While this is a small number of events and should be taken with a grain of salt, it does lend some credence to the practical reasoning behind using cartilage in larger perforations or ears that are deemed to be at higher risk for retraction. Although patient selection and surgical technique differ, the findings of Dinç et al. support the notion that cartilage may provide an anatomical benefit, such as increased graft durability. They reported graft success of 93.8% with cartilage island grafts compared with 80.2% with temporalis fascia.[14]

The long-term study by Shakya and Nepal provides further insight into this issue. At 5 years, the success rate was 87.17% in the cartilage group and 66.6% in the fascia group, with the difference between the two groups being statistically significant.[15] Importantly, there was no significant difference between the groups in hearing improvement, and these data indicate that a relatively small early difference in graft uptake may underestimate the longer-term benefit of a mechanically stronger graft compared to our 6-month results.

Our audiological results are of special interest. The mean ABG closure at 6 months was 13.2 dB for cartilage and 10.3 dB for temporalis fascia, with a difference between the groups of 2.9 dB. Cartilage was associated with a 2.52-dB lower postoperative ABG after adjustment for baseline ABG and large/subtotal perforation.

This is significant as cartilage was used preferentially in patients with larger perforations and a significantly higher baseline ABG. The adjusted analysis is more likely to show that the difference observed was not fully accounted for by the baseline audiological or perforation-size imbalance, as opposed to interpreting the unadjusted change alone.

Endoscopic randomized data supports the potential for good hearing results with cartilage. Hu et al. reported anatomical success rates of 95.24% for cartilage and 92.86% for fascia, with no significant difference between the groups.[16] Hearing improvement was greater in the cartilage group.[16] This is similar to our study, where the difference between the two was small but the improvement in the audiological parameters was in favour of cartilage.

The study has several strengths: prospective design, predetermined anatomical and audiological outcomes, and continuous PTA and ABG measures. Baseline ABG and perforation size were adjusted for because they were not randomized and cartilage was used more frequently in larger perforations. Postoperative complications were also assessed separately and showed a reduced risk of tympanic membrane retraction with cartilage.

The main limitations are the single-centre design, the lack of randomisation, the potential for residual confounding, the incomplete follow-up at 6 months in some patients, and the relatively short follow-up for late graft failure or retraction.

The audiological benefit of cartilage was also small and should be considered in the context of baseline disease characteristics and clinical relevance, and longer-term studies are suggested to further clarify differences in graft durability.[15]

Conclusion

Cartilage and temporalis fascia were both effective graft materials for endoscopic Type-I tympanoplasty. Cartilage showed comparable graft uptake, greater audiological improvement, and less

tympanic membrane retraction, supporting its use particularly in larger or higher-risk perforations.

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