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Comparison between cartilage and fascia grafts in type 1 tympanoplasty

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Abstract. *Comparison between cartilage and fascia grafts in type 1 tympanoplasty*. *Objectives*: We retrospectively analysed long-term hearing results and graft take rates in our cases with both temporalis muscle fascia and the cartilage island technique.
Methodology: Between September 2000 and October 2011, a total of 489 patients underwent cartilage tympanoplasty, while 318 patients had tympanoplasty using fascia. In this study we included patients with a follow-up period of at least 3 years. Exclusion criteria were ossicular chain defects, cholesteatoma, otorrhoea, middle ear granulation or effusion, and a history of middle ear surgery.
Results: The cartilage group consisted of 49 patients, with 28 patients being included in the fascia group. Both air conduction hearing thresholds and air bone gaps improved significantly in both groups. However, no statistical significance was found between the results for the two groups ($p>0.05$).
Conclusion: Our study concurs with many others in the literature, clearly indicating that cartilage produces hearing results that are comparable to temporalis muscle fascia grafts.

Introduction

The goal of tympanoplasty is to reconstruct the tympanic membrane and the sound-conducting mechanism in a long-lasting way. Tympanoplasty is now a common procedure for otolaryngologists[1] and many grafting materials have been proposed since its introduction in 1950 by Zoellner and Wullstein.[2,3] The most commonly used graft is temporalis muscle fascia. Its superior qualities, ready availability in the operative field and ideal handling properties have made it the standard for tympanic membrane grafting since its introduction in 1960.[4] Although Goodhill used tragal perichondrium and cartilage for grafting in 1967 with results resembling those for fascia,[5] this material was not widely used until recently. The need for more rigid grafting materials has encouraged the use of cartilage grafts. This may help to overcome complications seen in patients treated with fascia. On the other hand, the more rigid structure of cartilage has raised some concerns about possible hearing loss.

In this study we compared the long-term hearing results in patients treated with cartilage island technique or fascia tympanoplasty, as well as the failure rates of these procedures.

Materials and methods

The research protocol was approved by the Inonu University Clinical Research Ethics Committee (2011/69). Eight hundred and seventy-six patients who underwent tympanoplasties and/or mastoidectomies conducted by the same surgeon (MTK) between September 2000 and October 2011 at the department of Otolaryngology, Inonu University, Turkey, were analysed during this retrospective study. Patients with ossicular chain defects, cholesteatoma, otorrhoea, middle ear granulation or effusion, and a history of middle ear surgery were

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excluded from the study. In addition, cases with a follow-up period of less than 3 years were not included in the study.

A total of 819 patients who underwent tympanoplasty with or without mastoidectomy were included in the study. Four hundred and eighty-nine of them underwent tympanoplasties with the cartilage island technique using a chondroperichondrial graft taken from the tragus while 318 underwent tympanoplasties using temporalis muscle fascia. All of the patients in the fascia group had central tympanic membrane perforation and no retraction. The cartilage island technique was preferred for patients with total perforation and bilateral perforations because of possible Eustachian tube dysfunction, and in patients with tympanic membrane retraction.

The middle ear was usually exposed in a retroauricular approach. The endaural approach was rarely used. In the fascia group, the graft was taken from the temporalis muscle fascia and remaining muscle fibres were removed by dissection. If cartilage was used, the graft was taken from the tragus. A skin incision was made on the medial side of tragus and a few millimetres of tragal cartilage were left untouched for cosmetic reasons.

Perichondrium over the convex surface of the graft was removed by dissection as a flap. It was kept on the lateral side of the graft. The perichondrium flap was placed under the tympanomeatal flap to stabilise the graft. To prevent contact between the cartilage and the manubrium mallei, a small strip of cartilage with no perichondrium was removed from the cartilage island. The size of the strip matched the size of the tympanic membrane perforation. The grafting procedure in both techniques was performed in an over-underlay fashion (over the malleus, under the annulus) in both groups. A few gel-foam pieces (Pharmacia & Up-john Inc., Kalamazoo, MI, USA) were used in the middle ear cavity to support the graft medially. Additionally, a few gel-foam pieces were put on the graft and the remnant. Finally, the external auditory canal was filled with Chloramphenicol ophthalmic pomade (Carlo-Erba, Turkey) at the end of the operation.

To measure the effect of tympanoplasty preoperatively and postoperatively, pure-tone audiometry was used, assessing hearing differences at 250, 500, 1000, 2000 and 4000 Hz.

Student's t-test was used for statistical analysis. A p-value of <0.05 was considered statistically significant.

Results

One hundred and thirty-three patients in the cartilage group and 55 in the fascia group, without ossicular chain defects, cholesteatoma, otorrhoea, middle ear granulation or effusion, or a history of middle ear surgery, who underwent tympanoplasty type 1 were routinely followed up postoperatively. The study design focused on a longer follow-up period, and so 49 patients in the cartilage group and 28 in the temporalis muscle fascia group were included in the study. The median ages of the cartilage and fascia groups were 27 (range 13-56) and 26 (range 13-54) respectively. The mean follow-up periods for the groups were 71 months (range 36-92) and 78 months (range 36-99) respectively. In the cartilage group, 25 of the 49 patients were female and 24 were male. In the fascia group, 13 of 28 were female and 15 were male.

Pre-operative air conduction hearing levels were 47, 43, 31, 35, and 36 dB for the cartilage group and 53, 45, 36, 33, and 36 dB for the fascia group at 250, 500, 1000, 2000, and 4000 Hz frequencies respectively. Postoperative levels were 25, 24, 21, 21, and 29 dB and 27, 24, 21, 21, and 25 dB for the cartilage and fascia groups respectively. The average hearing improvements in air conduction after tympanoplasty were 22, 19, 10, 14, and 7 dB for the cartilage and 26, 21, 15, 12, and 11 dB for the fascia group at 250, 500, 1000, 2000 and 4000 Hz respectively (Figures 1 and 2).

The air-bone gaps were 33, 30, 25, 20, and 25 dB (median 27 dB) pre-operatively and 15, 14, 14, 12, and 20 dB (median 15 dB) postoperatively in the cartilage group and 39, 31, 25, 21, and 26 dB (median 28 dB) preoperatively and 16, 15, 15, 14, and 16 dB (median 15 dB) postoperatively in the fascia group at 250, 500, 1000, 2000 and 4000 Hz. Closures of air-bone gaps were 18, 16, 11, 8, and 5 dB and 23, 16, 10, 7, and 10 dB for the cartilage and fascia groups respectively.

When comparing pre-operative and postoperative air conduction hearing thresholds and air-bone gaps, significant improvement ($p = 0.0001$) was found for both groups. When we compared hearing improvement levels in the two groups, no statistical significance was found ($p>0.05$).

The failure rates were 6% and 7% in the cartilage and fascia groups respectively. In the cartilage group, 1 perforation and 2 retractions were found postoperatively. Using the classification of retraction

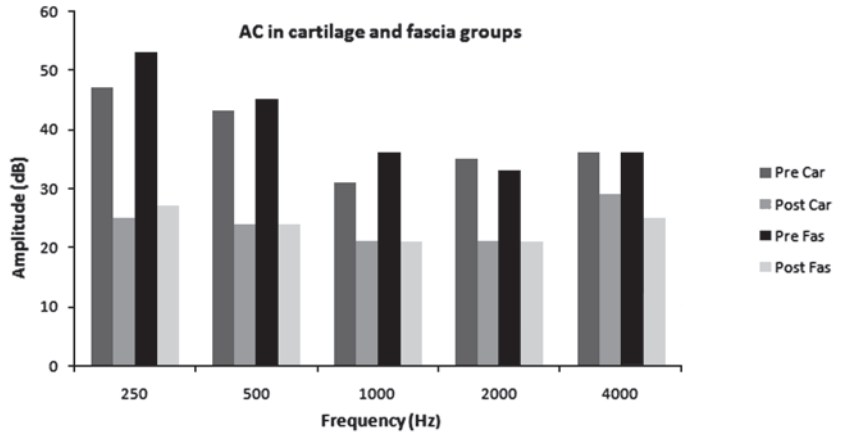

Figure 1
Air conduction hearing levels for cartilage and fascia

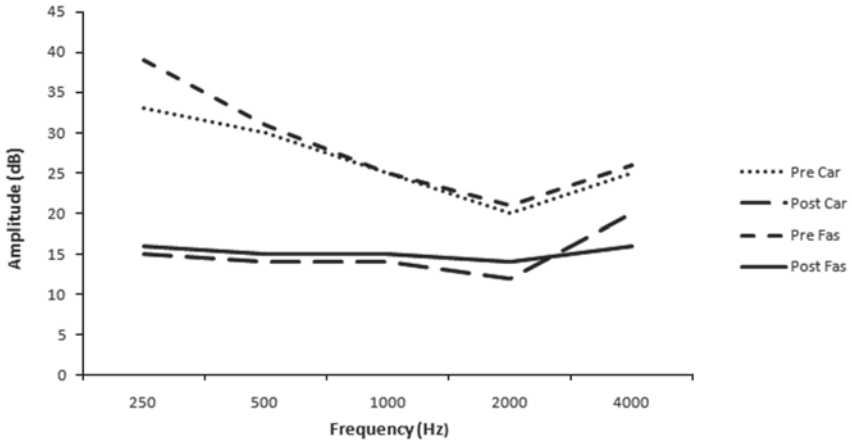

Figure 2
Air-bone gaps or fascia and cartilage group before and after surgery

pockets by Sade *et al*.,[5] the latter were classified as a type-2 atelectasis and a type-A retraction pocket. In the fascia group, 1 perforation and 1 type-2 atelectasis were found after surgery. No surgery had been performed for these complications at the time of writing. These patients are, however, still under follow-up.

Discussion

This study looked at the long-term results for type-one tympanoplasty, comparing the cartilage island technique and the temporalis muscle fascia technique. We published our results in a previous paper after a six-month follow-up period of the same patients. The results at that point showed clearly that cartilage and fascia can both be used for type-one tympanoplasty. However, no statistically significant difference was found when comparing cartilage and fascia.[6] The present study was initiated with the aim of making a longer-term comparison of the two grafting materials.

Both clinical and experimental studies have now demonstrated that cartilage can be used successfully for tympanoplasty. Given the difference between the textures of fascia and cartilage, one could anticipate some problems with both. As we know, temporal muscle fascia is composed of irregularly arranged elastic fibres and fibrous connective tissue. The postoperative dimensions of temporal muscle fascia are therefore unpredictable. Cartilage, on the other hand, has a constant shape,

is firmer than fascia and it does not contain fibrous tissue so that postoperative dimensions are predictable.[7] Re-absorption, inflammatory reactions or rejection are rare.[8] Furthermore, cartilage is also nourished by diffusion and it is incorporated well in the tympanic membrane.[7] In addition, it is very easy to work with because it is pliable and resists deformation resulting from pressure variations. As a result of these advantages, otologists have recently come to prefer cartilage grafts. However, problems with conducting vibrations are a possibility.

Given these differences, cartilage is more appropriate for more severe cases like retractions or total tympanic membrane perforations, with fascia grafts being used for more straightforward cases such as central perforations. In cases such as total perforations, severe retraction pockets, atelectasis or revision surgery, the prognosis for the healing of the tympanic membrane is much poorer, irrespective of the surgical technique. However, fascia can atrophy, resulting in failure in these cases.[9] Owing to the increased stability of cartilage and its resistance to negative middle ear pressure, even in cases where there is chronic Eustachian tube dysfunction, cartilage is the preferred grafting material in these cases.[10] On the other hand, surgeons should be aware that cartilage does not remedy the cause of retraction. Retraction and perforation may therefore still occur in other parts of the tympanic membrane that are not supported by cartilage.[11]

The stiffness and thickness of cartilage improve long-term integrity. However, tragal cartilage is approximately 1 mm thick, while a normal tympanic membrane is 0.1 mm thick.[12] So doubts have been raised about its conduction properties, and Gerber has suggested it may impair hearing.[13] Both Zahnert *et al*.[14] and Murbe *et al*.[15] suggested that a slight acoustic benefit can be achieved by thinning the cartilage to 0.5 mm. However, Atef *et al*.[16] concluded that thinning the cartilage made the procedure more difficult technically without a significant improvement in hearing. There is no support in the literature for the idea that cartilage has a negative effect on hearing. Recent studies have shown that there is no statistically significant difference between temporal fascia and cartilage tympanoplasties in terms of postoperative hearing. The same conclusion emerged from our previous short-term study and from the longer-term study discussed here.[6,7,17-19]

In our study the graft take rate for cartilage was 94%, which is comparable with other literature studies.[20] In the fascia group, the success rate was 93%. Literature reports a comparable survival rate of 78-92%.[6] We were not able to find any significant difference between the graft take rates for the two grafting materials.

Although many studies have compared fascia and cartilage, those results may have been affected by the frequent presence of differences in the indications used for fascia or cartilage grafts. In many studies, including ours, cartilage was preferred for the more severe cases, e.g. total perforations or retractions, and this could result in a misinterpretation of the results.[21] This emphasises the need for randomised controlled trials (RCTs). However, at the moment, the number of RCTs is limited. An RCT by Cabra *et al*.[8] found no statistically significant difference between the hearing results obtained with cartilage and fascia grafts. Another RCT by Yung *et al*.[22] also found significant differences in postoperative hearing results or graft take rates. A third RCT by Mauri *et al*.[23] analysed the results for perforations that were less than 50% of the size of the tympanic membrane. No significant differences in hearing results or graft take were found. Although there are a few studies suggesting that cartilage is preferable to fascia,[24] no statistically significant differences between the two have been found in a RCT. Even a meta-analysis by Yung *et al*.[22] failed to find any significant difference. The evidence therefore indicates that cartilage is comparable with fascia in terms of postoperative hearing results and graft take rates. Further studies would be needed to determine whether cartilage is superior in some settings.

At present, most of the evidence suggests that cartilage is a good grafting material, and that it is in fact a stable graft that is resistant to negative middle ear pressure but sufficiently elastic for good sound conduction. Furthermore, it is easily accessible, well tolerated, resistant to resorption and it does not involve additional costs. The only potential drawback of this graft material is the graft opacity, which limits the use of otoscopy so that high resolution computed tomography of the petrous bone must be performed for postoperative follow-up and the detection of any residual or recurrent cholesteatoma.[25]

Conclusion

Cartilage is a possible graft material for tympanoplasty, especially in advanced disorders of the

middle ear such as retractions and total tympanic membrane perforations. Even in these cases, our study concurs with the literature in finding a high graft take rate. Cartilage is therefore suitable for cases with total perforations, atelectasis with or without cholesteatoma or recurrent perforations. More and more studies are now finding similar, or even better, hearing results for cartilage by comparison with temporalis muscle fascia grafts. Furthermore, complications are minimal when this graft material is used. It is best to reserve fascia for the more straightforward cases like central perforations or cases without retraction. Similar results can be expected with both techniques when patients receive the best treatment for their individual problems.

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