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OTOLOGY

Cartilage graft or fascia in tympanoplasty in patients with low middle ear risk index (anatomical and audological results)

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Abstract The aim of this study was to compare anatomic and audiological results of cartilage graft with temporal fascia graft in type 1 tympanoplasty patients with low middle ear risk index (MERI). In this retrospective study, 63 patients that underwent type 1 tympanoplasty with chondroperichondrial island graft between July 2009 and November 2010 were compared with 45 patients in whom temporal muscle fascia was used. Patients in both groups had low MERI values varying between 1 and 3. Five and nine patients underwent masteidectomy in cartilage and fascia group, respectively. Mean duration of follow-up was 11.9 ± 3.7 (5–17) months. Mean value was calculated at pre-operative and post-operative hearing threshold 0.5, 1, 2, 4 kHz, and air bone gap (ABG) gain was compared in both cartilage and fascia groups. when pre-operative and post-operative ABG gain were compared, significant decrease was seen in ABG levels ($p < 0.001$). However, no significant difference was seen in ABG gain values ($p = 0.608$), which was 10.1 ± 7.00 dB in cartilage group and 10.8 ± 5.38 dB in fascia group. In both groups, age, sex, and the addition of mastoidectomy procedure had no significant effect on ABG gain and success. Cartilage is a graft material that may be preferred without concern about the effects on hearing results, especially, in patients with low MERI values. The addition of mastoidectomy had no impact on the outcome of operation and audiological results. However, further studies with larger case series may be carried out to further clarify the issue.

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Introduction

Tympanoplasty is a surgical procedure aiming to reconstruct the tympanic membrane and also hearing. Ever since it was first described by Zollner [23] and Wullstein [20] in 1952, various kinds of graft materials and techniques have been employed. At present, the most frequently used technique is temporal muscle fascia graft with underlay approach. Recently, cartilage has started to replace fascia in the reconstruction of the tympanic membrane. In the literature, success rates varying between 82 and 100 % have been reported for cartilage tympanoplasty operations [3, 6]. Variation in rates depends on the size of the perforation and the severity of middle ear pathology (chronic tubal dysfunction, atelectatic tympane membrane, and scutum defect); it was shown that fascia leads to shape changes and retraction in the fibrous connective tissue containing elastic fibrils with irregular arrangement [12, 13]. These histological characteristics lead to weak stability in fascia.

Since cartilage graft was first used in 1963 by Salen and Jansen [15], many techniques have been developed. Cartilage is resistant to retraction and infection, and preserves its viability and shape for a long period. In clinical and experimental studies, it was reported that cartilage is well tolerated by middle ear and has high chance of long-term survival [11, 21]. However, the fact that it impairs vibration pattern of tympanic membrane led to the concern about its functional results. Comparative audological studies found no significant difference between fascia and cartilage [9]. However, cartilage graft is mostly preferred in patients with high middle ear risk index (MERI).

The aim of the present study was to compare audiological and morphological results of cartilage and fascia tympanoplasty in patients with low middle ear risk who have similar middle ear pathologies and pre-operative hearing threshold.

Materials and methods

108 patients that underwent type 1 tympanoplasty between July 2009 and November 2010 were investigated retrospectively in the present study. Sixty-three patients that underwent type 1 cartilage tympanoplasty using chondropericondrial island graft were compared with 45 patients in whom temporal muscle fascia was used. Mean follow-up of all cases was 11.9 ± 3.7 months (min 5–max 17 months).

Middle ear pathologies of the patients were evaluated using MERI [16]. Using this scoring system developed by Kartush [16], middle ear pathologies of the patients participating in the study were standardized. Patients with low risk index score of 1–3 were included in the study. Perforations in these patients consist of those covering larger than 50 % of tympanic membrane surface area, central, marginal, and pars tensa subtotal perforations. Patients with ossicular chain defect, pathological middle ear mucosa, cholesteatoma, tympanosclerosis, atelectasia, and otorrhea were not included in the study.

Five patients in cartilage group and 9 patients in fascia group underwent mastoidectomy. Mastoidectomy was carried out in patients with the appearance of soft tissue in temporal CT in mastoid cavity and antrum. Operation procedure was standardized for both groups. Under general anesthesia, over-underlay technique was used with postauricular approach. In all patients undergoing cartilage tympanoplasty, tragal cartilage was used. Chondropericondrial island graft was placed using over-underlay technique described by Kartush et al. [16].

In the fascia group, temporal muscle fascia was taken as graft, then it was dried, shaped, and placed with the same technique. Patients were invited for controls at post-operative first and second weeks and first month. In the second post-operative week, the external ear canal was cleaned. Then, the patients were followed on monthly periods.

The criteria for anatomic success of operation on the operated side was accepted as intact graft and dry ear.

In follow-up, residual perforation occurred in 3 of 63 patients undergoing cartilage tympanoplasty and in 9 of 45 patients in fascia group, and these patients were excluded from audiological evaluation. Hearing threshold of the patients was measured with tonal audiometry. Pre-operative and post-operative hearing threshold were calculated at 0.5, 1, 2, 4 kHz, and then air bone gap (ABG) gain was calculated.

Analysis of the data was done using SPSS for Windows 11.5 program. Descriptive statistics were expressed as mean ± standard deviation for continuos variables, and as the number of cases and % for nominal variables. The significance of the difference between mean values of groups was evaluated by Students' t test. Nominal variables were investigated by Pearson's Chi-square and Fisher's exact Chi-square test. Whether there was significant change between pre- and post-op ABG levels within groups was evaluated by dependent t test. Odds ratio and 95 % CI of all factors that can influence success were calculated. p value < 0.05 was considered statistically significant in all results.

Results

Sixty-three patients (40 F, 23 M, mean age 38.6 ± 13.3 (12–62)) who underwent type 1 cartilage tympanoplasty using chondropericondrial island graft were compared with 45 patients [16 M, 29 F, mean age 39.8 ± 14.6 (16–65)] in whom temporal muscle fascia was used. Mean duration of follow-up was 11.9 ± 3.7 months (min 5–max 17 months). No significant difference was present between groups with regard to demographic chararacteristics ($p > 0.05$) (Table 1).

In both cartilage and fascia groups, when pre-operative and post-operative ABG were compared, significant closure was observed in ABG ($p < 0.001$). However, when they were compared between operation types, no significant difference was found between groups in terms of gain ($p = 0.608$) (Table 2), ABG gain was found to be 10.1 ± 7.0 dB in cartilage group while it was 10.8 ± 5.38 dB in fascia group.

When evaluation was made in terms of success (i.e., tympanic membrane perforation and ABG gain), it was found that success was not significantly associated with age, sex, and mastoidectomy ($p > 0.05$). It was established that type of operation was influential on success. Success rate in cartilage group is higher than rate in fascia group ($p = 0.013$). Graft success was obtained in 80 % of the cases in fascia group and 95.2 % of the cases in cartilage group (Table 3).

When groups with and without mastoidectomy procedure were compared, significant decrease was seen in both groups in post-op period with regard to ABG levels ($p < 0.05$). However, there was no significant difference between groups in terms of gain ($p = 0.210$) (Table 4).

26 cases in cartilage group (43.3 %) and 18 cases in fascia group (50.0 %) had gains under 10 dB. 27 cases in cartilage group (45.0 %) and 14 cases in fascia group (38.9 %) had gains between 10 and 19 dB, and 7 cases in cartilage group (11.7 %) and 4 cases in fascia group

Table 1 Demographic characteristics of the patients

Variables	Cartilage group ($n = 63$)	Fascia group ($n = 45$)	p value
Age	38.6 ± 13.3 (12–62)	39,8 ± 14,6 (16-65)	0.647
Sex			0.919
Male	23 (36.5 %)	16 (35.6 %)	
Female	40 (63.5 %)	29 (64.4 %)	
Pre-op ABG	21.6 ± 6.34 dB	22.1 ± 6.32 dB	0.687
Mastoidectomy	5 (7.9 %)	9 (20.0 %)	0.066

Table 2 Pre-op and post-op ABG levels and gain according to type of operation

Variables	Pre-op ABG (dB)	Post-op ABG (dB)	p value[a]	Gain (dB)	p value[b]
ABG					0.608
Cartilage group	21.6 ± 6.54	11.5 ± 6.90	<0.001	10.1 ± 7.00	
Fascia group	21.8 ± 6.47	11.0 ± 5.38	<0.001	10.8 ± 5.38	

[a] Comparison within the groups in terms of pre- and post-op ABG

[b] Comparison between the groups in terms of gain

Table 3 The effect of age, sex, type of operation, and mastoidectomy on operation success

Variables	Graft success (−) ($n = 12$)	Graft success (+) ($n = 96$)	p value	Odds ratio (95 % CI)
Age	40.1 ± 12.0	38.9 ± 14.1	0.788	0.99 (0.95–1.04)
Sex				
Male	5 (41.7 %)	34 (35.4 %)	–	1.00[a]
Female	7 (58.3 %)	62 (64.6 %)	0.753	1.30 (0.38–4.42)
Operation type				
Fascia	9 (75.0 %)	36 (37.5 %)	–	1.00[a]
Cartilage	3 (25.0 %)	60 (62.5 %)	0.013	5.00 (1.27–19.68)
Mastoidectomy				
+	2 (16.7 %)	12 (12.5 %)	–	1.00[a]
−	10 (83.3 %)	84 (87.5 %)	0.653	1.40 (0.27–7.18)

[a] Reference category

Table 4 Pre-op and post-op ABG levels and gain in groups that underwent with or without mastoidectomy

Variables	Pre-op ABG (dB)	Post-op ABG (dB)	p value[a]	Gain (dB)	p value[b]
ABG					0.210
Mastoidectomy (−)	21.5 ± 6.45	11.5 ± 5.96	<0.001	10.0 ± 6.24	
Mastoidectomy (+)	23.0 ± 6.93	10.4 ± 9.45	0.006	12.6 ± 9.29	

[a] Comparison of pre- and post-op ABG levels within groups

[b] Comparison between groups in terms of gain

(11.1 %) had gains at and over 20 dB. No statistically significant difference was found between groups in terms of gain ($p = 0.810$).

In addition, while in cartilage group, pre-op ABG was under 10 dB in 3 cases (5.0 %), it was between 10 and 19 dB in 20 cases (33.3 %), and 20 dB or over in 37 cases (61.7 %). In post-op period, it was under 10 db in 28 cases (46.7 %), between 10 and 19 dB in 26 cases (43.3 %), and at or over 20 dB in 6 cases (10 %). Statistically significant difference was found between pre-op and post-op ABG values ($p < 0.001$).

In the fascia group, pre-op ABG was between 10 and 19 dB in 16 cases (44.4 %) and 20 dB or over in 20 cases (55.6 %), while in post-op period, it was under 10 dB in 14 cases (38.9 %), between 10 and 19 dB in 18 cases (50.0 %), and 20 dB or over in 4 cases (11.1 %). Statistically significant difference was found between pre-op and post-op ABG values ($p < 0.001$).

No statistically significant difference was found between groups with regard to the distribution of pre-op ABG levels ($p = 0.158$). No significant difference was found between groups with regard to the distribution of post-op ABG level ($p = 0.757$).

In view of these results, it was established that outcome and ABG gain was not significantly associated with age, sex, and mastoidectomy.

Discussion

Although cartilage has long been used in middle ear surgery, it has only recently became a material that attracts attention. However, there is still a controversy regarding its employment, based upon the idea that using such a rigid and thick material in tympanoplasty may have an adverse effect on post-operative sound conduction [1]. Hence, cartilage graft is mostly preferred in patients with severe middle ear pathology such as large perforation, chronic tubal dysfunction, and atelectatic tympanic membrane, and with high MERI score. However, many studies in the literature have demonstrated that the results of hearing are favorable irrespective of the thickness of the graft [7–10, 18].

In the study of Gerber et al. [10], it was reported that post-operative hearing results were comparable between cartilage and fascia graft. Dornhoffer [9] compared audiological results between patients who underwent cartilage tympanoplasty and those who underwent fascia tympanoplasty and found that ABG gain was 6.8 dB in cartilage group and 7.7 dB in fascia group, with no statistically significant difference. Kirazli et al. [18] stated that they found no statistically significant difference with regard to post-operative ABG between fascia and cartilage tympanoplasty groups. Mean ABG gain was reported to be 11.9 and 11.5 dB in cartilage and fascia groups, respectively. Yetişer et al. [22] followed 115 patients for 3 years and reported that gain was better in cartilage tympanoplasty than that in fascia tympanoplasty. In the present study, no statistically significant difference was found between cartilage and fascia graft groups in terms of ABG gain ($p = 0.608$). ABG gain was found to be 10.1 ± 7.00 dB in cartilage group and 10.8 ± 5.38 dB in fascia group. As the results with low MERI were evaluated in the present study, lack of any audiological difference supports the use of cartilage graft, which yields higher success rates in routine use.

Varying success rates have been reported for both groups in the literature. Cabra et al. [7] reported success rates of 82 and 64 % for palisade tympanoplasty and fascia tympanoplasty, respectively, after 24 months of follow-up. Kaziktas [17] studied 51 patients with subtotal perforation in 2007 and reported success rates of 95.25 and 75 % in palisade tympanoplasty and fascia groups, respectively. Amedee et al. [3] performed cartilage tympanoplasty and reported 100 % success in short-term follow-up. Albirmawy [2] followed 82 child patients for 1 year and reported a success rate of 95 % in cartilage group and 76.2 % in fascia group. Cavaliere et al. [7] reported a success rate of 100 % in 236 primary shield cartilage tympanoplasty cases. These differences between success rates command atttention and they may be attributed to the differences in success criteria, used techniques, duration of follow-up and the number of cases. In the present study, it was seen that success rate was significantly higher in cartilage group ($p = 0.013$), with 95.2 % success rate compared to the rate of 80 % in fascia group.

In the present study, it was determined that age and sex had no significant impact on the success of the operation ($p > 0.05$). Likewise, Dornhoffer [9] reported that age and sex were not influential on the success of the operation.

The effect of mastoidectomy on the success of tympanoplasty has long been a controversial issue. Glasscock found no significant difference in operation success between the patient group that underwent mastoidectomy and the group that did not undergo mastoidectomy. In the study of Webb [5] in 2008, it was established that mastoidectomy has no impact on the success of tympanoplasty. Sanna et al. [4] in their study on 323 patients found no difference between mastoidectomy positive and negative groups in terms of operation success and audiological results. In addition to these studies, in the study of Mcgrew et al. [19] in 2004 comparing tympanoplasty cases who underwent masteidectomy with those who did not undergo tympanoplasty, it was reported that although mastoidectomy was not effective in successful repair of perforations, it influenced clinical course by decreasing the number of patients requiring further surgical intervention and slowing the progress of disease. They also reported that adding masteidectomy to tympanoplasty procedure is a reasonable option in the repair of simple perforations without active infection in that it improves the course of the underlying disease and decreases the need for further surgical procedures. In the study of Jackler et al. [14] carried out on 48 patients in 1984, it was suggested that masteidectomy should be added to the procedure in selected myringoplasty cases, since it helps mastoid pneumotisation and mastoid infection source eradication and increases the rate of graft survival. In the present study, it was determined that success and ABG gain was not significantly asssociated with mastoidectomy. In audological comparison, no difference was found between groups in terms of gain ($p = 0.210$).

Conclusion

Cartilage is a graft material that should be preferred to fascia in that it yields equal audological results and higher

surgical success rates. It is our recommendation that, especially, in patients with low MERI, cartilage graft should be used routinely without any concern about influencing the audiological results. The addition of mastoidectomy procedure has no effect on the success of the operation and audiological results. Further studies on the issue with larger series of patients should be carried out.

References

1. Adkins WY (1993) Composite autograft for tympanoplasty and tympanomastoid surgery. Laryngoscope 103:1352–1356
2. Albirmawy OA (2010) comparison between cartilage-perichondrium composite 'ring' graft and temporalis fascia in type one tympanoplasty in children. J Laryngol Otol 124(9):967–974 Epub 2010 Apr 20
3. Amedee RGI, Mann WJ, Riechelmann H (1989) Cartilage palisade tympanoplasty. Am J Otol 10:447–450
4. Balyan FR, Aslan A, Taibah A, Russo A, Sanna M (1997) Mastoidectomy in noncholesteatomatous chronic suppurative otitis media: is it necessary? Otolaryngol Head Neck Surg 117(6):592–595
5. Webb BD, Joseph Chang CY (2008) Efficacy of tympanoplasty without mastoidectomy for chronic suppurative otitis media. Arch Otolaryngol Head Neck Surg 134(11):1155–1158
6. Cabra J, Monux A (2010) Efficacy of cartilage palisade tympanoplasty: randomized controlled trial. Otol Neurotol 31(4):589–595
7. Cavaliere M, Mottola G, Rondinelli M, Iemma M (2009) Tragal cartilage tympanoplasty: anatomic and fuctional result in 306 cases. Acta Otolaryngol Ital 29:27–32
8. Ünlü CH (2010) Cartilage tympanoplasty with island technique for reconstruction of tympanic membrane perforation: anatomic and audiologic results. Kulak Burun Bogaz Ihtis Derg 20(1):7–12
9. Dornhoffer JL (1997) Hearing result with cartilage tympanoplasty. Laryngoscope 107:1094–1099
10. Gerber MJ, Maison JC, Lambert PR (2000) Hearing result after primary cartilage tympanoplasty. Laryngoscope 110:1994–1999
11. Hamed M, Samir M, El Bigermy M (1999) Fate of cartilage material used in middle earsurgery ligth and electron microscopy study. Auris Nasus Larynx 26:257–262
12. Indorewala S (2004) Dimensional stability of free fascia grafts: a human study. Laryngoscope 114(3):543–547
13. Indorewala S (2002) Dimensional stability of the free fascia grafts: an animal experiment. Laryngoscope 112(4):727–730
14. Jackler RK, Schindler RA (1984) Role of the mastoid in tympanic membrane reconstruction. Laryngoscope 94(4):495–500
15. Jansen C (1963) Cartilage tympanoplasty. Laryngoscope 73: 1288–1302
16. Kartush JM, Michaelides EM, Becvarovski Z et al (2002) Over–under tympanoplasty. Laryngoscope 112:802–807
17. Kaziktas KC, Onal K, Boyraz I, Karabulut E (2007) Palisade cartilage tympanoplasty for management of subtotal perforations: a comparison with the temporalis fascia technique. Eur Arch Otorhinolaryngol 264(9):985–989
18. Kirazli T, Bilgen C, Midilli R, Öğüt F (2005) Hearing result after primary cartilage tympanopalsty with island technique. Otolaryngol Head Neck Surg 132:933–937
19. McGrew BM, Jackson CG, Glasscock ME III (2004) Impact of mastoidectomy on simple tympanic membrane perforation repair. Laryngoscope 114(3):506–511
20. Wullstein HL (1952) Funktionelle operation in mittelohr mit hilfe des frejen spaltlappentranplantetes. Arc Ohren Nasen kehlkopfheilkd 161:22–35
21. Yamamoto E, Iwanaga M, Fukumoto M (1988) Histologic study of homograft cartilage implanted in the middle ear. Otolaryngol Head Neck Surg 98:546–551
22. Yetişer S, Hidir Y (2009) Temporalis fascia and cartilage-perichondrium composite shield grafts for reconstruction of the tympanic membrane. Ann Otol Laryngol 118(8):570–574
23. Zollner F (1955) The principles of plastic surgery of the sound-conducting apparatus. J Laryngol Otol 69:657–659