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Long-Term, High-Frequency Tympanometry and Audiometry Results after Cartilage and Fascia Tympanoplasty

Original Investigation

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Abstract

Objective: Fascia or cartilage can be used as grafts in tympanoplasty; however, the disadvantage of cartilage is that it causes stiffness and rigidity in the newly formed tympanic membrane. The aim of this study was to compare the long-term high-frequency tympanometry and audiometry outcomes of tympanoplasty using cartilage and fascia.

Methods: Forty patients in whom tragal cartilage was used in type 1 tympanoplasty and 40 patients in whom temporal muscle fascia was used were included in the study. The preoperative and postoperative audiometries of the two groups were compared. Postoperative high-frequency tympanometry (224, 668, 800, and 1000 Hz) and air volume, compliance, and pressure differences of the two groups were also compared.

Results: The mean age of the patients was 31.3±4.5 year. The success rates were 96% in the cartilage group and 92% in the fascia group. In the fascia group, the preoperative mean air bone gap was 27.9±97 decibels (dB), and the postoperative mean air bone gap was 19.1±7.6 dB. The postoperative mean air bone gap improvement was 8.8±9.9 dB; the difference was statistically significant. In the cartilage group, the preoperative mean air bone gap was 28.2±9.6 dB, and the postoperative mean air bone gap was 17.2±10.5 dB. The postoperative mean air bone gap improvement was 10.9±10.3 dB; the difference was statistically significant. When postoperative mean air bone gap improvement was compared, there was no statistical difference between the two groups. When high-frequency tympanogram values were compared, there were no significant differences between the two groups at 224, 668, 800, or 1000 Hz frequencies in terms of air volume, compliance, or pressure values.

Conclusion: The use of temporal muscle fascia and cartilage in tympanoplasty is statistically similar when compared in terms of tympanic membrane repair, hearing gain, air volume, pressure, and compliance. For this reason, cartilage graft can easily be preferred in tympanoplasty, especially in revision cases and adhesive otitis media, without fear of stiffness or rigidity effects.

Key Words: Temporal muscle fascia, tragal cartilage, tympanoplasty, high-frequency tympanometry

Introduction

The aim of tympanoplasty is to repair tympanic membranes and achieve better hearing outcomes. Various graft materials have been described in the literature, including skin graft (1), fascia lata (2), temporal fascia (3), vein graft, and cartilage (4). Temporal muscle fascia and cartilage are the most widely used graft materials. Cartilage is usually preferred in revision cases, cases with atelectatic membrane or presence of cholesteatoma, and revision tympanoplasty. However, the possibility that the thick and stiff tympanic membrane that forms in patients with cartilage tympanoplasty might reduce compliance and cause hearing loss has made the acceptance of cartilage as a routine graft material difficult (5, 6). Evaluations of graft material compliance have been conducted with standard 226 Hertz (Hz) tympanometry (7-9); however, the stiffness of new tympanic membrane might not be evaluated adequately with standard tympanometry (10, 11).

In this study, we evaluated the compliance of newly obtained tympanic membranes after tympanoplasty performed with temporal muscle fascia or cartilage using high-frequency tympanometry. We compared closure of tympanic membrane rate, hearing gain, and compliance results in the newly formed membranes between the two tympanoplasty techniques.

Methods

The study started once ethical board approval was received. This is a retrospective study of 140 patients who underwent temporal muscle fascia or cartilage tympanoplasty in our clinic between 2009 and 2011. The long-term results were evaluated; therefore, we examined the patients at least 1 year after the operation. Thirty-eight patients who had revision surgery, bone chain reconstruction, mastoidectomy, preoperative sensorineural hearing loss, tympanosclerosis, chronic sinusitis, nasal polyposis, or nasal allergy were excluded from the

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Table 1. Preoperative and postoperative air bone gap distribution

		Fascia Mean±SD	Cartilage Mean±SD	p
Air Bone Gap	Preoperative	27.9±9.6	28.2±9.3	0.888
	Postoperative	19.1±7.6	17.3±10.5	0.376
	ABG closure	8.8±9.9	10.1±10.3	0.348
	P	0.000	0.000	

ABG: air bone gap; Paired sample t test/independent sample t test

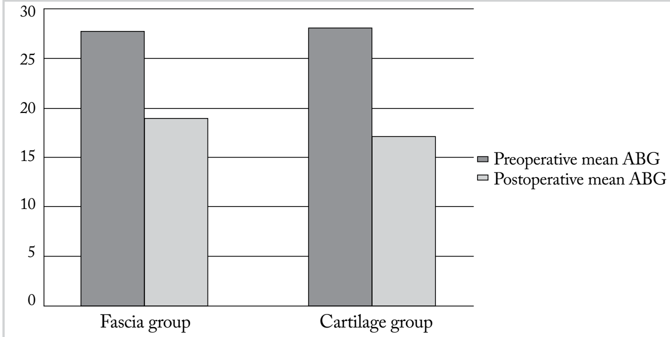

Figure 1. Mean preoperative and postoperative air bone gap distribution

study. Reperforation or chronic ear drainage was detected in 22 of the remaining 102 patients, and they were also excluded from the study. Of the remaining 80 patients, 40 underwent repair with temporal muscle fascia using an underlay technique, and 40 underwent repair with tragal cartilage. The perichondrium was protected in the patients who had cartilage tympanoplasty. An island tragal cartilage graft was used with a malleus notch. The same surgical team, including the senior assistant and physician, performed all the operations. Air volume, compliance, and pressure differences of the 80 patients were measured using high-frequency tympanometry (224 Hz, 668 Hz, 800 Hz, and 1000 Hz). Their preoperative and postoperative air and bone conductions were compared using pure tone audiograms. Informed consent was obtained from the patients.

Statistical Analysis

The SPSS program, version 20.0 was used in the analysis. Mean, standard deviation, median, min-max, ratio, and frequency values were used in the descriptive statistics of the data in this study. Distribution of the variables was checked with the Kolmogorov-Smirnov test. Independent sample t-test and Mann-Whitney U-test were used in the quantitative data analysis. Paired sample t-test and Wilcoxon test were used for repetitive measurements. The chi-square test was used to analyze qualitative data. P values <0.05 were accepted as statistically significant.

Results

Of the 80 patients included in the study, 53 were women and 27 were men. The mean age of the patients was 31.3±4.5 years (12-58). The rates of tympanic membrane closure were 96% in the cartilage graft patients and 92% in the temporal muscle fascia graft patients; the difference was not statistically significant (p>0.05). However, only patients who had intact postoperative tympanic membranes were included in the study. There were no significant differences in the age and sex distributions of the patients in the fascia and cartilage groups. The mean postoperative follow-up period was 10.8±2.1 (8-14) months.

In the fascia group, the preoperative mean air bone gap (ABG) was 27.9±9.7 dB (7-35 dB), and the postoperative mean ABG was 19.1±7.6 dB (2-37). The postoperative mean ABG improvement was 8.8±9.9 dB; the difference was statistically significant (p=0.000, p<0.05). In the cartilage group, the preoperative mean ABG was 28.2±9.6 dB (10-34), and the postoperative mean ABG was 17.2±10.5 dB (5-45). The postoperative mean ABG improvement was 10.9±10.3 dB; the difference was statistically significant (p<0.05). However, there was no significant difference in postoperative mean ABG improvement between the two groups (p>0.05) (Table 1, Figure 1).

When the high-frequency tympanometry values were compared, there were no statistically significant differences in air volume, compliance, or pressure values at 224, 668, 800, and 1000 Hz frequencies between the two groups (p>0.05) (Table 2, Figure 2, Figure 3).

Discussion

When compared with cartilage, temporal muscle fascia has the advantages of an easily moldable nature, lightness, and a structure that resembles tympanic membrane (12). Although temporal muscles show high success rates in the early postoperative period after tympanoplasty, some studies have reported a decrease in graft performance in later stages (13, 14). Due to these negative results, thicker and stronger cartilage grafts are used as alternatives (13, 15, 16). With its rigid and thick structure, cartilage is resistant to resorption and atrophy (17, 18). Because it can be placed precisely into a perforation, cartilage tympanoplasty is preferred in cases with large perforations, revision surgery, tympanosclerosis, tympanic membrane atelectasis, and Eustachian tube dysfunctions (19, 20). However, there is concern that using a thick material as a graft in tympanoplasty causes worse hearing outcomes by damaging the elasticity of the tympanic membrane. In studies regarding this issue, no statistically significant differences in hearing gains were found between cartilage graft and temporal muscle fascia graft patients (21-24). Karaman et al. (22) reported that the rate of composite cartilage island graft closure of the tympanic membrane in 74 patients was 97.3% and that ABG improvement was 20.2 dB. Khan et al. (23) reported a closing rate of 98.20% and an average improvement of 7.06 dB ABG in the study that they carried out using thinned tragal cartilage grafts. Kirazlı et al. (25) reported a postoperative ABG improvement of 11.9 dB in their cartilage group and 11.5 dB in their fascia group; there was no significant difference between the groups in their study. In our study, the rates of closure of the tympanic membrane were nearly similar in the cartilage and fascia groups. The difference in mean ABG improvement between the two groups was not significant. Our results indicate that there were no differences in repair rate or hearing gain between the cartilage and fascia tympanoplasty patients, similar to the results reported in the literature (24-26).

Table 2. Air volume, compliance, and pressure measurements

		Fascia Mean±SD	Cartilage Mean±SD	p
Air volume	224	2.22±1.9	1.92±1.5	0.474
	668	1.21±0.6	1.33±0.7	0.438
	800	1.27±0.5	1.25±0.5	0.891
	1000	1.13±0.5	1.24±0.6	0.406
Compliance	224	0.48±0.7	0.52±1	0.862
	668	0.87±1.2	0.85±1.7	0.964
	800	0.73±1.2	0.90±1.9	0.694
	1000	0.41±0.5	0.63±1	0.348
Pressure	224	-3.24±89.8	-14.73±135.1	0.387
	668	-48.19±154.8	16.20±139.1	0.210
	800	-20.76±149.9	-19.14±175.6	0.940
	1000	1.76±161.6	-48.10±197.8	0.240

There are a limited number of studies in the literature regarding the analysis of compliance of newly formed tympanic membrane and middle ear pressure. In those studies, a 226-Hz tympanogram was used to assess the function of the newly formed tympanic membrane (7-9). Moore et al. (7) used triangular fossa cartilage in revision tympanoplasties and the standard 226-Hz tympanometry to assess tympanic membrane movement and elasticity. The authors of that study suggested that triangular cartilage is more resistant to Eustachian tube dysfunction, as it is thicker than temporal muscle fascia, and that there would be no restrictions in the tympanic membrane movements, as it is thinner than tragal cartilage (7). In their study, Gierek et al. (9) examined the rate of tympanic membrane closure, hearing gain, and standard 226-Hz frequency tympanometry results of cartilage, temporal muscle fascia, and perichondrium grafts, and they found no statistically significant differences among the grafts. It has been suggested that inadequacy might become an issue when presenting the changes under the influence of stiffness in the ossicular-tympanic chain with a conventional immittance meter using a 226-Hz probe tone (26). The reason is that when a 226-Hz probe tone is used in an immittance meter, the middle ear is obviously under the influence of stiffness (10, 11). Therefore, while it is possible to identify large-scale rigidity that might cause stiffness in the ossicular-tympanic chain, minimal deviations in the stiffness of the system might not be perceived by this technique ($p>0.05$) (26). Therefore, a higher-frequency tympanogram is needed to assess the stiffness in the ossicular-tympanic system. The use of high-frequency tympanometry in cartilage tympanoplasty to assess compliance might provide healthier results due to the thick and rigid structure of the cartilage.

Thus, in order to be able to assess whether the cartilage and temporal muscle fascia had enough elasticity in terms of acoustic transfer in the postoperative tympanic membrane, the tympanometries in the current study were carried out at all frequencies between 226 Hz and 1000 Hz. In the tympanometry results, at all frequencies, no statistical differences in membrane elasticity or middle ear pressure were identified between the cartilage graft and temporal muscle fascia patients. It should be kept in mind that cartilage grafts can be used easily and are preferred for the closure of tympanic membrane rate, especially in risky

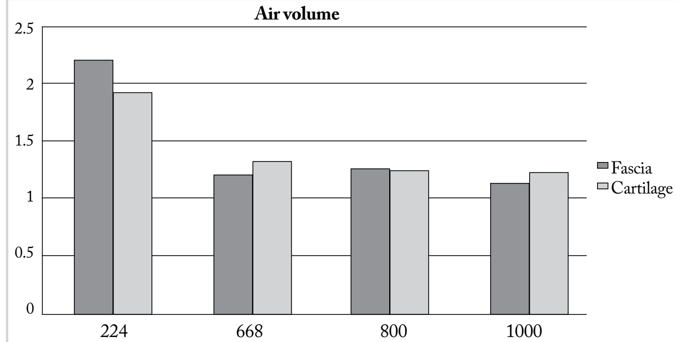

Figure 2. Mean air volume at frequencies of 224, 668, 800, and 1000 Hz in the fascia and cartilage groups

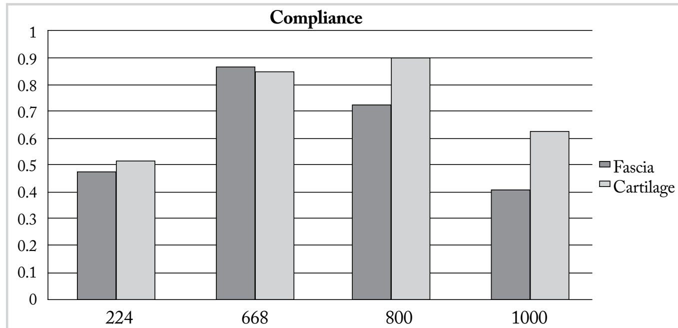

Figure 3. Mean compliance at frequencies of 224, 668, 800, and 1000 Hz in the fascia and cartilage groups

cases (revisions, total perforations, tympanosclerosis), and that it is possible to ensure adequate hearing gain as a result. In our study, the pressure values were 0 mm H_2O at 224 Hz, -4 mm H_2O at 668 Hz, 6 mm H_2O at 800 Hz, and 52 mm H_2O at 1000 Hz in the temporal fascia group and -13 mm H_2O at 224 Hz and 0 mm H_2O at 668, 800, and 1000 Hz in the cartilage group. It is evident that as we went up to higher frequencies in the high-frequency tympanograms, we obtained results closer to the normal pressure of the tympanic membrane. There were no statistical differences in the newly formed membrane pressures between the groups. At higher frequencies in high-frequency tympanometry, air volume values decrease, and the results are closer to normal values. Therefore, it can be said that high-frequency tympanometry is more efficient in showing membrane elasticity when compared to standard-frequency tympanometry.

Conclusion

In this study, we found no differences in hearing gain or rate of tympanic membrane closure between temporal muscle fascia and cartilage tympanoplasty. In addition, no statistical differences in air volume, pressure, or compliance values at any frequency in audiometry and tympanometry were identified between the cartilage and fascia groups. For these reasons, cartilage grafts can easily be preferred in tympanoplasty, especially risky cases, without fear of stiffness or rigidity effects.

Ethics Committee Approval: Ethics committee approval was received for this study from the ethics committee of Bağcılar Training and Research Hospital (2012-81).

Informed Consent: Written informed consent was obtained from the patients who participated in this study.

Peer-review: Externally peer-reviewed.

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