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Original Article / *Özgün Makale*

A comparison between fascia and cartilage graft tympanoplasty techniques in broad tympanic membrane perforations

Geniş timpanik perforasyonlarda fasya ve kıkırdak greft timpanoplasti tekniklerinin karşılaştırılması

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ABSTRACT

Objectives: This study aims to compare the results of temporal muscle fascia and cartilage graft tympanoplasty operations in patients with subtotal tympanic membrane perforations.

Patients and Methods: Between October 2011 and April 2013, a total of 67 patients (42 females, 25 males; mean age 30.1 years; range, 12 to 49 years) who underwent tympanoplasty due to inactive chronic otitis media and who had subtotal tympanic membrane perforation were included in this study. The patients were randomly divided into two groups as the cartilage graft group (CGG, n=33) and the fascia graft group (FGG, n=34). The mean air thresholds and mean air-bone gap (ABG) at 500, 1,000, and 2,000 Hz were measured by pure tone audiometry. Successful engraftment ratios and hearing outcomes were compared between the groups.

Results: The duration of follow-up was 12 months. The mean preoperative pure tone hearing threshold (PTHT) in CGG and FGG were 48.9 dB and 45.88 dB, respectively. The mean preoperative ABG in CGG and FGG were 29.03 dB and 30.94 dB, respectively. The mean postoperative pure tone hearing gain in CGG and FGG were 8.96 dB and 10.5 dB, respectively. The mean postoperative ABG in CGG and FGG were 6.45 dB and 9.11 dB, respectively. There was no significant difference between the two techniques in terms of the ABG and pure tone average scores (p=0.51-0.155). Successful engraftment ratio in CGG and FGG were 96.9% (32/33) and 82.3% (28/34), respectively.

Conclusion: Although successful engraftment ratio in CGG is higher than FGG in broad tympanic membrane perforations, both techniques yield similar hearing outcomes.

Keywords: Chronic otitis media, cartilage palisade tympanoplasty, temporalis fascia.

ÖZ

Amaç: Bu çalışmada subtotal timpanik membran perforasyonlu hastalarda, temporal kas fasya ve kıkırdak greftli timpanoplasti sonuçları karşılaştırıldı.

Hastalar ve Yöntemler: Ekim 2011-Nisan 2013 tarihleri arasında, inaktif kronik otitis media nedeniyle timpanoplasti yapılan ve subtotal timpanik membran perforasyonu olan toplam 67 hasta (42 kadın, 25 erkek; ort. yaş 30.1 yıl; dağılım 12-49 yıl) çalışmaya alındı. Hastalar kıkırdak greft grubu (CGG, n=33) ve fasya greft grubu (FGG, n=34) olmak üzere rastgele iki gruba ayrıldı. Ortalama hava eşiği ve ortalama hava-kemik aralığı (ABG) 500, 1000 ve 2000 Hz'de saf ton odyometrisi ile ölçüldü. Başarılı greftleme oranları ve işitme sonuçları gruplar arasında karşılaştırıldı.

Bulgular: Takip süresi 12 ay idi. Ameliyat öncesi ortalama saf ton işitme eşiği (PTHT) CGG ve FGG'de sırasıyla 48.9 dB ve 45.88 dB idi. Ameliyat öncesi ortalama ABG, CGG ve FGG'de sırasıyla 29.03 dB ve 30.94 dB idi. Ameliyat sonrası ortalama saf ton işitme kazanımı CGG ve FGG'de sırasıyla 8.96 dB ve 10.5 dB idi. Ameliyat sonrası ortalama ABG, CGG ve FGG'de sırasıyla 6.45 dB ve 9.11 dB idi. Hava-kemik aralığı ve saf ton ortalama skorları açısından iki grup arasında anlamlı bir fark yoktu (p=0.51-0.155). Başarılı greftleme oranı CGG ve FGG'de sırasıyla %96.9 (32/33) ve %82.3 (28/34) idi.

Sonuç: Geniş timpanik membran perforasyonlarında başarılı greftleme oranı FGG'ye kıyasla CGG ile daha yüksek olmakla birlikte, her iki tekniğin işitme sonuçları benzerdir.

Anahtar sözcükler: Kronik otitis media, kıkırdak palisad timpanoplastisi, temporal fasya.

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Earlier, radical techniques were used in surgery for chronic otitis media (COM) until Wullstein and Zöllner defined tympanoplasty in 1952. Currently, numerous graft materials such as cartilage, full thickness skin (Berthold, 1878), free skin graft (Wullstein and Zöllner, 1952), temporal muscle fascia (Heerman, 1958), vein, perichondrium, dura mater have been used for the repair of the perforated tympanic membrane. Recently, temporal muscle fascia and cartilage grafts are in common use.[1]

Jansen[3] was the first who introduced the use of cartilage tissue in ear operations in 1958. Salen[2] and Jansen[3] introduced the cartilage tissue as a graft material in repair of tympanic membrane in 1963.

Tos[4] defined more than 20 cartilage tympanoplasty techniques. Five different cartilage tympanoplasty techniques have been defined for the most practical use. Placement and size of perforation, status of ossicular chain, type of mucosal disease, discharge or cholesteatoma, choice and experience of surgeon determines the tympanoplasty technique.[4]

In the present study, we aimed to compare the results of temporal muscle fascia and cartilage graft tympanoplasty operations in patients with subtotal tympanic membrane perforations.

PATIENTS AND METHODS

Between October 2011 and April 2013, a total of 67 patients (42 females, 25 males; mean age 30.1 years; range, 12 to 49 years) who underwent tympanoplasty due to inactive COM in a tertiary hospital and who had subtotal tympanic membrane perforation were included in this study. A written informed consent was obtained from each patient. The study protocol was approved by the Erciyes University Ethical Committee of Clinical Researchs. The study was conducted in accordance with the principles of the Declaration of Helsinki.

Patients with COM without cholesteatoma and dry ear for at least two months were included in the study. Patients who underwent mastoidectomy or revision tympanoplasty were excluded from the study.

The patients were randomly divided into two groups as the cartilage graft group (CGG, n=33) and the fascia graft group (FGG, n=34). Pre- and postoperative physical examination findings, hearing outcomes, and intraoperative findings were recorded.

All operations were performed with a post-auricular approach by a single surgical team. The conchal cartilage graft with fascia graft was applied to one group and only temporal muscle fascia graft was applied to another group. The cartilage graft was harvested from the conchal cartilage with perichondrium on only one side and shaped as palisade and mosaic formation.

In CGG, pieces of cartilage were placed as underlay and fascia was placed between remnant membrane and these cartilages. In FGG, graft was taken from temporal muscle and prepared by thinning and drying. After supporting middle ear with gel foam, the graft was placed under the margins of perforation. The graft was supported with silk ribbon filled with lentil-sized mini cotton balls with antibiotic pomade.

Pre- and postoperative physical findings of grafts and hearing levels of patients were recorded. Postoperative values were defined the values measured at 12 months after surgery. Interacoustics audiometer, (Interacoustics AC-40, Assens, Denmark) was used to evaluate hearing levels. In addition, 500, 1,000, 2,000, and 4,000 Hz pure tone hearing thresholds (PTHTs) were recorded and 500, 1,000, and 2,000 Hz thresholds were used to measure the mean hearing level. The mean hearing level and air-bone gap (ABG) were compared pre- and postoperatively between the groups to measure hearing gain.

Statistical analysis

Statistical analysis was performed using the PASW version 18.0 software (SPSS Inc., Chicago, IL, USA). Descriptive data were expressed in mean ± standard deviation or number and frequency. The chi-square, Fisher exact, paired t test, and Mann-Whitney test were used. Distribution of normality was tested using the Shapiro-Wilk test. Qualitative data were compared using the chi-square and Fisher's exact test. Repetitive

Table 1
Preoperative average values of pure tone audiometry and air-bone gap

	Cartilage graft	Fascia graft	
	%	%	*p*
Pure tone audiometry	48.9	45.88	0.376
Air-bone gap	29.03	30.94	0.333

Table 2
Intraoperative findings

	Tympanosclerosis				Stapes fixation			
	Yes		No		Yes		No	
Intraoperative findings	n	%	n	%	n	%	n	%
Fascia graft	9	26.4	25	73.6	6	17.6	28	82.4
Cartilage graft	10	30.3	23	69.7	8	24.2	25	75.8

Table 3
Rates of engraftment

Gruop	Intact	Perforate	%	*p*
Cartilage graft	32	1	96.9	
Fascia graft	28	6	82.3	0.057
Total	60	7	89.5	

data were tested using the paired t test. The Mann-Whitney U test was used to compare independent groups. A *p* value of <0.05 was considered statistical significance.

RESULTS

Of 35 patients in the CGG, 19 were females and 14 were males with a mean age of 28.69 (range, 13 to 55) years. Of 34 patients in the FGG, 23 were females and 11 were males with a mean age of 31.58 (range, 12 to 56) years.

Sixteen patients had bilateral COM in CGG. Six of these patients previously underwent otologic surgery in an external medical center. Four of these patients had intact grafts, while the grafts of other two patients were perforated. Eleven patients had bilateral perforated tympanic membranes in the FGG. One of these patients previously underwent otologic surgery in an external medical center and had a perforated graft.

The mean preoperative PTHT in CGG and FGG was 48.9 dB and 45.88 dB, respectively. The mean preoperative ABG in CGG and FGG was 29.03 dB



Figure 1. A postoperative image of palisade and mosaic cartilage graft application.



Figure 2. An engraftment failure in a cartilage graft tympanoplasty, continuing perforation inferior.



Figure 3. An image of a fascia graft tympanoplasty at postoperative 12 months showing calcified plaques.



Figure 4. Image of an engraftment failure in a fascia graft tympanoplasty.

and 30.94 dB, respectively. There was no statistically significant difference in terms of the PTHT and ABG between the two groups (Table 1).

Type 1 tympanoplasty was performed to each patient; however, two patients in both groups had an intervention due to incus long process defects. In addition, fibrotic bands and calcified tissues around ossicular chain were cleared to increase the ossicular mobility, if necessary. Tympanosclerosis was one of the major problems during intervention to achieve hearing gain. Ten patients in CGG had tympanosclerosis. The stapes footplate was fixated in eight of these 10 patients. In FGG, nine patients had tympanosclerosis and stapes footplate was surrounded by sclerotic plaque in six of them (Table 2).

During follow-up postoperatively, one patient in CGG and three patients in FGG had perforation. Successful engraftment rate was 96.9% in CGG and 82.3% in FGG. Although there was no significant difference between the groups, this difference was approaching borderline statistical significance (Table 3). A total of 32 grafts in CGG were intact (Figure 1). Unfortunately, a patient had permanent perforation in CGG (Figure 2). In addition, 28 patients had intact fascia graft and six patients had perforation in FGG postoperatively (Figures 3 and 4).

The mean pre- and postoperative PTHT was 48.9 dB and 40.96 dB, respectively in CGG. In FGG, the mean pre- and postoperative PTHT was 45.88 dB and 35.38 dB, respectively. The mean preoperative ABG value was 30.94 dB and the mean postoperative ABG was 21.82 in FGG. The mean pre- and postoperative ABG values of CGG were 29.03 dB and 23.42 dB, respectively. The intra-group

Table 4
Comparing pre- and postoperative hearing values in fascia graft group

	Mean±SD	*p*
Average PTA threshold		
Preoperative	45.9±11.2	<0.05
Postoperative	35.4±14.1	
Air-bone gap		
Preoperative	31.0±7.1	<0.05
Postoperative	21.8±9.4	

PTA: Pure tone audiometry.

Table 5
Comparing pre- and postoperative hearing values in cartilage graft group

	Mean±SD	*p*
Average PTA threshold		
Preoperative	48.9±16.0	<0.05
Postoperative	41.0±16.6	
Air-bone gap		
Preoperative	29.0±8.9	<0.05
Postoperative	23.4±9.4	

PTA: Pure tone audiometry.

Table 6
Hearing gain in terms of pure tone audiometry threshold and air-bone gap

	Hearing gain		
	Cartilage graft	Fascia greft	*p*
Pure tone audiometry	8.96	10.5	0.510
Air-bone gap	6.45	9.11	0.155

Table 7
Distribution of patients according to hearing levels pre- and postoperative

	≤30 dB		>30 dB		Total	
	n	%	n	%	n	%
Preoperative pure tone audiometry values						
Cartilage graft	6	18.1	27	81.9	33	100
Fascia graft	4	11.7	30	88.3	34	100
Postoperative pure tone audiometry values						
Cartilage graft	12	36.3	21	63.7	33	100
Fascia graft	11	32.3	23	67.7	34	100

Table 8
Distribution of patients according to pre- and postoperative air-bone gap values

	≤20 dB		>20 dB		Total	
	n	%	n	%	n	%
Preoperative air-bone gap						
Cartilage graft	6	18.1	27	81.9	33	100
Fascia graft	4	11.7	30	88.3	34	100
Postoperative air-bone gap						
Cartilage graft	14	42.4	19	57.6	33	100
Fascia graft	14	41.1	20	58.9	34	100

analysis revealed significant differences in the pre- and postoperative PTHT and ABG values (Table 4 and 5).

The average gain for PTHT and ABG were estimated using postoperative results. There was 8.96 dB gain in average PTHT and 6.45 dB of gain in average ABG value in CGG. In FGG, the average PTHT and ABG gain was 10.5 dB and 9.11 dB, respectively. The hearing gain was higher in FGG, although it did not reach statistical significance (p=0.51 and 0.155) (Table 6).

While six patients had preoperative average PTHT under 30 dB (18.1%) in CGG, this number was 12 (36.3%) postoperatively. These pre- and postoperative values were 4 (11.7%) and 11 (32.2%), respectively in FGG. For ABG values, six patients had ABG under 20 dB preoperatively in CGG and it increased to 14 (42.4%) postoperatively. These pre- and postoperative values in FGG were 4 (11.7%) and 14 (41.1%), respectively (Tables 7 and 8).

DISCUSSION

Although fascia grafts are more used in tympanoplasty operations, the use of cartilage grafts has increased in recent years. The main disadvantage of cartilage grafts is their more rigid content than fascia grafts. These grafts destroy the original flexibility of tympanic membrane and, therefore, sound vibrations cannot be forwarded effectively. However, recent studies have reported that cartilage grafts prepared and applied appropriately have similar results of hearing gain to the fascia grafts with more successful graft retention rates.[5-8]

Fascia grafts are always harvested from the temporal muscle, regardless of the endaural or postauricular approaches. Cartilage grafts are harvested from the tragal or conchal area, depending on the location of the incision. Therefore, tragus is preferred, when enadaural approach is used, while concha is preferred, when postauricular incision is used. Some authors have suggested that tragal cartilage is more suitable than conchal cartilage to shape and form the perichondrium flap.[9] Both grafts harvested from these areas have similar results in the literature.[1,6] We believe that the most appropriate method is to harvest cartilage from the most comfortable area in the surgical site using minimum incision. In our study, we used postauricular approach in all patients and harvested cartilage from the concha.

Cartilage grafts can be prepared as one part or multiple pieces. As these grafts are more rigid than fascia grafts, when a piece of cartilage graft is broader, its vibration feature is reduced.[10] Therefore, we prepared our cartilage grafts as shape of palisade and mosaic rather than broad palisade and island grafts.

There are different approaches regarding the insertion of cartilage grafts. Heermann,[11] the pioneer of cartilage graft tympanoplasty, inserted inferior end of piece of graft prepared as palisades on the bone annulus. He, therefore, suggested that the graft was more durable against retraction with a such support from the bottom.[11] However, some authors suggested that this approach could cause vibration feature of the cartilage graft in a negative way. They also assumed that pieces of cartilage graft on bone annulus could cause to interfere with the adhesion of fibrous annulus to bone annulus.[10] In our study, we stripped the bottom of perichondrium of the graft and, then, sliced it as palisade and mosaic. We juxtaposed these pieces at the level of bone annulus and supported with Gelfoam, if necessary. We laid the fascia graft on these pieces and provided a smooth surface.

Considering success rates of engraftment, the CGG and FGG yielded 96.9% and 82.3% success rates, respectively. Although there was no significant difference between the groups, this difference was approaching borderline statistical significance (p=0.057). Success rates of engraftment changes between 80 and 100% for cartilage and 64.4 and 89.6% for fascia grafts in the literature.[6] Cartilage grafts are superior to fascia grafts, particularly in patients who are younger than 16 age and with adenoid hypertrophia or COM on the contralateral ear, whose are with reduced rates of successful engraftment.[12]

Hearing gain is an important indicator of engraftment success in tympanoplasty. It is thought that hearing gain results with cartilage graft is worse than fascia graft. However, we were unable to find any study showing that fascia grafts are more successful than cartilage grafts in terms of hearing gain in the literature. In numerous studies, it was reported that hearing gain was provided by both cartilage and fascia graft and there was no significant difference between the grafts in terms of hearing gain.[13-18] Lee et al.[19] reported a study with three groups: cartilage island graft, cartilage palisade graft, and fascia graft. In this study, there were 50% or more hearing gain in cartilage island graft and fascia graft groups, while it was only 13% in cartilage palisade group. The fascia grafts were more successful than palisade cartilage group. However, there was no significant difference between fascia group and island cartilage group. Based on these results, the authors concluded that fascia grafts were not superior to cartilage grafts in terms of hearing gain.

Preoperative average PTHT in CGG was 48.9±16.02 dB, while it was 40.96±16.63 dB postoperatively. In FGG, preoperative average PTHT was 45.88±11.24 and it was 35.38±14.12 dB, postoperatively. Between pre- and postoperative PTHT results, there was a significant difference in both groups. Between both group, there was no significant difference in terms of hearing gain. Pre- and postoperative ABG values were respectively 29.03±8.86 and 23.42±9.37 dB in CGG and 30.94±7.08 and 21.82±9.44 dB in FGG, respectively. Within the group, there was a significant difference in terms of pre- and postoperative ABG values, but not between the groups. In our study, we obtained hearing gain in a certain rate. However, we were unable to provide hearing thresholds at desired levels.

Preoperative hearing thresholds were high for patients who were candidates for a Type I tympanoplasty compared to previous studies in the literature. This is the most important reason of high hearing thresholds postoperatively. There were certain pathologies which interfere with ossicular chain mobility in both groups. Therefore, preoperative hearing thresholds were such a high. Tympanosclerosis is one of the most important reasons which interfere with ossicular chain mobility. Ten and nine patients had tympanosclerosis in CGG and FGG, respectively. These sclerotic plaques were widespread to stapes footplate in eight and six patients, respectively. We performed no intervention to them, except for cleaning plaques around the ossicular chain.

In conclusion, cartilage grafts are more durable materials than fascia grafts. Therefore, these grafts can be used as the first-choice in tympanoplasty cases with subtotal perforation, adhesion, and eustachian tube dysfunction. However, further studies are needed regarding serious middle ear diseases such as

tympanosclerosis to improve hearing loss depending on COM, as well as graft materials and operative techniques.

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