

## Original Article

# Comparison of temporalis muscle fascia and full-thickness cartilage grafts in type 1 tympanoplasty

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**Abstract:** Objective: To compare temporalis muscle fascia and full thickness tragal cartilage in type 1 tympanoplasty. Study design: Retrospective clinical chart review. Subjects and methods: In total, 247 patients (157 male, 90 female; average age of  $33.67 \pm 13.07$  years, range 18 to 65 years) who had been underwent type 1 tympanoplasty in our clinic were included in this study. Demographics, anatomical and functional outcomes were collected. Temporalis muscle fascia and tragal cartilage was used as graft material. The anatomical and functional outcomes of cartilage and fascia were compared. Audiometric results comparing the cartilage and fascia groups at six months also continued to patients follow up to one year after surgery. An intact graft and an air-bone gap (ABG)  $\leq 20$  dB were regarded as surgical success. Results with a  $p$ -value  $< 0.05$  were considered statistically significant. Results: The graft success rate was 91.3 per cent of the cartilage group compared with 68.9 per cent of the temporalis fascia group, respectively. In the fascia group, preoperative ABG was  $22.28 \pm 8.76$  dB and postoperative ABG was  $17.60 \pm 10.96$  dB. In cartilage group, preoperative ABG was  $22.43 \pm 8.07$  dB and postoperative ABG was  $14.93 \pm 8.69$  dB. The anatomical success rate of cartilage group was better than fascia group statistically ( $P < 0.01$ ). There was no statistically significant differences among functional outcomes between fascia and cartilage groups ( $P > 0.05$ ). Conclusion: Our data suggest that the anatomical success rate of cartilage tympanoplasty was higher compared with fascia tympanoplasty. Functional results with cartilage wasn't different than fascia despite we didn't thinning tragal cartilage.

**Keywords:** Tympanoplasty, cartilage, fascia, hearing

## Introduction

The tympanic membrane has special anatomical and physical features. It is responsible of the air-bone sound vibration of ossicular chain for this reason its acoustic quality is very important. Tympanoplasty is a surgical procedure to closure tympanic membrane perforation and reconstruct the tympanic membrane. Various kinds of graft materials are used to closure tympanic membrane perforations. These graft materials are consist of such as temporalis muscle fascia, cartilage, perichondrium, periosteum, dura mater, vein, fat and skin [1, 2]. The anatomical success is defined as intact graft, dry ear on the operated side and the functional success of operation is defined as air-bone gap (ABG)  $\leq 20$  dB.

Different portion of temporalis muscle fascia remains the most frequently used graft materi-

al due to neighborhood of the surgical area at tympanoplasty and results in successful closure of tympanic membrane 70-90% in studies [3, 4]. The use of cartilage in tympanoplasty is not new concept, in the past also cartilage was used but for hard cases such as recurrent perforations, total perforations, atelectatic tympanic membranes [5, 6]. Cartilage is resistant to retraction and resorption but, this controversial acoustically disadvantages or not. Some authors prefer thinning cartilage slicing with different tools because worrying of coneract sound conduction [3, 7, 8] but also several studies have reported good functional results of without thinning cartilage [6, 9, 10].

Tragal cartilage fibroelastic cartilage and being composed of collagen type II is also similar nature of the tympanic membrane, temporal muscle fascia consists primarily of collagen type

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I. Collagen type II has higher tensile strength than other types [8]. Nowadays, several institutes preferred cartilage not only hard cases but also simple tympanic membrane perforations.

The aim of our study as to compare the graft success and functional outcomes of temporalis muscle fascia and full thickness tragal cartilage in type 1 tympanoplasties with similar ear pathologies.

### Materials and methods

A retrospective review of data collected from January 2009 to October 2014 was performed at Bakırköy Dr. Sadi Konuk Training and Research Hospital-Department of Otolaryngology-Head and Neck Surgery. In total, 247 patients who underwent type 1 tympanoplasty were included in this study. All patients were informed about this study and written informed consent was obtained from the patients who participated in this study. The study protocol was approved by the same hospital's local ethics committee.

Patients with ossicular chain defect, cholesteatoma, tympanosclerosis, atelectasia, history of previous ear surgery, irregular follow-up and no written informed consent was excluded. Patients who included to study were followed up at least 1 years prior to surgery. All of the patients had audiograms preoperatively and postoperatively. Patients had surgery under general anesthesia with retroauricular approach with over-underlay technique.

The age, gender, the dimension of the perforation, the side of operated ear, the types of graft materials, the etiology of chronic otitis media, smoking history, middle ear pathologies, pre- or postoperative audiological outcomes, the status of the graft at the postoperative period and follow-up period was recorded for all of patients. Middle ear pathologies of all of the patients were evaluated using Middle Ear Risk Index (MERI) scoring system that was developed by Becvarovski and Kartush [11, 12]. We standardized our patients with this scoring system also we indeed to prevent the selection bias between groups. The patients with greater than three MERI scores were excluded in this study. The tympanic membrane perforations were classified as middle (smaller than 50%) subtotal (>50%) and total (100%). In group A middle

15, subtotal 117, total 0 perforation involved. In group B middle 39, subtotal 72, total 4 perforation were found.

All the operations were performed by one of the surgeons in our department (random allocation) according to well established principles of ear surgery. The surgeon decided to choose the type of graft material (fascia or tragal cartilage) The patients included in the study were divided into two groups according to the using graft material in type 1 tympanoplasty. In group A, temporalis muscle fascia was used as graft material. Temporalis muscle fascia was harvested with retroauricular incision. The tympanomeatal flap was after incisions at the six and twelve o'clock directions. After it was shaped according to the size of the perforations, it was placed over the malleus and under the anterior annulus with an over-underlay technique. Gelfoam® was used to support the graft medially and laterally. The tympanomeatal flap was then repositioned and a meatal pack was added and the incision was sutured and a mastoid bandage was used. In group B, tragal cartilage without thinning was used as graft material. To avoid visible scar skin incision can be made 1 mm inside the ear canal and outer edge of tragus protected to avoid cosmetic deformity. The tragal cartilage is harvested together with both sides perichondrium. We made inferior cut as low as possible to gain the total tragal cartilage. The perichondrium was peeled at the convex side and a triangle piece of cartilage was removed from the malleus level for better fitting graft. According to Tos this technique was categorized as a cartilage-perichondrium composite island technique [13]. The surgical procedure was similar with first group. All of the patients were visited us for control examinations at post-operative first, second and third weeks. In the first postoperative week, the sutures were removed and in the third postoperative week, the external ear canal was cleaned from gelfoam particules. Then, the patients were followed up for control examinations on monthly periods during post-operative first years. The status of tympanic membrane was recorded in postoperative first, third, six month and 1 year. The audiological evaluations were recorded postoperative six month. In this study, the anatomical success is defined as intact graft without perforation, retraction or lateralization and dry ear on the

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**Table 1.** The subjects data in the fascia and the cartilage groups.

Variables	Fascia (n=132)	Cartilage (n=115)	P
Age (years)	33.86±12.69	33.45±13.55	<sup>a</sup> 0.806
Gender			
-Females	78 (59.1)	79 (68.7)	<sup>b</sup> 0.118
-Males	54 (40.9)	36 (31.3)	
The side operated			
-Right	77 (58.3)	61 (53.0)	<sup>c</sup> 0.404
-Left	55 (41.7)	54 (47.0)	
Perforation size			
-Medium (25-50)	15 (11.4)	39 (33.9)	<sup>c</sup> 0.001**
-Total (%100)	0	4 (3.5)	
-Subtotal (>50)	117 (88.6)	72 (62.6)	
MERI	2.30±1.64 (1)	2.01±1.31 (1)	<sup>b</sup> 0.295

<sup>a</sup>Independent Samples Test; <sup>b</sup>Yates Continuity Correction; <sup>c</sup>Fisher's exact test. \*\*P<0.01.

operated side and the functional success of operation is defined as air-bone gap (ABG) ≤20 dB. ABG were calculated at 4 frequencies (0.5, 1, 2 and 4 kHz).

### Statistical analysis

The Number Cruncher Statistical System (NCSS) 2007 Statistical Software (UT, USA) was used for statistically analysis. The median values of total power were calculated from the filtered raw data for each of the two groups at each benchmark. Data were evaluated using descriptive statistical methods (mean, standard deviation, median, and interquartile range). In addition to the significance of intergroup differences was analyzed using Student's t test and the significance of the medians was analyzed with Mann-Whitney U test. A paired t-test was performed to test the differences between preoperative and postoperative anatomical and functional outcomes. The qualitative comparisons of data were performed using the chi squared test and Fisher Freeman Halton test. Results with a *p*-value <0.05 were considered statistically significant.

### Results

In total, 247 patients were included in this study, all of whom characterized by 157 female (63.6%) and 90 male (36.4%), an average age of 33,67±13,07 years with values ranging from 18 to 65 years. There were 132 patients in fas-

cia group and 115 patients in cartilage group. The characteristics of the groups are summarized in **Table 1**. The age, gender, side of surgery and MERI scores were not statistically significant different between two groups (P>0.05). MERI, mean ± SD) values were assessed that fascia 2.30±1.64, cartilage 2.01±1.31. Tympanoplasties were performed 55.9% (138 ears) of all patients on right ear and 44.1% (109 ears) of all patients on left ear. In fascia group, pre-and postoperative mean ABG was 22.28±8.76 dB and 17.60±10.96 dB, respectively. Postoperative gain was 4.68 dB in fascia group. In cartilage group, preoperative and postoperative mean ABG was 22.43±8.07 dB and 14.93±8.69 dB, respectively. Postoperative gain was

7.51 dB in cartilage group (**Table 2**). The functional success rate of the cartilage group was higher than the fascia group but no significant differences in functional success were observed (P>0.05). The graft success rate was 91.3% in the cartilage group and 68.9% in the fascia group. The graft success rate in cartilage group was significant higher than fascia group statistically (P<0.001) (**Table 3**).

### Discussion

In literature, there isn't consensus on the selection of graft materials for tympanoplasty. Selection depends on entirely surgeon experiences and preferences. However, cartilage graft is preferred in patients with high MERI scores because of resistant to retraction and infection and preserving its viability and shape for a long time in the presence of the middle ear pathologies but also its thickness and rigidity another problem. For these reasons different authors used different types such as palisades, stripes, slices, composite in tympanoplasty. Using the doppler interferometer Zahnert et al. suggested that the thickness of graft material increases the acoustic transmission loss, therefore thinning to the cartilage to 0.5 mm [14], but this advantages is offset by the thinning cartilage curling. Tragal and conchal cartilage compared at this study but there was no statistical difference between these two types [14]. In literature, previous comparative anatomical and audiological studies were

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**Table 2.** Comparison air-bone gap and the hearing gains between two groups pre- and postoperatively

Air Bone Gap	Preoperative ABG (dB)	Postoperative (dB)	<i>P</i> <sup>a</sup>	Gain	<i>p</i> <sup>b</sup>
Graft Type					
Fascia	22.28±8.76	17.60±10.96	0.001**	4.68±10.52	0.046
Cartilage	22.43±8.07	14.93±8.69	0.001**	7.51±9.83	

<sup>a</sup>Paired Samples test, <sup>b</sup>MannWhitney U test. \*\**P*<0.01. <sup>a</sup>Comparison ABG between two groups pre- and postoperatively. <sup>b</sup>Comparison between two groups in terms of gain.

**Table 3.** Comparison of success rates between two groups

	Cartilage group (N: 115)	Fascia group (N: 132)	<sup>a</sup> <i>P</i>
Graft success	91.3% (N: 105)	68.9% (N: 91)	0.001**
Hearing success (ABG ≤20 dB)	78.3% (N: 90)	68.9% (N: 91)	0.099

\*\**P*<0.01. <sup>a</sup>Paired Samples test.

reported different outcomes for cartilage and fascia graft. Also using cartilage type (tragal or conchal) and technique (palisade, slices, composite) differ from author to author. Human and animal studies have found some softening occurs with time, degeneration of the chondrocytes lead to these softening [5, 13]. In systematic review of Mohammad SH et al. shown that both cartilage and temporalis fascia give equal and comparable functional results independently type and cartilage technique [4]. There are many reasons for highly variable outcomes in the comparative studies. The sample size, surgical technique used, the size of the tympanic membrane perforations, simultaneous different middle ear surgery, various middle ear pathologies and follow-up period affect the functional and anatomical success rates of tympanoplasty.

Yung et al. [15] reported the anatomical success rate was 84.2% in fascia group and 80% in cartilage group at large perforation respectively. Our perforation was also mainly subtotal perforation (117 subtotal perforation in group A, 72 subtotal perforation in group B). Regarding higher rate of reperforation in fascia group, it is notable that size and location of perforation differed between studies, and that some studies did not describe either of these perforation characteristics. Small perforations have a comparatively good preoperative hearing and are easier to close. In the present study, tympanic membrane perforation was mainly subtotal

perforations, there might be heterogeneity between recently published meta-analysis. However, in fascia group, tympanic membrane perforation was mainly subtotal and subtotal perforation was higher in fascia group than in cartilage group. It was strongly suspected to contribute to the higher rate of reperforation in fascia group. No significant differences in functional success between both two grafts were reported by some authors, however, Onal et al. [16] reported functional success was higher in cartilage group than fascia group.

Cavaliere et al. reported that 306 tympanoplasty cases, thinning tragal cartilage with a hand press had excellent hearing results [17]. Callioglu shown that chondroperichondrial island graft should be preferred to fascia, equal audiological results and higher surgical success rates. Callioglu et al. reported there was no significant differences in ABG closure in tympanoplasty with low MERI scores [9]. Studies that the hearing results of tympanoplasty fairly good had bias between the groups [18, 19]. Cartilage tympanoplasty was performed in variable pathology such as retraction, cholesteatoma, middle ear mucosal pathology. In our study, preoperative evaluation of middle ear were assessed by MERI. So our groups had similar properties. Unfortunately, we didn't know exact thickness of our patient tragal cartilage. Tragal cartilage is not uniform thickness in every patient. Also we didn't know race, age, gender changing thickness of cartilage. Khan et al. found total average thickness of tragal cartilage was 1.228±0.204 mm in males and 1.090±0.162 mm in females in Indian population [20]. In another cadaveric study, Hizalan et al. was indicated that greatest thickness was 2.20 mm on the inferior part and thinnest part was superior medial part 0.7 mm [21]. These results lead to new discussions. In the present study, our data suggest that anatomical success rate was statistically higher in cartilage group [91.3%] and no significant differences in functional success between both two groups. The success rate of tympanoplas-

ties decreases by time. The success rate of tympanoplasty which was followed up a long-term was lowered compared with a short-term follow-up [15, 22, 23]. In the present study, all of the patients was followed-up at least 1 years. Long follow up is essential at tympanoplasty operation because repaired membranes often reperforate especially initial perforation is subtotal or total [24]. Our follow-up period was long enough to see reperforations. The limitations of this study were such as unable to assess after 1 years outcomes and unknown thickness of tragal graft.

### Conclusion

In conclusion, the anatomical success rate was high in cartilage graft. Further studies with a higher number of patients are needed to compare the anatomical and functional outcomes of various cartilage types and variable thickness of cartilage graft.

### Disclosure of conflict of interest

None.

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