

Inlay Butterfly Cartilage Tympanoplasty: A Retrospective Analysis of 31 Cases

İnlay Butterfly Kartilaj Timpanoplasti: 31 Olgunun Retrospektif Analizi

Nejla KARA, MD,¹ Mustafa KARAKAŞ, MD,² Hasan Hüseyin BALIKÇI, MD,³
Murat Haluk ÖZKUL, MD,⁴ Muhammet Mustafa GÜRDAL, MD⁵

¹ Sultanbeyli State Hospital, Clinic of Otorhinolaryngology, İstanbul,

² Kahramanmaraş City State Hospital, Clinic of Otorhinolaryngology, Kahramanmaraş,

³ Susehri State Hospital, Clinic of Otorhinolaryngology, Sivas,

⁴ Haseki Teaching and Research Hospital, Clinic of Otorhinolaryngology, İstanbul,

⁵ Üsküdar State Hospital, Clinic of Otorhinolaryngology, İstanbul

ABSTRACT

Objective: To determine the results of inlay butterfly cartilage tympanoplasty (IBCT).

Material and Methods: This retrospective study involved 30 patients (31 ears) with tympanic membrane perforations (diameter: 2 - 6 mm) treated with IBCT in the Department of ENT, Haseki Research and Training Hospital, between May 2010 and April 2012. Operative success was defined as the total closure of the perforation evaluated at 6 weeks postoperatively. Pure tone audiometric analyses were performed preoperatively and at 8 weeks postoperatively. In addition, operative success was evaluated according to the patient age, perforation location and perforation size.

Results: The success rate was 80.6%, even though all operations were performed by residents with limited experience under academic supervision. Moreover, the success rate did not vary with perforation size, perforation location or patient age. After IBCT, the mean air-bone gap improved from 18.50 dB to 11.86 dB, and the mean pure tone average improved from 28.56 dB to 17.82 dB.

Conclusion: IBCT is a safe, efficient, cost-effective and easy technique to close small-to-medium sized tympanic membrane perforations. It could be used as an alternative technique for patients requiring type I tympanoplasties, and can be performed by surgeons with relatively limited experience.

Keywords

*Butterfly technique; inlay tympanoplasty;
cartilage graft; tympanic membrane*

ÖZET

Amaç: İnlay butterfly kartilaj timpanoplastinin (İBKT) sonuçlarını belirlemektir.

Gereç ve Yöntemler: Bu retrospektif çalışma, Haseki Eğitim ve Araştırma Hastanesi Kulak Burun Boğaz Kliniği'nde, Mayıs 2010 ve Nisan 2012 tarihleri arasında timpanik membran perforasyonu (2-6 mm çapında) olan ve İBKT ile tedavi edilen 30 hastayı (31 kulak) içermektedir. Operasyon başarısı 6 hafta sonra yapılan değerlendirmede perforasyonun tam kapanması olarak tanımlanmıştır. Pür ton odyometrik incelemeler preoperatif dönemde ve postoperatif 8. haftada yapılmıştır. Ayrıca başarı; yaşa, perforasyon büyüklüğüne ve perforasyon lokalizasyonuna göre değerlendirilmiştir.

Bulgular: Tüm operasyonların akademik denetim altında sınırlı deneyimi olan asistan cerrahlar tarafından uygulanmasına rağmen, başarı oranı %80,6'dır. Ayrıca; başarı oranı perforasyon büyüklüğü, perforasyon lokalizasyonu ve hasta yaşına göre değişmemiştir. Ortalama hava-kemik aralığı 18,50 dB'den 11,86 dB'e, ve ortalama pür ton odyometri değerleri 29,56 dB'den 17,82 dB'e düşmüştür.

Sonuç: İBKT, küçük ve orta boy perforasyonları kapatmak için güvenli, etkili, maliyet etkin ve kolay bir yöntemdir. Tip I timpanoplasti gerektiren hastalarda alternatif bir yöntem olarak kullanılabilir ve göreceli olarak sınırlı deneyime sahip cerrahlar tarafından uygulanabilir.

Anahtar Sözcükler

*Butterfly teknik; inlay timpanoplasti;
kıkırdak grefti; timpanik membran*

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Correspondence

Hasan Hüseyin BALIKÇI, MD

Susehri State Hospital,

Clinic of Otorhinolaryngology,

Sivas, TURKEY

E-mail: balikcient@gmail.com

INTRODUCTION

Popular myringoplasty techniques include either an underlay or an overlay approach to place tissue grafts such as temporalis fascia and perichondrium grafts. The inlay butterfly cartilage tympanoplasty (IBCT) was first described by Eavey in 1998 and has become a widely accepted technique for the repair of perforations of the tympanic membrane.¹ In the original surgery described by Eavey, the tragal cartilage with the perichondrium on either side was transferred to the tympanic membrane as an inlay graft via a transcanal approach; the cartilage graft was then supported with a split-thickness skin graft. Since then, the IBCT technique has been investigated in many studies, and the indications for IBCT have been expanded.²⁻⁶ IBCT has also been conducted in children.²

The IBCT technique has various practical advantages over classical techniques. First, the surgeon can insert the cartilage graft into a myringosclerotic tympanic membrane without any need for external canal packing or middle ear support, as the graft stabilizes instantly during insertion. Second, it is an easy and time-saving procedure, and is also a cost-effective surgery because of the reduced operative and recovery times. IBCT does not require the elevation of a tympanomeatal flap because the only incision is in the tragus; therefore, aural comfort and tidiness are enhanced. Finally, it can be performed as an outpatient procedure under local anaesthesia in adults and under mask anaesthesia in children without any endotracheal intubation.²⁻⁷

However, this technique also has some limitations. It is difficult to perform in patients in whom the entire perforation cannot be viewed via the transcanal approach. IBCT can only be performed in patients who require type I tympanoplasty with mild conductive type hearing loss (20-40 dB) due to tympanic membrane perforation because other types of tympanoplasty require the elevation of a tympanomeatal flap, and it cannot be performed for perforations that include the bone annulus.¹

The ITCB is effective but not commonly used procedure by ENT surgeons in Turkey. We desired to introduce this technique by evaluating our case series. In the current study, we determined the efficacy of transcanal IBCT by assessing the graft "take" rate and postoperative pure tone audiometric results.

MATERIAL AND METHODS

Patient Selection and Assessments

The present study involved 30 patients (31 ears) who had tympanic membrane perforations (diameter, 2-6 mm) and were operated on in the Department of ENT, Haseki Research and Training Hospital, between May 2010 and April 2012.

Patients with perforations larger than 6 mm, a history of otorrhoea within the last 2 months, cholesteatoma, probable mastoid cell pathology and conductive hearing loss that could not be explained solely on the basis of the tympanic perforation (> 40 dB) were excluded from the study. The study protocol was approved by our institutional ethics committee, and all patients included in the study provided written informed consent.

Patients were divided into groups based on their age and the size (< 4 mm vs. ≥ 4 mm) and location of their tympanic perforations. Since the largest perforation size was 6 mm, we determined 4 mm as the best cut off point for dividing according to size of perforation. Operative success was defined as total closure of the perforation, and was evaluated 6 weeks after the operation (Figure 1). Both operative duration and success were assessed according to patient age, perforation location and perforation size. Pre- and postoperative (at 8 weeks) pure-tone audiometric evaluations were conducted to determine the average value of hearing thresholds at 0.5, 1, 2 and 4 kHz. Any complications that occurred were recorded. Possible complications included otitis externa, otitis media, retraction of the tympanic membrane, graft lateralization or medialization and increment of the air-bone gap (ABG).



Figure 1. Appearance of the inlay graft during the sixth week postoperatively.

Surgical Technique

All patients were operated under local anaesthesia by residents with limited experience under academic supervision. Lidocaine and 1/100,000 epinephrine was injected into all four sides (anterior, posterior, superior, inferior) of the external auditory canal and into the skin over the tragus, via a 30-gauge dental injector. A tragal cartilage graft with perichondrium on either side was harvested via a 10-mm incision made with a 15-gauge lancet. The incision was made on the medial side of the tragus, and thus, the resultant scar would be hidden. The incision was closed with 5/0 polypropylene sutures. Ear speculums were then used to widen the ear canal and expose the operative field. A transcanal approach was used in all operations, which were performed under a surgical microscope. A long, straight, sharp pick was used to refresh the margins of the perforation. The perforation was measured with a 90° pick with a 2-mm process. The cartilage graft was prepared using the same pick, and was made to match the shape of the tympanic perforation, with a 2-mm margin on all sides. The graft was then incised all along its edge with a 15-gauge lancet to a depth of 2 mm in order to create a “butterfly” margin (Figure 2). The graft was placed into the perforation, with one side under the tympanic membrane (underlay) and the other side over it (overlay), so that the graft was finally placed as an inlay graft. The procedure was similar to a grommet tube insertion. Total closure of the perforation by the wings of the graft was confirmed using a straight, sharp pick. We applied the Eavey technique as modified by Lubianca-Neto in all patients.⁶

Statistical Analyses

Statistical analysis of the results was performed using the Statistical Package for Social Sciences (SPSS) for Windows 19.0 (Chicago, IL, USA). The paired-samples *t*-test and independent-samples *t*-test were used. The results were evaluated in terms of a 95% confidence interval and at a significance level of $p < 0.05$.

RESULTS

The mean age of the patients was 31.1 ± 13.6 years (range, 16–56 years); 45.2% (14 patients) of the patients were female, and 54.8% (17 patients) were male. The mean operative duration was 35.0 ± 9.3 min. The size of the perforations ranged between 2 and 6 mm; 21 patients had perforations <4 mm, and 10 patients had perforations ≥ 4 mm. The mean middle ear risk index (MERI)



Figure 2. Preparation of the inlay cartilage graft.

Table 1. Success rate of inlay butterfly cartilage graft according to age, perforation size and location.

	n	Success rate (%)
Perforation diameter		
<4 mm	21	17 (81%)
≥ 4 mm	10	8 (80%)
Age (years)		
10–18	7	6 (85%)
19–29	10	8 (80%)
30–49	11	8 (73%)
>50	3	3 (100%)
Perforation location		
Anterior, inferior	8	7 (88%)
Anterior, superior	5	4 (80%)
Anterior, marginal	4	3 (75%)
Posterior, inferior	5	4 (80%)
Central	9	7 (89%)

score was 1 point (low degree). The mean follow-up duration was 8.3 ± 6.4 months, and the success rate was 80.64% (25 of 31 ears). The success rates according to perforation size, perforation location and patient age are shown in Table 1. In this study, the success rate did not significantly differ with perforation size (<4 mm vs. ≥ 4 mm), perforation location or patient age ($p > 0.05$).

After IBCT, the mean ABG improved from 18.5 dB (preoperative) to 11.86 dB (8 weeks postoperatively; $p < 0.05$). The ABG was divided into 10 dB ranges, and the postoperative differences in ABG were as follows. In two patients, both the pre- and postoperative ABGs were in the 0–10 dB range. The ABG was in the 11–20 dB range in 19 patients; it shifted to the 0–10 dB range after the surgery in 14 patients, but stayed in the same range in 5 patients. In all 10 patients with ABGs in the 21–30 dB range, this value shifted to the 11–20 dB range postoperatively. The mean pure-tone average improved from 28.5 dB (preoperative) to 17.8 dB (8 weeks postoperatively; $p < 0.05$).

There were no complications in our study. There were no instances of graft lateralization or medialization, and no cases of postoperative hearing loss.

DISCUSSION

In 1963, Salen and Jansen first used septal cartilage grafts for the reconstruction of tympanic membrane defects.^{8,9} Since then and over the last 10 years in particular, many types of cartilage tympanoplasty techniques have been described. IBCT, which was first described by Eavey in 1998,¹ was classified as a special cartilage tympanoplasty method by Tos in 2008.¹⁰ Initially, IBCT was not recommended in conditions such as inadequate exposure of the perforation margins via the transcanal approach, necessity of middle ear exploration, marginal perforations and granular myringitis.¹ In the present study, we adopted similar exclusion criteria, except that we included four patients with anterior marginal tympanic membrane perforations. In some studies, the indications for IBCT have been extended by combining middle ear exploration with the retroauricular approach.^{2,4,11}

IBCT has been reported to be as successful as underlay tympanoplasty.^{4,7,12} Mauri et al. compared 34 cases of inlay and underlay tympanoplasty each, and reported 88.2% and 86.1% graft "take" rates, respectively.³ Couloigner et al. compared 59 inlay and 29 underlay tympanoplasties, which yielded 73% and 83% success rates, respectively.⁴ In the present study, all operations were performed by residents, who had only a limited experience with IBCT, and yet, the success rate was 80.6%. Therefore, we consider that IBCT is easy to learn. We thought that IBCT must be used only tympanic membrane perforations without any kind of middle ear pathology. So, all operated patients were evaluated as low degree according to the MERI. The patients with higher risk indexes were treated with more comprehensive middle ear procedures.

IBCT has been performed in patients of different ages, with perforations of varying sizes, including large perforations, with similar success rates.^{1,2,4,7} In the present study, we operated on patients with perforations measuring 2-6 mm, and obtained similar success rates to those reported in the previous studies. Furthermore, we did not observe any significant difference in the graft "take" rate between ears with small perforations (<4 mm, n=21) and those with large perforations (≥4 mm, n=10). However, Monfared et al.

have reported that perforations >5 mm were associated with a 1.55-fold greater failure rate.⁶ Couloigner et al. reported an 81% success rate when the graft diameter was at least 2 mm larger than the perforation diameter; however, the success rate dropped to 47% when the graft diameter was <2 mm larger than the perforation diameter. Thus, graft diameter seems to be the most important parameter determining operative success.⁴ The IBCT is not recommended in marginal perforations.¹ However, in the present study we achieved 75% success rate in 4 cases with anterior-marginal perforation.

Karakullukcu et al. performed IBCT on 11 patients, and reported that the ABG decreased from 18 dB to 6.5 dB after IBCT.¹¹ Ghanem et al. reported that the ABG decreased from 23 dB to 21 dB in their series of 99 cases.² This decrease was not statistically significant, possibly because their series included patients with total perforations and/or cholesteatoma. Mauri et al. reported that the average ABG was less than 20 dB in 94.1% of patients who underwent IBCT.³ In addition, Monfared et al. have observed that the pure tone average improved from 36.8 dB to 28.2 dB after IBCT.⁵ In the present study, the mean pure tone average improved from 28.56 dB to 17.82 dB, and the ABG improved from 18.50 dB to 11.86 dB. Early audiometric evaluations were done because of the not using any kind of graft support material in middle ear. In control examinations we decided subjectively that 8 week is enough for evaluation of the middle ear performance.

In many studies on IBCT, parameters such as smoking, accompanying chronic systemic disorders such as diabetes mellitus, and any history of radiotherapy were not taken into consideration.⁵ Lin et al. have reported that smoking increases the failure rate of tympanoplasty by seven-fold.¹³ In contrast, variables such as age, sex, side and location of the perforation have not been found to influence operative success.^{2,4,5,7} Consistent with this, we found no differences in IBCT outcomes according to the age of the patients and location of the perforation.

The advantages of IBCT are that it is easy to perform, can be performed under local anaesthesia, is cost-effective, does not necessitate air bandage, has a short operation duration and yields a similar success rate to the underlay technique.^{4,5,12,14} Furthermore, IBCT can be combined with middle ear exploration via the elevation of a tympanomeatal flap.⁴ Ghanem et al. extended the indications for IBCT from non-marginal perforations

measuring <4 mm to total perforations of the tympanic membrane.² They reported a 92% graft “take” rate among 99 cases, which included tympanoplasty via the retroauricular or endaural approach and/or tympanomastoidectomy.²

Theoretically, the superficial layer of the tympanic membrane can migrate below the lips of the cartilage graft, leading to the risk of cholesteatoma formation. However, neither the studies reported in the literature nor the present study included any cases of cholesteatoma formation after IBCT.^{1,3,4,11}

CONCLUSION

IBCT is similar to other methods of tympanoplasty in terms of both functional and anatomical success. In addition, it is superior to other tympanoplasty methods in terms of cost-effectiveness, short operation duration and easy application. We recommend IBCT as an alternative technique for patients requiring type I tympanoplasties, especially in small perforations. The IBCT procedure is easy to learn, and successful results can be achieved even by surgeons with limited experience.

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