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ARAŞTIRMA / RESEARCH

Outcome of incudostapedial reconstruction with endoscopic modified butterfly tympanoplasty

Endoskopik modifiye kelebek timpanoplasti ile incudostapedial rekonstrüksiyon sonuçları

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Abstract

Purpose: The aim of this study was to evaluate the results of endoscopic butterfly tympanoplasty in perforations that involve the ossicular chain pathologies.

Materials and Methods: We assessed the outcome of endoscopic modified butterfly tympanoplasty in 29 patients. The study included those with large tympanic membrane perforations covering the manubrium of malleus and has ossicular chain pathologies, operated via endoscopic transcanal tympanoplasty.

Results: The tympanic membrane closure rate was 89.7% (26 of 29 ears). The mean air conduction in the pre- and postoperative period was 37.75±5.20 dB and 18.96±6.52 dB, respectively, with a statistically significant decrease of 18.79±7.33. The mean pre- and the postoperative air-bone gap was 27.82±4.74 dB and 9.17±4.89 dB, respectively, with a statistically significant decrease of 18.62±7.11

Conclusion: The endoscopic modified butterfly tympanoplasty technique is a minimally invasive technique that can provide successful results in large perforations with defective incudostapedial joint.

Keywords:. Tympanoplasty, butterfly, perforation, endoscopic, incudostapedial bridge

Öz

Amaç: Bu çalışmanın amacı, kemikçik zincir patolojilerini de içeren perforasyonlarda endoskopik kelebek timpanoplasti sonuçlarını değerlendirmektir.

Gereç ve Yöntem: Çalışmada 29 hastada endoskopik modifiye kelebek timpanoplasti sonuçlarını değerlendirdik. Çalışmaya malleus manubriumunu içeren geniş timpanik membran perforasyonları olan ve kemikçik zincir patolojileri olanlar, endoskopik transkanal timpanoplasti ile ameliyat edilen hastalar dahil edildi.

Bulgular: Timpanik membran kapanma oranı % 89.7 idi (n=26). Ameliyat öncesi ve sonrası dönemde ortalama hava iletimi sırasıyla 37.75 ± 5.20 dB ve 18.96 ± 6.52 dB idi. Ameliyat sonrası dönemdeki hava yolu saf ses ortalamalarındaki düşüş istatistiksel olarak anlamlı 18.79 ± 7.33 bulundu. Ameliyat öncesi ve sonrası hava-kemik aralığı sırasıyla 27,82 ± 4,74 dB ve 9,17 ± 4,89 dB olarak bulundu. Ameliyat öncesi ve sonrası karşılaştırıldığında hava kemik aralığındaki azalma 18,62 ± 7,11 olarak bulundu ve istatistiksel olarak anlamlı olarak değerlendirildi.

Sonuç: Endoskopik modifiye kelebek timpanoplasti tekniği, incudostapedial eklem defektli büyük perforasyonlarda başarılı sonuçlar verebilen minimal invaziv bir tekniktir.

Anahtar kelimeler: Timpanoplasti, kelebek, perforasyon, endoskopik, incudostapedial köprü

INTRODUCTION

The tympanic membrane perforations can be repaired by using various techniques. Currently, the retroauricular or transcanal approaches, and onlay or underlay tympanoplasties are the most commonly used techniques[1,2]. However, they generally result in morbidities as both techniques require canal skin incision, postoperative follow-up, and care. Previously, Gross et al. used the inlay technique with adipose tissue for small perforations, and Eavey described a novel transcanal inlay technique with

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grafting cartilage for tympanic membrane repair[3,4]. The advantages of the transcanal butterfly cartilage technique over the onlay and underlay tympanoplasties are a decrease in operation time, shorter duration of post-operative follow-up and care, lower cost. When first described, it was used only for non-marginal small perforations, but today it is also used for larger perforations[5].

Ghanem et al. demonstrated successful graft closure in patients with medium and large perforations[6]. Alain et al. have successfully used the butterfly tympanoplasty technique in subtotal perforations involving the manubrium of the malleus[7]. Finally, Kaya et al. evolved a techniquemore applicable than the conventional butterfly method[8]. However, none of these studies had interfered with ossicular chain pathologies, and there is no such study in the literature.

In this study, we aimed to evaluate the efficiency of an endoscopic modified butterfly tympanoplasty technique without the need for flap elevation in repairing large perforations that including manubrium of the malleus and incudostapedial dislocation.

MATERIALS AND METHODS

In this study, we assessed the outcome of endoscopic modified butterfly tympanoplasty in 29 patients operated in a tertiary care university teaching hospital (Sanliurfa Mehmet Akif İnan Training and Research Hospital) between January 2014 and December 2018. Informed consent was obtained from all participants. Ethics committee approval was received for this study from the Harran University Clinical Research Ethics Committee (Project number and date 18/12/08,10/12/2018).

Patient selection

All patients underwent preoperative endoscopic ear examination, pure tone audiogram and preoperative temporal computerized tomography were performed. The study included those with tympanic membrane perforations covering the manubrium of the malleus and ossicular chain pathologies that could be treated with transcanal endoscopic tympanoplasty without the need for mastoidectomy and the lack of any active otorrhea for at least three months. Patients with limited incus lenticular process and with incus long arm defects that are not over 2 mm were included in the study. The exclusion criteria were; having pathologies that require mastoidectomy, having a perforation suitable for classical butterfly tympanoplasty and patients with no pathology in the ossicular chain were excluded from the study. Patients who have a defect over 2 mm on incus long arm were excluded. Patients on whom we used transcanal endoscopic tympanoplasty with the usage of tympanomeatal flap were excluded. One year after surgery, patients with closure of the tympanic membrane and improvement of the air-bone gap (ABG) were considered successful. In order to calculate the mean air bone conduction (AC) and bone conduction (BC) thresholds, the average value of pure tone thresholds at 0.5, 1, 2, and 3 kHz were evaluated following the Committee on Hearing and Equilibrium[9].

Surgical technique

All operations performed under general anesthesia. A transcanal approach with a rigid 0 and 30 degree 2,7-mm endoscope (Karl Storz, Tutlingen, Germany) was utilized for surgery. The perforation was trimmed circumferentially at the margin by using a pick. Epithelium placed on the manubrium mallei, and the ossicular chain were examined (Figure 1). Ossiculoplasty was performed using glass ionomeric bone cement (Ketac™ Cem Easymix, 3M ESPE, Neuss, Germany) between the damaged long process of the incus and an intact stapes superstructure (Figure 1). To secure the graft properly, the edge of TM should be sufficiently left. For this purpose, the size and shape of the perforation were measured via cardboard paper (Figure 2). Then, the incision of the tragal graft was made, leaving just 1-2 mm of the rim in the lateral tragal dome site not only for cosmetic reasons but also to harvest the graft with perichondrium on both sides to obtain a larger size than the actual perforation. Then, the triangular cartilage was removed from the graft that came to the manubrium mallei preserving the perichondrium (Figure 2). The thin edge of the remaining cartilage, where it was parallel to two perichondrial sheets, was notched circumferentially around its entire perimeter that ultimately led to a butterfly-wings shape (Figure 2). Then, the insertion of the graft was performed and removed cartilage portion was placed on the manubrium mallei overlay, while the remaining part of one of the wings was placed on the lateral, and the other one on the medial side of the perforation (Figure 3). Neither external auditory canal packing nor ear dressings were used. All of the patients were

prescribed antibiotics (Siprogut, Bilim Pharmaceuticals, İstanbul, Turkey) and steroid (Onadron, İbrahim Etem – Menarini, İstanbul, Turkey) ear drops and discharged on the day of operation.

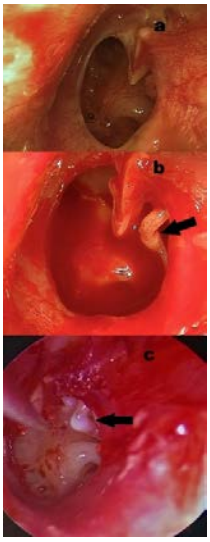

Figure 1. (a) an intraoperative view of the tympanic membrane perforation, (b) Endoscopic views of a patient with left tympanic membrane after desepithelizaton, (c) an intraoperative view of perforation after ossiculoplasty.

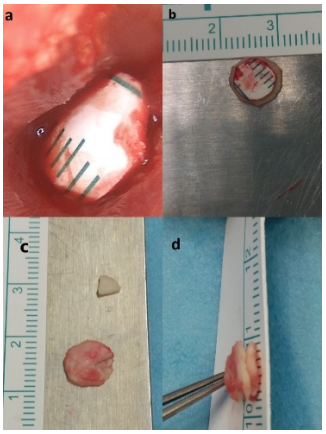

Figure 2. a) determination of the size of the cartilage before grafting b) appropriate grafting according to the size c) cartilage resection and preservation of the perichondrium from the part that will reach the manibrium mallei d) the final form of the graft

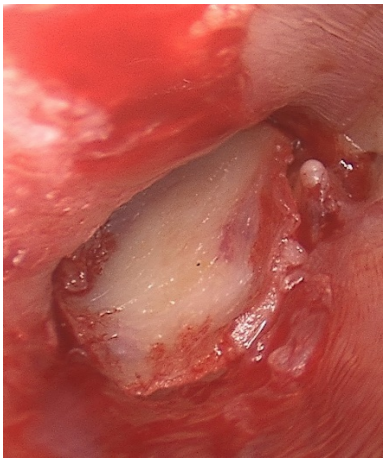

Figure 3. Endoscopic view after the graft is placed.

Statistical analysis

Whether the distributions of continuous variables were normally or not being was determined by Shapiro-Wilk test. Descriptive statistics for continuous variables were expressed mean ± SD. Number of cases and percentages were used for categorical data. The mean differences in clinical measurements (i.e. AC and ABG) between pre- and post-operative were compared by Paired samples t-test. Data analysis was performed by using IBM SPSS Statistics version 17.0 software (IBM Corporation, Armonk, NY, USA). A p-value less than 0.05 was considered statistically significant.

RESULTS

Endoscopic modified butterfly tympanoplasty was performed on the right side in 13 patients and on the left side in 16. Of the patients, 16 (55.2%) were male, and 13 (44.8%) were female; patients' age ranged between 16 and 47 years, with an average of 27.2. The closure of the tympanic membrane could be achieved in 26 of the 29 ears (89.7%). The failure of the graft was observed in two patients; the cartilage was infected and eroded in one patient, it was lateralized and posteriorly perforated in the other. Revised surgery was performed on this patient by fat myringoplasty. As the assessment of post-op hearing gain could not be done in the patients with graft failure, they were excluded from the study. The average post-op follow-up period was 13.9 months (range: 12 - 26). No complications like hearing loss,

facial nerve paralysis, vertigo, retraction pocket, and wound-related complications were observed during the follow-up period.

The mean pre- and postoperative BC pure tone averages (PTA) were 9.93±3.06 dB and 9.75±3.21 dB, and the mean pre- and postoperative AC PTAs were 37.75±5.20 dB and 18.96±6.52 dB, respectively. Decrease in AC PTAs was 18.79±7.33 dB and it was statistically significant (p <0.001). The mean ABG improved from 27.82±4.74 dB preoperatively to 9.17±4.89 dB postoperatively. Thus the ABG gain was 18.62±7.11 dB (p <0.001) (Table 1).

Table 1. Pre- and post-operative clinical measurements

Measure	Pre-op	Post-op	p-value †	Difference
Air conduction (dB)	37.75±5.20	18.96±6.52	<0.001	-18.79±7.33
Bone conduction (dB)	9.93±3.06	9.75±3.21	0.057	-0.17±0.46
Air bone gap (dB)	27.82±4.74	9.17±4.89	<0.001	-18.62±7.11

Data were shown as mean±SD, † Paired samples t-test.

While the percents of ears with ABG between 0-10 dB, 11-20 dB, 21-30 dB, and >30 dB were as follows 0 % (0/29), 3.4% (1/29), 69% (20/29) and 27.6% (8/29) at preoperative period; postoperatively, they improved to 75.9% (22/29), 17.2% (5/23), 6.9% (2/29), 0% (0/29), respectively (Table 2).

Table 2. Pre- and post-operative distribution of ABG.

Air-Bone Gap (dB)	Preoperative: n (%)	Postoperative: n (%)
0-10	0 (0 %)	22 (56.5%)
11-20	1 (8.6 %)	5 (39.1%)
21-30	20 (56.5 %)	2 (4.4%)
>31	8 (34.9%)	0 (0%)
Total	29	29

DISCUSSION

In recent years the use of endoscopes has increased during otology-related surgeries. They are especially beneficial to serve as a visual aid of a wider area, and as a provider of a brisk shift during the evaluation of the middle ear, ossicular chain, harder-to-reach regions like facial recess, and perforations on the anterior side. Therefore, the requirement of a minimally invasive intervention for otologic surgeries has been met by the endoscopic approach, which is also relatively less traumatic for intact tissues[10]. The use of endoscopic systems in tympanoplasty provides a wide field of view. Angled endoscopes especially facilitate the control of anteriorly located marginal perforations and seeing hard-to-reach regions such as the attic, hypotympanum, sinus tympani, and facial recess. Besides, the ossicular chain and related pathologies can be better evaluated and easily resolved[10,11].

Complications such as flap rupture and damage to chorda tympani are common occurrences in conventional tympanoplasty and ossicular chain repair techniques performed by using tympanomeatal flap. Since the butterfly tympanoplasty does not require the use of a tympanomeatal flap and can be done with a single tragal incision instead of endaural or retroauricular incisions, it is superior to conventional tympanoplasty. Moreover, inserting the cartilage graft into the tympanic membrane does not require the surgeon to make an external canal packing or support of the middle ear, because the stabilization of the graft can be achieved instantaneously during insertion. As the duration of the surgery and the recovery period are significantly reduced, this technique is highly convenient and cost-effective[3-6]. However, since the microscopically performed butterfly tympanoplasty technique does not have a clear view of the front dial, the perforation cannot be seen completely and this limits the usage area of this technique[5,7]. Due to this limitation, butterfly tympanoplasty is more frequently performed endoscopically in the pediatric and adult populations[12].

Since the microscopic image is also not as wide as endoscopic in the posterior quadrant, the necessity of

forming a tympanomeatal flap to increase vision in ossicular chain pathologies was another factor that limited the use of butterfly technique[5-7]. As known chronic otitis media commonly affects the ossicular chain. Particularly the long process of the incus is the most frequently eroded ossicular part and is missing or defective in 60% of ossicular chain defects[13]. In large perforations involving the posterior quadrant, since we find the endoscopic vision sufficient and can perform surgical manipulations without any problems; we perform the incudostapedial joint defect repairs that we encounter frequently, by modifying the butterfly technique without creating a tympanomeatal flap in our clinic. Since we could not see a publication describing this modification in the literature, we needed to share the results of this modified technique. While reconstructing the incudostapedial bridge, we used bone cement that proven success and easily applicable[14-16]. Due to the risk of absorption and dislocation with the material made with bone or cartilage, we use bone cement very often in our clinic in order to minimalize the failure in ossiculoplasty. We do not use ossicular replacement materials much due to their high cost.

At the end of follow-up, anatomic closure rate was 89.7%, similar to other techniques[17,18]. Also our results with endoscopic modified butterfly tympanoplasty were similar to those in previous studies. For example, Ozgur at al. obtained a success rate of 95.6% for grafts in their study, while Alain et al. reported a closure rate of 94%[7,10]. Mauri et al. reported a graft take rate of 85.3% and Hod et al. reported a graft take rate of 92%[5,19]. Lee et al. have compared endoscopic and microscopic butterfly tympanoplasty in their study and found similar success rates[12]. Our results are similar to those made in this study of endoscopic butterfly tympanoplasty results.

When we look at the audiological results in the patient group who underwent butterfly tympanoplasty without hearing reconstruction in the literature Hod et al. reported postoperative ABG was 11,28 dB butterfly tympanoplasty group[19]. We have seen similar gains in the literature in incudostapedial reconstruction studies. Galy-Bernadoy et al, using different materials. achieved an ABG gain of 10.63 in the cartilage reconstruction group, 13.72 in the reconstruction group with titanium partial ossicular replacement prostheses, and 15 dB in the hydroxyapatite bone cement group[14]. Demir et al. reported another 12.30 dB ABG gain with bone cement in another incudostapedial reconstruction study involving the long-term results of the 40 patients he performed[15]. In another study performed by Güngör et al, an ABG gain of 13 dB was reported in 30 patients who underwent incudostapedial reconstruction[16]. In our study ABG gain was 18.65±7.11 dB, consistent with the literature.

Hypothetically, there is a risk of cholesteatoma formation as a result of migration of the superficial layer of the tympanic membrane under the lips of the cartilage graft. Postoperative cholesteatoma was not observed in any of the patients in our study, and it was not reported in previous studies. Due to the opacity of the cartilage graft, the middle ear can not be evaluated clearly in the postoperative period. Magnetic resonance imaging may be preferred if cholesteatoma is suspected[19,20].

In this study, we present our results with the endoscopic butterfly tympanoplasty for large perforations which has ossicular chain pathologies. We applied this technique in patients who cannot be treated with the conventional butterfly technique. The retrospective kind of the study and the small number of cases are the limitations of the study. This study is a preliminary report, and we suggest the results of this study should be further supported by future studies with a larger number of patients to confirm the success of our modified endoscopic butterfly tympanoplasty technique.

Consequently, the endoscopic modified butterfly tympanoplasty technique is a minimally invasive technique that can provide successful results in large perforations with defective incudostapedial joint. Transcanal implementation, lack of requirement for multiple incisions, short duration of hospitalization are the advantages of this technique compared to other conventional modes of surgical interventions.

Yazar Katkıları: Çalışma konsepti/Tasarımı: BE, MEK; Veri toplama: MEK, SA; Veri analizi ve yorumlama: BE, MEK; Yazı taslağı: BE, MEK; İçeriğin eleştirel incelenmesi: BE, MEK, SA; Son onay ve sorumluluk: MEK, BE, SA; Teknik ve malzeme desteği: MEK, SA; Süpervizyon: MEK, BE; Fon sağlama (mevcut ise): yok.
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Author Contributions: Concept/Design : BE, MEK; Data acquisition: MEK, SA; Data analysis and interpretation: BE, MEK; Drafting manuscript: BE, MEK; Critical revision of manuscript: : BE, MEK, SA; Final approval and accountability: BE, MEK, SA; Technical or material support: MEK, SA; Supervision: MEK, BE; Securing funding (if available): n/a.

Ethical Approval: Ethical approval was obtained for this study from the Ethics Committee of Harran University Faculty of Medicine with the decision dated 10.12.2018 and numbered 18/12/08.
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Conflict of Interest: Authors declared no conflict of interest.
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