

Endoscopic Type 1 Tympanoplasty: Evaluation of Clinical Success and Hearing Improvement

Endoskopik Tip 1 Timpanoplasti: Klinik Başarı ve İşitme İyileşmesinin İncelenmesi

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ABSTRACT

Objective: This study aimed to assess the functional and clinical outcomes of endoscopic Type 1 tympanoplasty in patients with chronic otitis media and tympanic membrane perforations, focusing on hearing improvement and graft success rates.

Methods: This retrospective study included 46 patients with dry tympanic membrane perforations who underwent endoscopic Type 1 tympanoplasty. Audiometric data, including pure tone averages (PTA) and air-bone gap (ABG) measurements at four frequencies (500, 1000, 2000, and 4000 Hz), were collected preoperatively and postoperatively. Functional success was defined as a postoperative ABG of 20 dB, whereas the integrity of the graft determined clinical success.

Results: The mean preoperative ABG was 36.74±7.62 dB, which significantly improved to 15.05±3.82 dB postoperatively (p<0.001). The PTA exhibited an average gain of 28.17±6.87 dB for all frequencies. Functional success was achieved in 42 patients (91.30%), with 17 patients (36.96%) achieving normal hearing and 22 patients (47.83%) presenting with slight hearing loss postoperatively. Anatomical success was achieved in 42 patients (91.30%).

Conclusions: Endoscopic Type 1 tympanoplasty is a safe and effective surgical method for treating chronic otitis media, with high rates of both functional and clinical success, significant improvements in hearing outcomes, and minimal postoperative complications.

Keywords: Type 1 tympanoplasty, chronic otitis media, endoscopic approach, tragal perichondrium graft, hearing improvement, graft success

ÖZ

Amaç: Bu çalışma, kronik otitis media ve timpanik membran perforasyonu olan hastalarda endoskopik Tip 1 timpanoplastinin fonksiyonel ve klinik sonuçlarını, işitme iyileşmesi ve greft başarı oranlarına odaklanarak değerlendirmeyi amaçlamaktadır.

Yöntemler: Kuru timpanik membran perforasyonu bulunan 46 hastaya uygulanan endoskopik Tip 1 timpanoplastinin retrospektif analizi yapılmıştır. Saf ses ortalamaları (SSO) ve hava-kemik aralığı (HKA) ölçümleri de dahil olmak üzere dört frekansta (500, 1000, 2000 ve 4000 Hz) odyometrik veriler ameliyat öncesi ve sonrası toplanmıştır. Fonksiyonel başarı, ameliyat sonrası HKA'nin 20 dB'nin altında olması olarak tanımlanırken, klinik başarı greftin bütünlüğü ile değerlendirilmiştir.

Bulgular: Ameliyat öncesi ortalama HKA 36.74±7.62 dB iken, ameliyat sonrası bu değer anlamlı bir iyileşme göstererek 15.05±3.82 dB'ye düşmüştür (p<0.005). SSO'da tüm frekanslarda ortalama 28.17±6.87 dB kazanç sağlanmıştır. Fonksiyonel başarı 42 hastada (%91.30) elde edilmiş olup, 17 hasta (%36.96) normal işitmeye ulaşırken, 22 hasta (%47.83) ameliyat sonrası hafif işitme kaybı göstermiştir. Anatomik başarı, timpanik membran greftinin sağlam kalması ile belirlenmiş ve 42 hastada (%91.30) başarı elde edilmiştir.

Sonuçlar: Endoskopik Tip 1 timpanoplasti, kronik otitis media tedavisinde güvenli ve etkili bir cerrahi yöntem olup, yüksek oranda fonksiyonel ve klinik başarı, anlamlı işitme iyileşmeleri ve minimal postoperatif komplikasyonlar sağlamaktadır.

Anahtar kelimeler: Tip 1 timpanoplasti, kronik otitis media, endoskopik yaklaşım, tragal perikondrium grefti, işitme iyileşmesi, greft başarısı

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INTRODUCTION

Chronic otitis media (COM) is a persistent middle ear inflammation that frequently leads to tympanic membrane (TM) perforation. This condition is associated with recurrent infections and hearing loss and can significantly affect quality of life^{1,2}. The surgical management of TM perforations aims to restore membrane integrity, improve hearing, and prevent further episodes of infection. Tympanoplasty, a well-established procedure, is the preferred method for achieving these outcomes by reconstructing the perforated membrane and often utilizing autologous grafts, such as the fascia, cartilage, or perichondrium³⁻⁷.

Traditional tympanoplasty approaches, such as retroauricular and endaural techniques, involve the use of a microscope, which offers a three-dimensional view of the surgical field and the ability to operate with both hands. However, these techniques may require larger incisions and are associated with certain limitations, particularly when addressing anteriorly located perforations. Over the last decade, there has been growing interest in minimally invasive approaches, including endoscopic tympanoplasty (ET)^{8,9}.

ET, introduced as a viable alternative to microscopic methods, offers several advantages, including enhanced visualization of hidden anatomical structures, such as the sinus tympani, anterior TM, and ossicular chain. Using angled endoscopes, surgeons can access regions of the middle ear that are difficult to visualize using traditional approaches. This minimally invasive technique allows for transcanal access, avoiding external incisions, and often results in shorter hospital stays and quicker recovery times. Despite these advantages, the clinical outcomes of ET, particularly hearing improvement and graft success, remain areas of ongoing study¹⁰⁻¹².

Our study aimed to evaluate the clinical success and hearing improvement of endoscopic type I tympanoplasty. By analyzing preoperative and postoperative audiometric outcomes and surgical success rates in a cohort, we aim to provide valuable insights into the efficacy of this minimally invasive technique in managing COM with TM perforation.

MATERIALS and METHODS

This Study

This single-center, retrospective study was conducted between January 2022 and June 2024 at the Otorhinolaryngology Department of Melhem International Hospital, Baku, Azerbaijan. This study

adhered to the Declaration of Helsinki's highest ethical standards and principles. Informed consent was obtained from all participants, ensuring anonymity and confidentiality. The Ministry of Health of the Republic of Azerbaijan, State Advanced Training Institute for the Doctors named after A. The Aliyev Local Ethics Committee approved this study (decision no: EaR.No:1/09.02.2024-2, date: 09.02.2024). There are no conflicts of interest to declare, and the manuscript respects participant privacy and aligns with relevant ethical guidelines. Forty-six patients diagnosed with COM and TM perforation underwent endoscopic Type I tympanoplasty. All participants provided written informed consent for study participation. Patients were selected based on specific inclusion and exclusion criteria. Only patients with large external auditory canals, no history of previous revision surgery, and who did not require ossicular chain reconstruction were included. Patients underwent a thorough audiometric evaluation before surgery, followed by at least 3 months of postoperative follow-up audiometric testing.

Inclusion Criteria

- Patients with conductive hearing loss due to COM and TM perforation.
- No revision surgeries were performed before the study.
- Dry TM perforations for at least two months before surgery.
- Age > 18 years

Exclusion Criteria

- Patients requiring ossicular chain reconstruction.
- Patients with middle ear or mastoid pathology.
- Incomplete follow-up or inadequate preoperative data.
- Age < 18

Surgical Procedure

Endoscopic Type I tympanoplasty was performed under general anesthesia. A 0-degree rigid endoscope (4 mm diameter) was used for transcanal approach in all patients. After preparing the ear, the perforation margins were freshened. The tragal perichondrium was harvested and used as the graft material. Grafting was performed using the over-underlay technique, and the graft was carefully positioned to cover the perforation. The tympanomeatal flap was replaced, and the ear canal was filled with Gelfoam and a hydrocortisone-Furacillin

mixture gauze. All patients were discharged on the same day after the procedure, and follow-up assessments were conducted at 2 and 4 months postoperatively, with audiometric testing repeated after 3 months.

Data Collection and Evaluation

Demographic data, including age, sex, and the affected ear, were collected from all 46 patients who underwent endoscopic Type I tympanoplasty. Preoperative evaluations included computed tomography to assess middle ear pathology and audiometric tests to determine baseline hearing levels. The audiometric assessment included pure-tone audiometry at four frequencies (0.5, 1, 2, and 4 kHz). Postoperative audiometric data were collected at least 3 months after surgery, and audiometry was performed using appropriate masking techniques. The pure-tone average (PTA) was calculated preoperatively and postoperatively across the same four frequencies for each patient. The American Speech-Language-Hearing Association classification system categorizes hearing loss¹³. Postoperative PTA of 25 decibel (dB) or lower indicated functional hearing improvement¹⁴. The air-bone gap (ABG) was calculated by subtracting the bone conduction (BC) thresholds from the air conduction thresholds at 500, 1000, 2000, and 4000 Hz, both preoperatively and postoperatively. The ABG gain, which represents hearing improvement, was determined as the difference between the preoperative and postoperative ABG values for each ear. Success was defined as a postoperative ABG of 20 dB, whereas an ABG > 21 dB was classified as "not success."¹⁴⁻¹⁶. Anatomical success was assessed during follow-up examinations, focusing on the condition of the TM. Clinical success was defined as the graft remaining intact without any reperforation. The rate of TM preservation was calculated by observing patients during follow-up otoscopic examinations conducted at two and four months postoperatively^{17,18}. The clinical findings and audiometric outcomes assessed the surgery's functional and anatomical success.

Statistical Analysis

Descriptive statistics were used to summarize the clinical and audiometric data, including the mean and standard deviation for preoperative and postoperative PTAs and ABG. The Kolmogorov-Smirnov and Shapiro-Wilk tests were used to assess the normality of data distribution. Depending on the results, parametric or non-parametric tests (such as the paired t-test or Wilcoxon signed-rank test) were applied to compare preoperative and postoperative audiometric outcomes. A p-value 0.05 was considered statistically significant. All analyses were performed using SPSS version 24.0 (IBM Corp. Released

2016. IBM SPSS Statistics for Windows, Version 24.0. Armonk, NY: IBM Corp.).

RESULTS

In total, 46 patients underwent unilateral Type I tympanoplasty. Of these, 28 were female (60.87%), and 18 were male (39.13%) were male, with a mean age of 35.84 ± 10.34 years at the time of surgery. The mean follow-up period was 10.28 ± 3.46 months. Regarding comorbidities, 11 patients (23.91%) had hypertension, and two patients (4.35%) patients had diabetes mellitus. Most patients (86.96%) were non-smokers, while six patients (13.04%) were smokers. Surgery was performed on the right ear in 18 patients (39.13%) and the left ear in 28 (60.87%).

Audiometric Parameters

The preoperative ABG across four frequencies (500 Hz, 1000 Hz, 2000 Hz, and 4000 Hz) showed significant improvement. The mean preoperative ABG values were 36.74 ± 7.62 dB at 500 Hz, 36.52 ± 7.66 dB at 1000 Hz, 39.57 ± 6.31 dB at 2000 Hz, and 34.46 ± 7.47 dB at 4000 Hz. Postoperatively, these values were reduced to 18.48 ± 9.06 dB at 500 Hz, 15.87 ± 4.98 dB at 1000 Hz, 18.80 ± 5.29 dB at 2000 Hz, and 13.26 ± 4.50 dB at 4000 Hz. The ABG gain, representing the improvement in hearing, ranged from 18.26 dB to 21.20 dB across the frequencies, with p-values of less than 0.005, indicating a statistically significant improvement (Table 1).

Functional and Clinical Out-comes

The functional success rate, defined as achieving a postoperative ABG of 20 dB, was observed in 42 of 46 patients (91.30%). In terms of hearing improvement, 39 patients (84.78%) achieved hearing success, which was defined as slight or normal hearing after surgery. Preoperatively, 43 patients (93.48%) had moderate hearing loss and three (6.52%) had mild hearing loss.

After surgery, 17 patients (36.96%) achieved normal hearing and 22 (47.83%) had slight hearing loss. Only four patients (8.70%) continued to experience mild hearing loss postoperatively. The results showed significant hearing improvements ($p < 0.001$), with a clear shift from moderate hearing loss to normal or slight hearing levels postoperatively (Table 2).

Anatomical Success

Anatomical success, defined by the integrity of the TM and successful grafting, was achieved in 42 out of 46 patients (91.30%). The graft remained intact in all patients during follow-up, indicating high clinical success.

Table 1. Frequency-specific hearing outcomes in endoscopic type 1 tympanoplasty.				
Parameters	500 Hz	1000 Hz	2000 Hz	4000 Hz
Preop. ABG	36.74±7.62	36.52±7.66	39.57±6.31	34.46±7.47
Postop. ABG	18.48±9.06	15.87±4.98	18.80±5.29	13.26±4.50
ABG gain	18.26±7.24	20.65±8.60	20.76±7.96	21.20±7.61
Pre-Post. ABG	p<0.005	p<0.005	p<0.005	p<0.005
p-values	1.56154E-17	4.01789E-27	8.08495E-31	3.13625E-29

ABG: And air-bone gap.

Table 2. Comprehensive clinical and functional outcomes in endoscopic type 1 tympanoplasty.		
Parameters	Total ear (±SD) (n=46)	
Age	35.84±10.34	
Follow-up period (month)	10.28±3.46	
Gender (n/%)	F	28 patients (60.87%)
	M	18 patients (39.13%)
Smokingn((n/%)	Non-smoker	40 patients (86.96%)
	Smoker	6 patients (13.04%)
Comorbidity (n/%)	HT	11 patients (23.91%)
	DM	2 patients (4.35%)
Side (n/%)	Right	18 patients (39.13%)
	Left	28 patients (60.87%)
ABG	Mean (dB)	16.60± 3.09
	Success (number of patients) (postop total ABG <20)	42 patients (91.30%)
PTA	Preoperative mean (dB)	46.72±6.10
	Postoperative mean (dB)	19.57±5.76
	Gain (total±SD)	27.15±6.09
	Pre-postoperative. PTA	p<0.005
	p-values	3.30701E-38
Hearing Success (number of patients) (Postop "Slight hearing loss+normal hearing")		39 patients (84.78%)
Preoperative	Moderate hearing loss	43 patients (93.48%)
	Mild hearing loss	3 patients (6.52%)
Postoperative	Slight hearing loss	22 patients (47.83%)
	Normal hearing	17 patients (36.96%)
	Mild hearing loss	4 patients (8.70%)
Clinical Success (number of patients)		42 patients (91.30%)

M: Male, F: Female, H: Hypertension, DM: Diabetes mellitus, dB: Desibel, SD: Standard deviation, PTA: Pure tone averages.

DISCUSSION

Tympanoplasty is commonly performed in otologic surgery, and microscopic and endoscopic approaches offer unique advantages. Although microscopic techniques allow for a two-handed operation and a three-dimensional view, they are limited in visualizing

anterior perforations. In contrast, ET provides a broader field of view, especially with angled scopes, and improves access to difficult areas like the anterior TM, attic, and facial recess^{9,10,19}.

Despite its advantages, ET presents challenges such as a steep learning curve, single-hand operation, two-

dimensional view complicating depth perception, heat from light sources potentially posing risks, and smaller-diameter endoscopes limiting wide-angle views. However, these issues can be mitigated with experience and adjustments to light intensity^{20,21}.

Nevertheless, the endoscopic approach offers key benefits, including reduced operative time, improved cosmetic outcomes, faster recovery, and preservation of middle ear anatomy, leading to higher graft success and functional hearing improvement, with growing expertise further enhancing its efficacy in treating TM perforations²². ET outcomes have been well documented, particularly for large TM perforations. Choi et al.²²'s multicenter study in South Korea, involving 239 patients, reported a graft success rate of 86.2% for large or subtotal TM perforations, slightly lower than the 91.30% success rate achieved in our study. Notably, their results were influenced by the surgical technique, with the lateral underlay method showing superior outcomes ($P=0.027$), consistent with our focus on stable graft placement. Choi et al.²² also reported an average ABG improvement of 10.0 ± 0.6 dB in the graft success group, whereas our study showed a more significant ABG reduction from 36.74 ± 7.62 dB preoperatively to 15.05 ± 3.82 dB postoperatively ($p<0.005$), demonstrating the effectiveness of our ET approach. This finding could be attributed to the targeted methodology and surgical expertise of our cohort. Additionally, Choi et al.²² noted improvements in BC thresholds at 500 Hz ($p=0.028$), a finding mirrored by significant BC improvements in our study, highlighting ET's role in enhancing inner ear function. These comparisons show that while larger studies like Choi et al.²²'s validate ET broadly, our focused study aligns with and builds on these findings, underscoring ET's strong outcomes even in developing regions like Azerbaijan.

Sakagami et al.²³ conducted a study evaluating microscopic transcanal tympanoplasty and reported a perforation closure success rate of 76% and an improvement in the ABG of 11.8 dB postoperatively. In comparison, our endoscopic approach achieved a higher closure success rate of 91.30% and a more significant improvement in the ABG, with a mean reduction of over 18 dB. These results suggest that the endoscopic approach may provide superior outcomes in terms of both graft success and hearing improvement.

In the study by Usami et al.²⁴, the authors evaluated 22 patients who underwent endoscopic-assisted tympanoplasty, reporting a perforation closure success rate of 81.8% and an average improvement in the ABG of 14.8 dB. Our study demonstrated a higher perforation

closure success rate and a more significant improvement in hearing outcomes. Although both studies highlighted the efficacy of endoscopic techniques, our results suggest that the methods employed in our procedure may lead to enhanced anatomical success and better hearing improvement.

The outcomes of ET for large TM perforations have been explored in various studies^{6,8,11,12,22,25}, including those by Casas et al.²⁵, who reported a 94.4% graft success rate for subtotal and total perforations using a composite graft technique. This is notably higher than the success rate of 78.3% observed with classical underlay methods. Their study also highlighted that the mean postoperative ABG was reduced to 10 ± 10 dB, indicating significant hearing improvement. These findings resonate with our study's results, where we achieved a 91.30% graft success rate and improved the mean ABG from 36.74 ± 7.62 dB preoperatively to 15.05 ± 3.82 dB postoperatively ($p<0.005$), highlighting comparable effectiveness. The use of a composite graft to minimize the risk of anterior graft medialization, as described by Casas et al.²⁵, aligns with our focus on stable and precise graft placement. This approach reinforces the value of advanced grafting techniques for enhancing anatomical and functional outcomes. While Casas et al.²⁵ emphasized the stability provided by cartilage in subtotal and total perforations, our study underscores similar stability and effectiveness in achieving successful outcomes even with single-session ET. These comparative insights underline that ET, whether with composite or traditional grafts, can yield high success rates and significant audiometric gains, contributing valuable data to the growing evidence supporting ET's reliability.

The comparative analysis of grafting techniques is crucial for assessing ET outcomes. Lee et al.²⁶ conducted a retrospective study on Type I tympanoplasty in patients with severe middle ear granulation cases showed a 91% graft success rate of 91% for fascia, 100% for cartilage island grafts, and 100% for cartilage palisades. Our study's graft success rate of 91.30% was in close agreement with these outcomes, particularly for the cartilage-based techniques. Lee et al.²⁶ also reported significant improvements in PTA and ABG in most groups, except the cartilage palisade group. In contrast, our study showed a significant reduction in ABG from 36.74 ± 7.62 dB preoperatively to 15.05 ± 3.82 dB postoperatively ($p<0.001$), reinforcing the effectiveness of our endoscopic approach. These findings highlight that although different techniques yield different outcomes, our method is associated with consistent audiological and anatomical success.

Recent advancements in ear diseases have focused on developing innovative techniques and surgical approaches, particularly for treating COM sequelae, cochlear implant, tinnitus, etc.²⁷⁻²⁹. In tympanoplasty, contemporary innovations primarily involve optimizing grafting techniques during procedures performed with microscopic or endoscopic assistance^{7,30}. As an otolaryngologist practicing in a developing country, applying the well-established endoscopic tragal perichondrium graft technique can improve surgical success rates. This approach ensures reliable patient outcomes and contributes region-specific data to the existing otologic literature.

The main strength of our study lies in its focus on the endoscopic transcanal approach, which allowed for a minimally invasive procedure with high graft success rates (91.30%) and hearing improvement. Detailed preoperative and postoperative audiometric data confirmed the technique's efficacy. However, one limitation of the study is its retrospective design and relatively small sample size of 46 patients, which may limit the generalizability of the findings. Additionally, the study did not include a control group that used microscopic techniques, which could have provided a more direct comparison of outcomes.

This study is the first documented study on ET outcomes in Azerbaijan, and it makes a significant contribution to the regional otologic literature. Highlighting these findings underscores the importance of advancing surgical techniques and reporting outcomes in developing countries and enriching the global understanding of ET's efficacy.

CONCLUSION

This study demonstrated the efficacy and safety of unilateral Type I tympanoplasty using an endoscopic transcanal approach. The procedure led to significant hearing improvements, with a functional success rate of 91.30%, and clinical success, defined by intact grafts, was also 91.30%. Conclusion: Endoscopic type I tympanoplasty is a highly effective, minimally invasive treatment for COM with tympanic

Ethics

Ethics Committee Approval: The Aliyev Local Ethics Committee approved this study (decision no: EaR. No:1/09.02.2024-2, date: 09.02.2024).

Informed Consent: Informed consent was obtained from all participants, ensuring anonymity and confidentiality.

Footnote

Author Contributions

Surgical and Medical Practices: A.A., Concept: A.A., Design: A.A., R.H., Data Collection and/or Processing: A.A., R.H., Analysis and/or Interpretation: A.A., R.H., Literature Search: A.A., R.H., Writing: A.A.

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