Volume 4, Issue 6, 2026

Frontier in Medical & Health Research

ISSN: (e) 3007-1607 (p) 3007-1593

ASSESSMENT OF HEARING IMPROVEMENT AND GRAFT UPTAKE RATES IN ENDOSCOPIC AND MICROSCOPIC TYMPANOPLASTY: A COMPARATIVE STUDY

Saria Shahzadi[1], Muhammad Ahmad Raza[*2], Ayesha Iqbal[3], Waqar Ahmad[4], Raheel Abrar[5], Asif Hidayat[6]

[1]*MS Speech Language Pathology & Hearing Sciences, Department of Rehabilitation, University of Lahore, Lahore, Punjab, Pakistan*

[*2]*HOD/Lecturer, Department of Radiography & Imaging Technology, Hussain College of Health Sciences, Lahore, Punjab, Pakistan*

[3]*PhD Scholar (Biochemistry), Department of Biochemistry, Government College University, Faisalabad, Punjab, Pakistan*

[4]*Lecturer, University Institute of Radiological Sciences & MIT, University of Lahore, Lahore, Punjab, Pakistan*

[5]*BMIS (9th Semester Student), University Institute of Radiological Sciences & MIT, University of Lahore, Lahore, Punjab, Pakistan*

[6]*BMIS (9th Semester Student), University Institute of Radiological Sciences & MIT, University of Lahore, Lahore, Punjab, Pakistan*

[1]sariashahzadi541@gmail.com, [*2]dr.ahmad663@gmail.com, [3]ayeshaiqbal58538@gmail.com, [4]waqar.ahmad@rsmi.uol.edu.pk, [5]70131757@student.uol.edu.pk, [6]asifbaloch2754@gmail.com

[2]0009-0002-2932-8424, [4]0009-0005-7477-6615

DOI: https://doi.org/10.5281/zenodo.21389709

Keywords

Endoscopic and Microscopic Tympanoplasty, Graft Uptake Rates, Hearing Improvement

Article History

Received: 02 May 2026
Accepted: 15 June 2026
Published: 30 June 2026

Corresponding Author: *
Muhammad Ahmad Raza

Abstract

Objective: *To compare Audiological outcomes of endoscopic and microscopic tympanoplasty by assessing postoperative air conduction, bone conduction, and air–bone gap improvement*

Material & Methods: *A cross-sectional study was conducted at the ENT and Surgical Department, Mayo Hospital Lahore, who underwent Type I endoscopic or microscopic tympanoplasty. Audiological outcomes, graft success, operative time, postoperative complications, and hospital stay were compared between the two techniques. Data were analyzed using SPSS version 20.0, with $p < 0.05$ considered statistically significant.*

Results: *A total of 240 patients were included, with comparable baseline age, gender, perforation size, and revision status between the endoscopic and microscopic tympanoplasty groups ($p > 0.05$). Significant differences were observed only in disease laterality, perforation location, and anesthesia type ($p < 0.05$). Preoperative audiological parameters were largely similar between groups, except for operative-side speech discrimination score and low-tone hearing threshold. Both surgical techniques produced significant postoperative improvements in air conduction, air–bone gap, and low- and high-tone hearing thresholds (all $p < 0.05$), while bone conduction thresholds remained unchanged. The endoscopic group demonstrated a higher graft success rate than the microscopic group (93.3%*

Volume 4, Issue 6, 2026

Frontier in Medical & Health Research

ISSN: (e) 3007-1607 (p) 3007-1593

vs. 86.7%), although the difference was not statistically significant ($p = 0.083$). Rates of re-perforation, otorrhea, otalgia, and wound infection were comparable between groups (all $p > 0.05$). However, endoscopic tympanoplasty was associated with a significantly shorter operative time (80.11 ± 10.81 vs. 95.01 ± 17.21 minutes; $p < 0.001$) and a shorter hospital stay (5.12 ± 2.01 vs. 8.09 ± 1.27 days; $p < 0.001$).

Conclusion: *The audiological outcomes of Type I endoscopic tympanoplasty were comparable to those of microscopic tympanoplasty, with no significant differences in hearing improvement between the two techniques. However, endoscopic tympanoplasty was associated with a significantly shorter operative time and reduced length of hospital stay, indicating greater surgical efficiency while maintaining similar clinical outcomes.*

Introduction

Tympanoplasty is a commonly performed surgical procedure used to repair a perforated tympanic membrane (eardrum) and reconstruct damaged middle ear structures to prevent recurrent infections and restore hearing. Traditionally, the procedure has been performed using an operating microscope, which provides excellent magnification, illumination, three-dimensional visualization, and depth perception, allowing surgeons to operate with both hands. However, advances in endoscopic technology have led to the increasing use of endoscopic tympanoplasty, in which a rigid endoscope is introduced through the external auditory canal to visualize and repair the middle ear. Initially used only for diagnostic purposes, endoscopes are now widely employed in various otologic procedures, including tympanoplasty, cochlear implantation, otitis media surgery, and otosclerosis surgery[1,2]. Compared with microscopic tympanoplasty, the endoscopic approach is considered minimally invasive because it generally avoids large postauricular incisions, resulting in improved cosmetic outcomes, less tissue trauma, reduced postoperative pain, and faster patient recovery. Additionally, the wide-angle view provided by the endoscope allows surgeons to directly visualize anatomically hidden regions of the middle ear, such as the sinus tympani, epitympanum, and facial recess, which are often difficult or impossible to inspect adequately using a microscope[3,4].

Despite these advantages, endoscopic tympanoplasty has certain limitations. Unlike the operating microscope, which provides a three-dimensional view and excellent depth perception, the endoscope offers only a two-dimensional image, making it more challenging to accurately judge the depth of delicate middle ear structures. Furthermore, the surgeon must hold the endoscope with one hand while performing the operation with the other, limiting bimanual dexterity and making fine surgical maneuvers, bleeding control, and graft placement more technically demanding. Successful performance of endoscopic tympanoplasty therefore requires considerable training, experience, and familiarity with endoscopic anatomy, resulting in a steeper learning curve compared with the conventional microscopic technique[5].

Previous studies comparing endoscopic and microscopic tympanoplasty have reported favorable outcomes for both techniques; however, many of these investigations had important methodological limitations. Most studies involved multiple surgeons with varying levels of expertise, introducing variability due to differences in surgical skills and experience rather than the techniques themselves. In addition, the majority of earlier research primarily evaluated hearing improvement while giving less attention to other clinically relevant outcomes such as graft success, operative time, postoperative complications, and duration of hospital stay[6-9]. To overcome these limitations, the present study included surgeries performed by three surgeons experienced in both endoscopic and microscopic techniques, thereby minimizing the influence of the learning curve and reducing surgeon-related

Frontier in Medical & Health Research

ISSN: (e) 3007-1607 (p) 3007-1593

bias. Besides assessing audiological improvement, the study also evaluated graft uptake rates, surgical duration, frequency of postoperative complications, and length of hospitalization to provide a more comprehensive comparison of the two approaches[10].

The study was particularly important because there is limited local evidence comparing endoscopic and microscopic tympanoplasty in the Pakistani population under standardized surgical conditions. As the adoption of endoscopic ear surgery continues to increase due to its minimally invasive nature and potential clinical benefits, it is essential to determine whether these advantages translate into improved patient outcomes within local healthcare settings. Therefore, the primary objective of this study was to compare the efficacy of endoscopic and microscopic tympanoplasty by evaluating hearing improvement, graft success, operative efficiency, postoperative complications, and recovery outcomes, thereby determining the overall comparative effectiveness of both surgical techniques in the management of tympanic membrane and middle ear diseases.

Material & Method

A Cross sectional study was conducted at the ENT and Surgical Department, Mayo Hospital Lahore, from 26 August 2024 to 30 January 2026. A total of 240 adult patients undergoing Type I endoscopic or microscopic tympanoplasty without ossicular reconstruction were enrolled using convenience sampling. The sample size was calculated using G Power software, and ethical approval was obtained. Patients with previous otologic surgery or inadequate follow-up were excluded. Participants were divided into endoscopic and microscopic groups based on the surgical technique used. Preoperative and postoperative hearing was evaluated using pure-tone audiometry, air-bone gap measurements, speech audiometry, and image-based assessment of tympanic membrane perforation size. To minimize bias, all procedures were performed by three experienced surgeons using standardized surgical protocols. Endoscopic tympanoplasty employed a transcanal approach with tragal perichondrium grafts, while microscopic tympanoplasty used a postauricular approach with temporalis fascia grafts. Patients were followed for at least three months, with audiological improvement as the primary outcome and operative time, graft uptake, postoperative complications, and hospital stay as secondary outcomes. Data were analyzed using SPSS version 20.0, with continuous variables compared using the independent t-test and categorical variables using the chi-square test. Statistical significance was defined as $p < 0.05$.

Results

The baseline demographic and clinical characteristics of 240 patients in the endoscopic and microscopic tympanoplasty groups. The mean age was 35.8 ± 11.4 years in the endoscopic group and 37.4 ± 10.9 years in the microscopic group, with no statistically significant difference between the groups ($p = 0.27$). Similarly, the gender distribution was comparable, with males accounting for 58 (48.3%) and 63 (52.5%) patients in the endoscopic and microscopic groups, respectively ($p = 0.52$). A statistically significant difference was observed in the laterality of disease between the two groups. Right-sided ear involvement was more frequent in the microscopic group (65.8%) than in the endoscopic group (35.0%), whereas left-sided involvement was more common in the endoscopic group (65.0% vs. 34.2%; $p < 0.001$). Likewise, perforation location differed significantly between the groups, with anterior inferior quadrant perforations occurring more frequently in the endoscopic group (75.0%) compared with the microscopic group (57.5%), while posterior inferior quadrant perforations were more common in the microscopic group (42.5% vs. 25.0%; $p = 0.001$). The type of anesthesia also differed significantly between groups. General anesthesia was used in 100 (83.3%) patients in the endoscopic group and 115 (95.8%) patients in the microscopic group, whereas local anesthesia was administered to 20 (16.7%) and 5 (4.2%) patients, respectively ($p = 0.002$). There was no significant difference in the relative perforation size between the endoscopic

Frontier in Medical & Health Research

ISSN: (e) 3007-1607 (p) 3007-1593

and microscopic groups (39.2 ± 11.6% vs. 41.3 ± 12.2%, p = 0.17). Similarly, the proportion of revision surgeries was low and comparable between the groups (1.7% vs. 2.5%, p = 0.65), indicating no statistically significant difference. Overall, both groups were comparable in terms of age, gender, perforation size, and revision status, whereas significant differences were observed in laterality, perforation location, and anesthesia type (Table 1).

Table 1: Patient Characters (n=240)

Variables	Endoscopic Group Mean ± SD/ Frequency	Microscopic Group Mean ± SD /Frequency	p-Value
Mean Age	35.8 ± 11.4	37.4 ± 10.9	0.27
Gender			
Male	58 (48.3%)	63 (52.5%)	0.52
Female	62 (51.7%)	57 (47.5%)	
Laterality			
Right	42 (35%)	79 (65.8%)	<0.001
Left	78 (65%)	41 (34.2%)	
Perforation Location			
Anterior Inferior Quadrant	90 (75%)	69 (57.5%)	0.001
Posterior Inferior Quadrant	30 (25%)	51 (42.5%)	
Anesthetic			
General	100 (83.3%)	115 (95.8%)	0.002
Local	20 (16.7%)	5 (4.20%)	
Relative Perforation Size	39.2 ± 11.6	41.3 ± 12.2	0.17
Revisions	2(1.7%)	3 (2.5%)	0.65

Table 2 compares the preoperative audiological parameters between the endoscopic and microscopic tympanoplasty groups. On the operative side, the mean air conduction threshold (40.31 ± 15.88 dB vs. 40.41 ± 19.23 dB; p = 0.968), mean bone conduction threshold (19.21 ± 13.34 dB vs. 18.91 ± 14.43 dB; p = 0.879), and mean air–bone gap (21.19 ± 7.69 dB vs. 20.61 ± 9.41 dB; p = 0.632) were comparable between the endoscopic and microscopic groups, with no statistically significant differences. The endoscopic group demonstrated a significantly higher speech discrimination score (97.80 ± 9.49% vs. 93.63 ± 18.14%; p = 0.045) and a significantly higher mean low-tone hearing threshold (49.67 ± 21.72 dB vs. 42.12 ± 16.17 dB; p = 0.006). However, the mean high-tone hearing threshold did not differ significantly between the groups (51.50 ± 20.40 dB vs. 52.91 ± 22.52 dB; p = 0.644). On the contralateral side, there were no statistically significant differences between the two groups. Mean air conduction (23.71 ± 16.95 dB vs. 21.31 ± 14.58 dB; p = 0.283), mean bone conduction (25.43 ± 13.43 dB vs. 24.09 ± 16.41 dB; p = 0.525), and speech discrimination scores (98.12 ± 3.94% vs. 99.01 ± 6.19%; p = 0.235) were similar in the endoscopic and microscopic groups. Overall, the baseline audiological characteristics were largely comparable between the two groups, with significant differences observed only in operative-side speech discrimination scores and low-tone hearing thresholds.

Table 2: Pre-operative Audiological Parameters (n=240)

Variables	Endoscopic Group	Microscopic Group	p-Value

Frontier in Medical & Health Research

ISSN: (e) 3007-1607 (p) 3007-1593

	(Mean ± SD)	(Mean ± SD)	
Operative Side			
Mean Air Conduction (dB)	40.31 ± 15.88	40.41 ± 19.23	0.968
Mean Bone Conduction (dB)	19.21 ± 13.34	18.91 ± 14.43	0.879
Mean Air–Bone Gap (dB)	21.19 ± 7.69	20.61 ± 9.41	0.632
Speech Discrimination Score	97.80 ± 9.49	93.63 ± 18.14	0.045
Mean Low-Tone Threshold	49.67 ± 21.72	42.12 ± 16.17	0.006
Mean High-Tone Threshold	51.50 ± 20.4	52.91 ± 22.52	0.644
Contralateral Side			
Mean Air Conduction (dB)	23.71 ± 16.95	21.31 ± 14.58	0.283
Mean Bone Conduction (dB)	25.43 ± 13.43	24.09 ± 16.41	0.525
Speech Discrimination Score	98.12 ± 3.94	99.01 ± 6.19	0.235

Table 3 compares the preoperative and postoperative audiological outcomes within the endoscopic and microscopic tympanoplasty groups. In the endoscopic group, the mean air conduction threshold improved significantly from 40.31 ± 15.88 dB preoperatively to 31.21 ± 18.42 dB postoperatively ($p < 0.001$). Similarly, the mean air–bone gap decreased significantly from 21.19 ± 7.69 dB to 9.54 ± 5.32 dB ($p < 0.001$). Significant improvements were also observed in the low-tone hearing threshold, which decreased from 49.67 ± 21.72 dB to 27.54 ± 19.92 dB ($p < 0.001$), and in the high-tone hearing threshold, which improved from 51.50 ± 20.40 dB to 44.34 ± 19.40 dB ($p = 0.003$). However, the change in bone conduction threshold was not statistically significant (19.21 ± 13.34 dB vs. 18.65 ± 12.90 dB; $p = 0.214$). Similarly, in the microscopic group, the mean air conduction threshold improved significantly from 40.41 ± 19.23 dB preoperatively to 30.34 ± 17.01 dB postoperatively ($p < 0.001$). The mean air–bone gap also showed a significant reduction from 20.61 ± 9.41 dB to 10.12 ± 6.44 dB ($p < 0.001$). Significant improvements were observed in both low-tone hearing thresholds (42.12 ± 16.17 dB vs. 28.00 ± 18.84 dB; $p < 0.001$) and high-tone hearing thresholds (52.91 ± 22.52 dB vs. 46.94 ± 20.71 dB; $p = 0.009$). In contrast, bone conduction thresholds remained stable, with no statistically significant difference between the preoperative and postoperative values (18.91 ± 14.43 dB vs. 19.35 ± 11.49 dB; $p = 0.348$).

Table 3: Comparison of Preoperative and Postoperative Hearing Thresholds

Variable	Endoscopic Group		p-Value	Microscopic Group		p-Value
	Pre-operative Mean ± SD	Post-operative Mean ± SD		Pre-operative Mean ± SD	Post-operative Mean ± SD	
Air Conduction	40.31 ± 15.88	31.21 ± 18.42	<0.001	40.41 ± 19.23	30.34 ± 17.01	<0.001
Bone Conduction	19.21 ± 13.34	18.65 ± 12.90	0.214	18.91 ± 14.43	19.35 ± 11.49	0.348
Air Bone Gap	21.19 ± 7.69	9.54 ± 5.32	<0.001	20.61 ± 9.41	10.12 ± 6.44	< 0.001
Low Tone	49.67 ± 21.72	27.54 ± 19.92	<0.001	42.12 ± 16.17	28.00 ± 18.84	<0.001
High Tone	51.50 ± 20.4	44.34 ± 19.40	0.003	52.91 ± 22.52	46.94 ± 20.71	0.009

Table 4 compares the operative parameters and postoperative complications between the endoscopic and microscopic tympanoplasty groups. The graft success rate was higher in the

Frontier in Medical & Health Research

ISSN: (e) 3007-1607 (p) 3007-1593

endoscopic group (112 [93.33%]) than in the microscopic group (104 [86.67%]); however, this difference was not statistically significant (p = 0.083). Similarly, the incidence of re-perforation was comparable between the endoscopic and microscopic groups (5.0% vs. 4.16%; p = 0.760). There were no significant differences in the rates of otorrhea (3.33% vs. 3.33%; p = 1.000), otalgia (1.67% vs. 1.67%; p = 1.000), or wound infection, with no cases reported in either group (p = 1.000). In contrast, significant differences were observed in operative efficiency. The mean surgery duration was significantly shorter in the endoscopic group (80.11 ± 10.81 minutes) compared with the microscopic group (95.01 ± 17.21 minutes; p < 0.001). Likewise, the length of hospital stay was significantly reduced in patients undergoing endoscopic tympanoplasty (5.12 ± 2.01 days) compared with those undergoing microscopic tympanoplasty (8.09 ± 1.27 days; p < 0.001).

Table 4: Operative Parameters and Postoperative Complications

Variable	Endoscopic Group Mean ± SD	Microscopic Group Mean ± SD	p-value
Graft Success Rate	112 (93.33%)	104 (86.67%)	0.083
Re-perforation	6 (5.0%)	5 (4.16%)	0.760
Otorrhea	4 (3.33%)	4 (3.33%)	1.000
Otalgia	2 (1.67%)	2 (1.67%)	1.000
Wound Infection	0 (0.0%)	0 (0.0%)	1.000
Surgery Duration (minutes)	80.11 ± 10.81	95.01 ± 17.21	<0.001
Length of Hospital Stay (days)	5.12 ± 2.01	8.09 ± 1.27	<0.001

Discussion

The discussion highlights the advantages and limitations of endoscopic tympanoplasty compared with the conventional microscopic approach. Endoscopic ear surgery has gained increasing popularity because it is minimally invasive and provides superior visualization of the middle ear through a wide-angle view. Earlier limitations of endoscopic surgery, including poor image quality and low-resolution visualization, have largely been overcome with advances in endoscopic technology and high-definition imaging systems. Nevertheless, certain challenges remain, such as the need to operate with only one hand while holding the endoscope with the other and the relatively long learning curve required to master the technique. According to Gkrinia et al., the endoscope is particularly useful in cases with limited visibility or when lesions are suspected in hidden regions of the tympanic cavity, such as the sinus tympani and facial recess, where microscopic visualization is inadequate. However, excessive bleeding or procedures requiring extensive bone removal may obscure the endoscopic view, indicating that the microscope still has an important role in complex middle ear surgeries[11].

The findings of the present study demonstrated that audiological outcomes were comparable between endoscopic and microscopic tympanoplasty, with both techniques producing similar improvements in hearing thresholds and air bone gap closure. However, the endoscopic approach showed superior operative efficiency, particularly in terms of shorter surgical duration and reduced hospital stay. These results are consistent with previous studies that reported similar hearing outcomes while emphasizing the minimally invasive advantages of endoscopic surgery [12.13].

Yang et al. similarly found that endoscopic type I tympanoplasty required less operative time, produced better patient comfort[14], and achieved comparable hearing improvement and

Frontier in Medical & Health Research

ISSN: (e) 3007-1607 (p) 3007-1593

graft success to microscopic tympanoplasty. In the present study, graft uptake rates were also similar between the two techniques, with successful graft healing observed in 93.33% of patients undergoing endoscopic tympanoplasty and 86.67% of those undergoing microscopic tympanoplasty, indicating no statistically significant difference. Comparable findings have been reported by Elnahal et al., who observed graft success rates of 85% and 86.4%, respectively[15]. Likewise, Zakir et al. reported no significant difference in graft uptake but demonstrated a significantly lower recurrence rate following endoscopic surgery compared with microscopic surgery, suggesting a potential long-term advantage of the endoscopic technique[16].

Other published evidence also supports the comparable effectiveness of both procedures. Ulkumen et al. found no significant differences between endoscopic and microscopic tympanoplasty regarding operative time[17], graft uptake, or hearing improvement, whereas Gulsen et al. reported better canaloplasty rates and superior cosmetic outcomes with the endoscopic approach[18]. The present study carefully addressed potential confounding factors by ensuring that all surgeries were performed by three surgeons with more than five years of experience in both techniques and by limiting the study population to patients undergoing uncomplicated type I tympanoplasty without ossicular chain reconstruction. Although different graft materials were used in the two groups tragal perichondrium in the endoscopic group and temporalis fascia in the microscopic group both materials have been shown in previous literature to provide comparable graft success, minimizing their influence on the overall findings.

One of the most clinically important findings of the present study was the significantly shorter operative time associated with endoscopic tympanoplasty (80.11 ± 10.81) compared with microscopic tympanoplasty (95.01 ± 17.21; $p < 0.001$). This is similar to previous studies [19, 20,21]. Reducing operative duration is beneficial because it decreases the patient's exposure to anesthesia, lowers the risk of anesthesia-related complications, improves operating room efficiency, and may contribute to faster postoperative recovery. These findings are consistent with previous studies demonstrating that endoscopic tympanoplasty is an effective minimally invasive alternative to the microscopic technique, offering similar audiological and anatomical outcomes while providing additional advantages in surgical efficiency and patient recovery.

Conclusion

The audiological outcomes of Type I endoscopic tympanoplasty were comparable to those of microscopic tympanoplasty, with no significant differences in hearing improvement between the two techniques. However, endoscopic tympanoplasty was associated with a significantly shorter operative time and reduced length of hospital stay, indicating greater surgical efficiency while maintaining similar clinical outcomes.

Conflict of Interest: None

REFERENCES

Choi N, Noh Y, Park W, Lee JJ, Yook S, Choi JE, Chung WH, Cho YS, Hong SH, Moon IJ. Comparison of endoscopic tympanoplasty to microscopic tympanoplasty. Clinical and experimental otorhinolaryngology. 2017 Mar 10;10(1):44-9.

Kuo CH, Wu HM. Comparison of endoscopic and microscopic tympanoplasty. European archives of oto-rhino-laryngology. 2017 Jul;274(7):2727-32.

Hsu YC, Kuo CL, Huang TC. A retrospective comparative study of endoscopic and microscopic tympanoplasty. Journal of otolaryngology-head & neck surgery. 2018 Jan;47(1):44.

Gkrinia E, Ntziovara AM, Brotis AG, Tzimkas-Dakis K, Saratziotis A, Korais C, Hajiioannou J. Endoscopic versus microscopic tympanoplasty: a systematic review and metanalysis. The Laryngoscope. 2024 Aug;134(8):3466-76.

Frontier in Medical & Health Research

ISSN: (e) 3007-1607 (p) 3007-1593

Akyigit A, Sakallıoglu O, Karlidag T. Endoscopic tympanoplasty. Journal of otology. 2017 Jun 1;12(2):62-7.

Kim DJ, Lee HM, Choi SW, Oh SJ, Kong SK, Lee IW. Comparative study of endoscopic and microscopic tympanoplasty performed by a single experienced surgeon. American Journal of Otolaryngology. 2021 Jan 1;42(1):102788.

Anzola JF, Nogueira JF. Endoscopic techniques in tympanoplasty. Otolaryngologic Clinics of North America. 2016 Oct 1;49(5):1253-64.

Yang Q, Wang B, Zhang J, Liu H, Xu M, Zhang W. Comparison of endoscopic and microscopic tympanoplasty in patients with chronic otitis media. European Archives of Oto-Rhino-Laryngology. 2022 Oct;279(10):4801-7.

Schwam ZG, Cosetti MK. Endoscopic myringoplasty and type I tympanoplasty. Otolaryngologic Clinics of North America. 2021 Feb 1;54(1):75-88.

Manna S, Kaul VF, Gray ML, Wanna GB. Endoscopic versus microscopic middle ear surgery: a meta-analysis of outcomes following tympanoplasty and stapes surgery. Otology & Neurotology. 2019 Sep 1;40(8):983-93.

Gkrinia E, Ntziovara AM, Brotis AG, Tzimkas-Dakis K, Saratziotis A, Korais C, Hajiioannou J. Endoscopic versus microscopic tympanoplasty: a systematic review and metanalysis. The Laryngoscope. 2024 Aug;134(8):3466-76.

Anzola JF, Nogueira JF. Endoscopic techniques in tympanoplasty. Otolaryngologic Clinics of North America. 2016 Oct 1;49(5):1253-64.

Marchioni D, Gazzini L, De Rossi S, Di Maro F, Sacchetto L, Carner M, Bianconi L. The management of tympanic membrane perforation with endoscopic type I tympanoplasty. Otology & Neurotology. 2020 Feb 1;41(2):214-21.

Yang Q, Wang B, Zhang J, Liu H, Xu M, Zhang W. Comparison of endoscopic and microscopic tympanoplasty in patients with chronic otitis media. European Archives of Oto-Rhino-Laryngology. 2022 Oct;279(10):4801-7.

Elnahal KB, Hassan MA, Maarouf AM. Comparison of endoscope-assisted and microscope-assisted type I tympanoplasty; a systematic review and meta-analysis. European Archives of Oto-Rhino-Laryngology. 2024 May;281(5):2243-52.

Zakir I, Ahmad AN, Pasha HA, Aqil S, Akhtar S. Comparison of endoscopic versus microscopic tympanoplasty. Iranian Journal of Otorhinolaryngology. 2022 May;34(122):139.

Ulkumen B, Yuceturk AV. Endoscopic versus microscopic tympanoplasty: A prospective randomized comparison of outcomes: Endoscopic versus microscopic tympanoplasty. Journal of Surgery and Medicine. 2025 Feb 12;9(2):18-22.

Gulsen S and Baltacı A. Comparison of endoscopic transcanalandmicroscopicapproachinType1 tympanoplasty.BrazilianJournalofOtorhinolaryn-gology.2021Mar;87(2):157-63.doi:10.1016/j.bjorl .2019.07.005.

Tseng CC, Lai MT, Wu CC, Yuan SP, Ding YF. Comparison of the efficacy of endoscopic tympanoplasty and microscopic tympanoplasty: a systematic review and meta-analysis. The Laryngoscope. 2017 Aug;127(8):1890-6.

Choi N, Noh Y, Park W, Lee JJ, Yook S, Choi JE, Chung WH, Cho YS, Hong SH, Moon IJ. Comparison of endoscopic tympanoplasty to microscopic tympanoplasty. Clinical and experimental otorhinolaryngology. 2017 Mar 10;10(1):44-9.

Akyigit A, Sakallıoglu O, Karlidag T. Endoscopic tympanoplasty. Journal of otology. 2017 Jun 1;12(2):62-7.