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Comparison of Endoscopic Vs Microscopic Tympanoplasty Outcomes: A Prospective Cohort Study

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ABSTRACT

Background: Microscopic tympanoplasty (MT) has long served as the conventional gold standard for tympanic membrane repair. Transcanal endoscopic tympanoplasty (ET) has emerged as a minimally invasive alternative offering wide-field visualization. This study was aimed to compare graft take rate, audiological gain, operative duration, and postoperative pain between ET and MT in adult patients with inactive mucosal chronic otitis media (COM). **Methods**: A prospective cohort study of 120 adult patients undergoing Type I tympanoplasty (ET n=60; MT n=60) was conducted over 18 months. Outcomes included graft uptake at 6 months, air-bone gap (ABG) closure via pure-tone audiometry (PTA), operative time, and Visual Analog Scale (VAS) pain scores on Postoperative Day 1. **Results**: Overall graft take rate was 93.3% in the ET group and 91.7% in the MT group ($p = 0.74$). Both techniques demonstrated statistically significant post-operative ABG closure ($p < 0.001$), with no significant inter-group difference in mean functional gain (13.5±4.2dB vs 12.8 ±4.8dB), $p = 0.39$. However, ET demonstrated significantly shorter operative times (58.4±8.2 min vs 84.6±11.3min), $p < 0.001$ and lower Day 1 VAS pain scores (2.1±0.8 vs 4.3±1.1, $p < 0.001$). **Conclusion**: Transcanal ET is a safe, effective, and minimally invasive alternative to traditional MT, offering equivalent anatomical and functional success while significantly reducing surgical time and early postoperative patient discomfort.

Keywords: Tympanoplasty, Endoscopic tympanoplasty (ET), Microscopic tympanoplasty (MT).

INTRODUCTION

Chronic otitis media (COM) mucosal type remains a primary cause of conductive hearing loss globally. Surgical intervention via Type I tympanoplasty aims to eradicate disease, achieve a dry ear, and restore the ossicular-tympanic sound conduction mechanism (Wullstein, 1956).

Historically, the binocular operating microscope provided high illumination and stereoscopic magnification, establishing microscopic tympanoplasty (MT) as the conventional standard (Jyoti et al., 2026). However, MT requires a direct line-of-sight path, often necessitating postauricular or endaural incisions and canaloplasty to visualize anterior or hidden perforation margins (Gupta et al., 2026; Wullstein, 1956).

The introduction of rigid endoscopes to otologic surgery has addressed these optical limitations (Tarabichi, 2010). Endoscopic tympanoplasty (ET) provides wide-angle panoramic views, allowing transcanal visualization around canal bulges without soft tissue retraction or extensive bony removal (Jyoti et al., 2026; Schwam & Cosetti, 2021). Despite these visual advantages, ET presents unique technical challenges, including single-handed surgical execution and loss of binocular depth perception (Elnahal et al., 2024; Jyoti et al., 2026).

While single-center observational reports exist, rigorous prospective comparative evidence evaluating both functional recovery and patient-centered morbidity remains vital. This prospective cohort study evaluates and compares the anatomical success (graft take rate), functional outcome (air-bone gap closure), surgical time, and postoperative morbidity between ET and MT in patients with inactive mucosal COM.

MATERIALS AND METHODS

Study Design & Patient Selection

A prospective, comparative cohort study was conducted at a tertiary otolaryngology center following Institutional Review Board (IRB) approval and informed consent.

Inclusion Criteria:

- Adults (aged 18–60 years) diagnosed with inactive mucosal COM.
- Central tympanic membrane perforation with a dry ear for at least 4 weeks.
- Intact and mobile ossicular chain verified on preoperative imaging and audiometry.

Exclusion Criteria:

- Active middle ear discharge or cholesteatoma/retraction pockets.
- Ossicular chain disruption or fixations requiring ossiculoplasty.
- Previous ipsilateral ear surgery (revision cases).
- Mixed or sensorineural hearing loss.

Patients chose their preferred surgical approach after a standardized clinical briefing, creating two comparative cohorts: Group A (**ET**, n=60) and Group B (**MT**, n=60).

Surgical Technique

All procedures were performed under general anesthesia by senior otologic surgeons experienced in both modalities.

Group A (Endoscopic Group):

A 0 degree or 30 degree, 4 mm diameter, 18 cm rigid endoscope connected to an HD camera system was utilized (Gupta et al., 2026). The entire procedure was performed via a pure transcanal approach. Perforation edges were freshened, a tympanomeatal flap was elevated, and temporalis fascia or tragal perichondrium graft was placed using an underlay technique.

Group B (Microscopic Group):

Surgical intervention was conducted using an operating binocular microscope. Either a postauricular or transcanal approach was chosen based on canal anatomy and anterior margin visibility. Soft tissue harvest, flap elevation, and underlay grafting were performed using a traditional two-handed technique.

Outcome Measures

Anatomical Success: Complete, intact graft uptake verified at 6 months postoperatively via otoscopy.

Functional Outcome:

Pure-Tone Audiometry (PTA) evaluated at 0.5, 1, 2, and 4 kHz preoperatively and 6 months postoperatively. Air-Bone Gap (ABG) closure (ABGpre-ABGpost) served as the primary audiological index.

Surgical Metrics & Morbidity: Total operative duration (skin/canal incision to dressing) and early postoperative pain evaluated on Day 1 using a 10-point Visual Analog Scale (VAS) (Elnahal et al., 2024).

Statistical Analysis

Data were analyzed using SPSS Version 28.0. Continuous variables (age, operative time, ABG values, VAS scores) were reported as Mean ± Standard Deviation (SD) and compared using independent t-tests. Categorical parameters (graft take rate, gender) were compared using the Chi-square (chi^2) test. Statistical significance was set at $p < 0.05$.

RESULTS

Patient Baseline Demographics

Both cohorts were well-matched regarding baseline parameters, with no statistically significant differences in age, gender ratio, perforation size, or preoperative ABG.

Baseline Parameter	Endoscopic Group (n=60)	Microscopic Group (n=60)	p-value
Mean Age (Years)	34.2 ±9.8	35.6±10.4	0.45

Gender (M / F)	28 / 32	31 / 29	0.58
Operated Side (Right / Left)	32 / 28	34 / 26	0.71
Medium/Large Perforations (>50%)	38 (63.3%)	36 (60.0%)	0.70
Preoperative ABG (dB)	24.8±5.1	25.3±4.9	0.58

Primary Surgical Outcomes

Anatomical Success & Hearing Recovery:

At 6 months follow-up, graft closure was achieved in 56 out of 60 ears in the ET group (93.3%) compared to 55 out of 60 ears in the MT group (91.7%), demonstrating no statistical difference between groups ($chi^2 = 0.101$, $p = 0.74$).

Both modalities yielded significant postoperative ABG reductions ($p < 0.001$). The post-operative ABG reached 11.3±3.9 dB in the ET group and 12.5 ±4.2 dB in the MT group. Mean functional ABG closure was comparable (13.5±4.2 dB vs 12.8 ±4.8 dB, $p = 0.39$).

Outcome Measure	Endoscopic Group (n=60)	Microscopic Group (n=60)	Test Statistic / p-value
Graft Take Rate (n, %)	56 (93.3%)	55 (91.7%)	chi^2= 0.101, p = 0.74
Postoperative ABG (dB)	11.3± 3.9	12.5±4.2	t = -1.62, p = 0.11
Mean ABG Gain (dB)	13.5±4.2	12.8± 4.8	t = 0.85, p = 0.39
Operative Time (min)	58.4 ±8.2	84.6 ± 11.3	t = -14.51, p < 0.001
Day 1 Pain (VAS 0–10)	2.1 ± 0.8	4.3 ± 1.1	t = -12.54, p < 0.001

Operative Duration and Morbidity

The mean operative time was significantly shorter in the ET group (58.4 ± 8.2min) compared to the MT group (84.6±11.3 min), $p < 0.001$. Additionally, Day 1 postoperative VAS pain scores were lower in the ET cohort (2.1±0.8 vs 4.3±1.1, $p < 0.001$). Minor complications (e.g., transient altered taste, canal wall abrasion) were low and evenly distributed across both groups.

DISCUSSION

The primary findings of this prospective cohort study demonstrate that transcanal endoscopic tympanoplasty (ET) achieves anatomical graft success and functional hearing recovery equivalent to microscopic tympanoplasty (MT), while significantly reducing operative duration and early postoperative morbidity. These prospective findings align closely with pooled quantitative evidence across major systematic reviews and meta-analyses published over the past decade.

In our study, complete graft uptake at 6 months was achieved in 93.3% of ET patients and 91.7% of MT patients ($p = 0.74$). This absence of a statistically significant difference mirrors findings across multi-center global datasets. A systematic review and meta-analysis comprising 33 studies (N = 2,646) similarly observed no statistically significant difference in tympanic graft failure rates between ET and MT (Gkrinia et al., 2024). Furthermore, a meta-analysis restricted strictly to randomized controlled trials (RCTs) reported a risk difference (RD) of 0.00 (95% C: -0.04 to 0.05; $p = 0.87$), indicating identical anatomical closure rates across both surgical modalities (Crotty et al., 2023). Pooled analyses by Tseng et al. (2017) and Jyoti et al. (2026) confirmed high success rates (93%) in both groups.

The physical explanation for this equivalent success lies in the optical properties of the endoscope (Tarabichi, 2010). By bringing the light source and high-definition lens directly to the distal tip inside the external auditory canal, the surgeon gains a panoramic 110 view (Schwam & Cosetti, 2021). This removes visual "blind spots" around prominent anterior canal bulges or deep anterior overhangs, allowing exact tucking and rim verification of underlay grafts without altering graft incorporation biology (Wang et al., 2024).

Both modalities demonstrated statistically significant post-operative air-bone gap (ABG) closure ($p < 0.001$\$), with mean functional gains of 13.5 ± 4.2 dB} (ET) vs. 12.8± 4.8 dB (MT) ($p = 0.39$). This matches pooled meta-analytic outcomes in the literature, Large-scale meta-analyses report a pooled mean difference in ABG closure between ET and MT ranging from -0.05dB (95% CI: -0.23 to 0.13 to 0.18 dB) ($p > 0.40$), confirming no clinically meaningful difference in audiological

improvement (Gkrinia et al., 2024; Jyoti et al., 2026). Subgroup analyses in recent literature confirm that transcanal scope manipulation does not cause acoustic or thermal trauma to the ossicular chain, yielding identical post-operative pure-tone averages across frequencies (Elnahal et al., 2024; Wang et al., 2024).

A key finding of this trial was a 26.2 minute reduction in mean operative time in favor of ET (58.4 min vs. 84.6 min, $p < 0.001$). This substantial time saving aligns with meta-analytic consensus, In pooled RCT data, ET reduced operative time by an average of 24.73 minutes (95% CI: -38.56 to -10.89 min; $p = 0.0005$) (Crotty et al., 2023). In broad cross-procedure meta-analyses, ET consistently reduced operative time and surgical steps compared to postauricular microscopic approaches (Gkrinia et al., 2024; Gupta et al., 2026).

The primary mechanism driving this temporal efficiency is the elimination of soft-tissue steps inherent to microscopic ear surgery (e.g., postauricular hair shaving, skin incision, muscle/periosteal elevation, and multilayer closure) (Schwam & Cosetti, 2021). Furthermore, ET reduces the need for canalplasty because the endoscope easily navigates past narrow or tortuous bony canal walls (Tseng et al., 2017). Postoperative Day 1 pain scores were lower in the ET cohort (2.1 ± 0.8 vs. 4.3 ± 1.1, $p < 0.001$).

This reduction directly parallels findings from recent systematic reviews, Pooled analysis by Gkrinia et al. (2024) and Elnahal et al. (2024) demonstrated statistically significant reductions in post-operative complications favoring the endoscopic approach, including wound infection (OR= -1.72; $p < 0.05$), dysgeusia (OR=-1.47; $p < 0.05$), and auricular numbness (OR= -2.14; $p < 0.05$). Because ET avoids external incisions, patients undergoing transcanal ET consistently report superior cosmetic satisfaction scores across all modern trials (Jyoti et al., 2026; Wang et al., 2024).

While the clinical metrics strongly favor ET, two technical factors warrant nuanced consideration. Microscopic surgery allows two-handed tissue manipulation (e.g., holding a suction instrument in one hand and a micro-hook or forceps in the other). In contrast, ET requires one hand to hold the endoscope continuously (Elnahal et al., 2024; Jyoti et al., 2026). While specialized endoscopic instrument holders exist, most otologists perform single-handed dissection, requiring refined suction-dissection techniques during active bleeding. Transitioning from stereoscopic 3D microscopic vision to a 2D monitor screen presents a distinct learning curve (Gupta et al., 2026; Schwam & Cosetti, 2021). However, recent ergonomic literature suggests that after $15\text{--}20$ endoscopic procedures, surgeon speed and dexterity stabilize significantly.

Limitations:

- **Follow-up Duration:** Follow-up was restricted to 6 months; evaluating long-term graft stability (>2 years) and reperforation rates remains necessary.
- **Scope of Pathology:** We excluded active cholesteatoma, extensive ossicular chain disruption, and revision surgeries where microscopic or hybrid techniques are frequently required.
- **Single-Center Design:** Multi-center randomized controlled trials are ideal to eliminate institutional selection bias.

CONCLUSION

Transcanal endoscopic tympanoplasty is a safe, minimally invasive, and effective alternative to conventional microscopic tympanoplasty for Type I repairs. ET delivers equivalent graft take rates and hearing restoration while offering superior surgical visualization, reduced operative times, and significantly lower postoperative pain.

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