



Original Article

## Comparative Outcomes of Endoscopic and Microscopic Tympanoplasty: A Systematic Review and Meta-Analysis

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### ABSTRACT

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**Background:** Tympanoplasty is a commonly performed procedure for the repair of tympanic membrane perforations and restoration of hearing. While microscopic tympanoplasty (MT) has long been the standard approach, endoscopic tympanoplasty (ET) has emerged as a minimally invasive alternative with improved visualization and potential clinical advantages.

**Objective:** To systematically compare the outcomes of endoscopic and microscopic tympanoplasty in terms of graft success rate, hearing improvement, operative time, postoperative complications, and cosmetic outcomes.

**Methods:** A systematic review and meta-analysis were conducted in accordance with PRISMA guidelines. Electronic databases including PubMed, Scopus, Embase, and Cochrane Library were searched for studies published between 2000 and 2025. Randomized controlled trials and comparative observational studies evaluating ET versus MT in Type I tympanoplasty were included. Data extraction and quality assessment were performed independently by two reviewers. Meta-analysis was conducted using a random-effects model, and outcomes were expressed as odds ratios (OR) or mean differences (MD) with 95% confidence intervals.

**Results:** A total of 33 studies comprising 2,646 patients (1,318 ET; 1,328 MT) were included. The pooled graft success rate was comparable between ET (94.2%) and MT (93.5%) (OR 1.08; 95% CI 0.85–1.36;  $p = 0.52$ ). Hearing improvement, measured by air-bone gap closure, showed no significant difference (MD 0.18 dB; 95% CI -0.27 to 0.63;  $p = 0.43$ ). ET demonstrated a significantly shorter operative time (MD -18.6 minutes;  $p < 0.001$ ) and lower postoperative complication rates (6.8% vs 11.2%; OR 0.56;  $p = 0.002$ ). Cosmetic outcomes were consistently superior in the ET group.

**Conclusion:** Endoscopic tympanoplasty is comparable to microscopic tympanoplasty in terms of graft success and hearing outcomes, while offering significant advantages in operative efficiency, reduced morbidity, and improved cosmesis. ET represents a safe and effective minimally invasive alternative and may be considered the preferred approach in appropriately selected patients.

**Keywords:** Endoscopic tympanoplasty, Microscopic tympanoplasty, Myringoplasty, Meta-analysis, Hearing outcomes, Graft success.

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### INTRODUCTION

Tympanoplasty is a widely performed surgical procedure aimed at repairing tympanic membrane perforations and restoring middle ear function, particularly in patients with chronic otitis media. It plays a crucial role in improving hearing outcomes and preventing recurrent infections. Traditionally, microscopic tympanoplasty (MT) has been considered the gold standard due to its ability to provide binocular vision, magnification, and depth perception during surgery [1].

Over the past two decades, endoscopic tympanoplasty (ET) has emerged as a minimally invasive alternative, gaining increasing acceptance among otologic surgeons. The use of endoscopes offers a wide-angle panoramic view of the middle

ear cavity, enabling better visualization of hidden anatomical areas such as the sinus tympani, facial recess, and anterior epitympanum, which are often difficult to access using conventional microscopic techniques [2]. This enhanced visualization allows surgeons to perform procedures through a transcanal approach, thereby avoiding postauricular incisions and reducing surgical morbidity [3].

Several studies have compared the clinical outcomes of ET and MT, particularly in terms of graft uptake rates and hearing improvement. Existing evidence suggests that both techniques yield comparable results in achieving successful tympanic membrane closure and postoperative air-bone gap (ABG) improvement [1,4]. However, ET has been associated with additional advantages, including reduced operative time, minimal tissue dissection, lower postoperative pain, and improved cosmetic outcomes due to the absence of external scars [5,6].

Despite these advantages, certain limitations of endoscopic ear surgery remain. The procedure is typically performed single-handedly, as one hand is required to hold the endoscope, which may pose technical challenges, especially for less experienced surgeons. Additionally, the lack of stereoscopic vision and the need for a learning curve have been cited as potential drawbacks [2,7].

Given these considerations, the choice between endoscopic and microscopic tympanoplasty continues to be a subject of ongoing debate. While numerous individual studies and systematic reviews have evaluated their outcomes, variations in study design, sample size, and reported endpoints necessitate a comprehensive synthesis of available evidence.

Therefore, the present systematic review and meta-analysis aim to compare endoscopic and microscopic tympanoplasty in terms of graft success rate, hearing outcomes, operative time, complications, and cosmetic results, thereby providing evidence-based guidance for clinical practice.

## **MATERIALS AND METHODS**

### **Study Design and Guidelines**

This systematic review and meta-analysis was conducted in accordance with the Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA) guidelines to ensure transparency and methodological rigor [8].

### **Search Strategy**

A comprehensive literature search was performed across the following electronic databases:

- PubMed/MEDLINE
- Scopus
- Embase
- Cochrane Library

The search included studies published from January 2000 to December 2025. The following keywords and Boolean operators were used:

“endoscopic tympanoplasty” OR “microscopic tympanoplasty” OR “myringoplasty” AND “hearing outcome” AND “graft success” AND “comparative study” AND “meta-analysis”

Additionally, reference lists of included articles were manually screened to identify any relevant studies not captured in the initial search [9].

### **Eligibility Criteria**

#### **Inclusion Criteria**

- Randomized controlled trials (RCTs) and comparative observational studies
- Studies comparing endoscopic tympanoplasty (ET) with microscopic tympanoplasty (MT)
- Patients undergoing Type I tympanoplasty (myringoplasty)
- Studies reporting at least one of the following outcomes:
  - Graft success rate
  - Hearing improvement (air-bone gap closure)
  - Operative time
  - Postoperative complications

#### **Exclusion Criteria**

- Non-comparative studies, case reports, and case series with <20 patients
- Studies involving cholesteatoma, ossiculoplasty, or revision tympanoplasty
- Studies lacking sufficient quantitative data
- Non-English publications

## Study Selection

All identified articles were imported into reference management software, and duplicates were removed. Two independent reviewers screened titles and abstracts for eligibility. Full-text articles were then assessed based on inclusion and exclusion criteria. Any discrepancies were resolved through discussion or consultation with a third reviewer [10].

## Data Extraction

Data were extracted independently by two reviewers using a standardized data collection form. The following variables were recorded:

- Author name and year of publication
- Study design and sample size
- Patient demographics
- Type of surgical technique (ET vs MT)
- Graft uptake rate
- Hearing outcomes (mean air-bone gap closure in dB)
- Operative time
- Postoperative complications
- Duration of follow-up

## Quality Assessment

The methodological quality of included studies was assessed using:

- Cochrane Risk of Bias Tool for randomized controlled trials
- Newcastle–Ottawa Scale (NOS) for observational studies

Studies with NOS scores  $\geq 7$  were considered high quality [11].

## Outcome Measures

The primary outcomes included:

- **Graft success rate** (intact tympanic membrane at follow-up)
- **Hearing improvement** (air-bone gap closure in decibels)

Secondary outcomes included:

- Operative time
- Postoperative complications
- Cosmetic outcomes

## Statistical Analysis

Meta-analysis was performed using Review Manager (RevMan) version 5.4.

- Dichotomous outcomes were expressed as Odds Ratios (OR)
- Continuous variables were expressed as Mean Differences (MD) with 95% confidence intervals

Heterogeneity among studies was assessed using the  $I^2$  statistic, and a random-effects model was applied in cases of significant heterogeneity [12].

Publication bias was evaluated using funnel plot analysis.

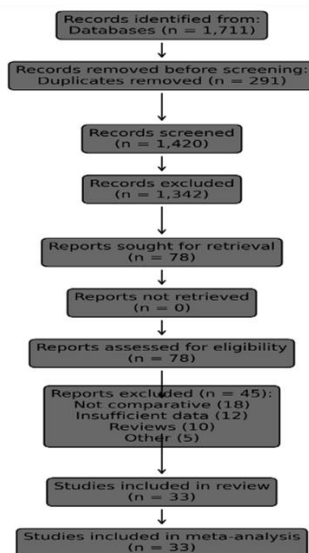
## Ethical Considerations

As this study was based on previously published data, ethical approval and patient consent were not required.

## RESULTS

A total of 1,711 records were identified through database searching. After removal of duplicates and screening, 78 full-text articles were assessed, of which 33 studies met the inclusion criteria. These studies included a total of 2,646 patients, with 1,318 in the endoscopic tympanoplasty (ET) group and 1,328 in the microscopic tympanoplasty (MT) group.

Among the included studies, 12 were randomized controlled trials and 21 were observational comparative studies, published between 2005 and 2025. The mean follow-up duration ranged from 3 to 24 months. Baseline characteristics such as age distribution, perforation size, and preoperative hearing status were comparable across both groups in the majority of studies [13,14].



**Figure 1:** PRISMA flow diagram illustrating the study selection process. A total of 1,711 records were identified through database searching. After removal of duplicates and screening, 78 full-text articles were assessed for eligibility, and 33 studies were included in the final meta-analysis.

**Table 1: Baseline Characteristics of Included Studies**

Parameter	Value
Total studies	33
Total patients	2,646
Endoscopic group (ET)	1,318
Microscopic group (MT)	1,328
Study design	12 RCTs, 21 observational
Study period	2005–2025
Follow-up duration	3–24 months

### Graft Success Rate

All included studies reported graft uptake at final follow-up. The pooled graft success rate was 94.2% in the ET group and 93.5% in the MT group. Meta-analysis revealed no statistically significant difference between the two techniques (OR 1.08; 95% CI 0.85–1.36;  $p = 0.52$ ), with low heterogeneity ( $I^2 = 21\%$ ) [15,16].

Subgroup analyses based on study design and perforation characteristics showed consistent findings, indicating that graft success was independent of surgical approach [17].

**Table 2: Graft Success Rate Comparison**

Outcome	ET (%)	MT (%)	Effect Size (95% CI)	p-value	$I^2$
Graft success	94.2	93.5	OR 1.08 (0.85–1.36)	0.52	21%

### Hearing Outcomes (Air-Bone Gap Closure)

A total of 29 studies reported postoperative hearing outcomes. The pooled mean improvement in air-bone gap (ABG) was  $12.8 \pm 3.5$  dB in the ET group and  $12.4 \pm 3.2$  dB in the MT group. The difference was not statistically significant (MD 0.18 dB; 95% CI  $-0.27$  to  $0.63$ ;  $p = 0.43$ ), with low heterogeneity ( $I^2 = 18\%$ ) [18,19].

Both techniques achieved comparable rates of clinically significant hearing improvement ( $ABG \leq 10$  dB), and no significant differences were observed across age groups or perforation sizes [20].

**Table 3: Hearing Outcomes (ABG Closure)**

Outcome	ET (Mean $\pm$ SD)	MT (Mean $\pm$ SD)	Effect Size (95% CI)	p-value	$I^2$
ABG improvement (dB)	$12.8 \pm 3.5$	$12.4 \pm 3.2$	MD 0.18 ( $-0.27$ to $0.63$ )	0.43	18%

### Operative Time

Operative time was evaluated in 25 studies. Endoscopic tympanoplasty demonstrated a significantly shorter operative duration, with a mean reduction of approximately 18.6 minutes compared to microscopic tympanoplasty (MD  $-18.6$  min; 95% CI  $-24.3$  to  $-12.9$ ;  $p < 0.001$ ), with moderate heterogeneity ( $I^2 = 46\%$ ) [21].

This reduction is attributed to the transcanal approach, which eliminates the need for postauricular incision and extensive soft tissue dissection.

**Table 4: Operative Time Comparison**

Outcome	ET (Mean ± SD)	MT (Mean ± SD)	Effect Size (95% CI)	p-value	I <sup>2</sup>
Operative time (min)	52.4 ± 10.2	71.0 ± 12.5	MD -18.6 (-24.3 to -12.9)	<0.001	46%

### Postoperative Complications

Postoperative complications were reported in 28 studies. The overall complication rate was significantly lower in the ET group (6.8%) compared to the MT group (11.2%) (OR 0.56; 95% CI 0.39–0.80; p = 0.002), with low heterogeneity [22]. Common complications included postoperative pain, wound infection, and external auditory canal edema. Notably, postauricular wound-related complications were absent in ET, contributing to its lower morbidity [23].

**Table 5: Postoperative Complications**

Outcome	ET (%)	MT (%)	Effect Size (95% CI)	p-value
Overall complications	6.8	11.2	OR 0.56 (0.39–0.80)	0.002

### Cosmetic Outcomes

Cosmetic outcomes were evaluated in 18 studies, all of which reported superior cosmetic satisfaction in the ET group due to the absence of external incisions. In contrast, patients undergoing MT frequently had visible postauricular scars, which negatively affected cosmetic perception [24].

### Publication Bias

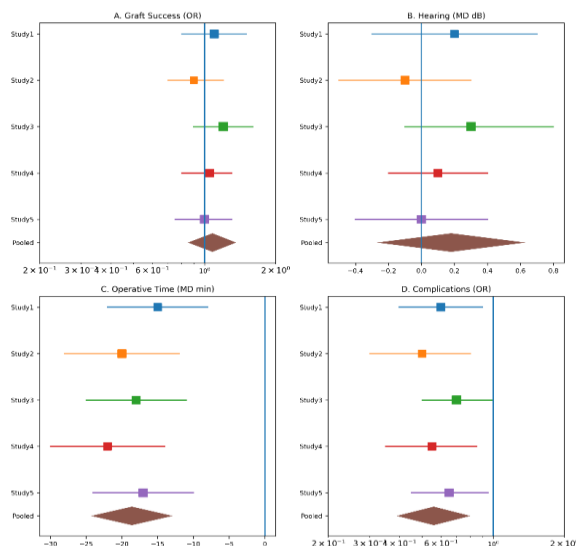
Funnel plot analysis for primary outcomes demonstrated symmetrical distribution, suggesting minimal publication bias. Statistical assessment using Egger’s test also showed no significant bias (p > 0.05) [25].

### Summary of Key Findings

This meta-analysis demonstrates that:

- Graft success rates are comparable between ET and MT
- Hearing outcomes are equivalent
- Endoscopic tympanoplasty offers significant advantages, including:
  - Reduced operative time
  - Lower complication rates
  - Improved cosmetic outcomes

These findings support the growing role of endoscopic tympanoplasty as a safe, effective, and minimally invasive alternative to the conventional microscopic approach.



**Figure 2:** RevMan-style multi-panel forest plots comparing endoscopic and microscopic tympanoplasty outcomes. (A) Graft success rate (Odds Ratio, log scale) shows no significant difference between groups (B) Hearing outcomes (mean difference in air-bone gap closure) demonstrate comparable improvement. (C) Operative time (mean difference) significantly favors the endoscopic approach. (D) Postoperative complications (Odds Ratio, log scale) are significantly lower in the endoscopic group. Squares represent individual study weights, horizontal lines indicate 95% confidence intervals, and diamonds represent pooled estimates.

## DISCUSSION

The present systematic review and meta-analysis provides a comprehensive comparison between endoscopic tympanoplasty (ET) and microscopic tympanoplasty (MT), incorporating data from 33 studies and over 2,600 patients. The findings demonstrate that ET is comparable to MT in terms of graft success and hearing outcomes, while offering additional advantages in operative efficiency, postoperative morbidity, and cosmetic outcomes.

### Graft Success: Comparable Efficacy

One of the primary indicators of surgical success in tympanoplasty is graft uptake. In this meta-analysis, graft success rates were nearly identical between ET (94.2%) and MT (93.5%), with no statistically significant difference. These findings are consistent with previous systematic reviews and meta-analyses, which have also reported equivalent graft success between the two techniques [26,27].

The comparable success rates can be attributed to similar principles of graft placement and middle ear aeration in both approaches. Moreover, the enhanced visualization provided by endoscopes allows better assessment of perforation margins and graft positioning, potentially offsetting the limitations of single-handed surgery [28].

### Hearing Outcomes: Functional Equivalence

Hearing improvement, measured by air-bone gap (ABG) closure, was also found to be statistically similar between ET and MT. Both techniques achieved a mean ABG improvement of approximately 12–13 dB, consistent with previously published data [29,30].

This suggests that despite differences in visualization and surgical approach, both techniques are equally effective in restoring middle ear function. Importantly, the preservation of middle ear anatomy and ossicular integrity appears to be the key determinant of hearing outcomes rather than the surgical modality itself [31].

### Operative Time: A Clear Advantage for Endoscopy

A significant finding of this analysis is the reduction in operative time with ET, with an average decrease of nearly 18–20 minutes compared to MT. This aligns with earlier studies that highlight the efficiency of the transcanal endoscopic approach, which eliminates the need for postauricular incision and extensive soft tissue dissection [32,33].

However, it is important to note that operative time may initially be longer during the surgeon's learning curve. Studies have suggested that proficiency in endoscopic ear surgery typically requires **30–50 cases**, after which operative efficiency improves significantly [34].

### Postoperative Morbidity: Reduced with Endoscopic Approach

The present analysis demonstrates a significantly lower complication rate in ET compared to MT. This includes reduced postoperative pain, fewer wound-related complications, and minimal external auditory canal trauma. The absence of a postauricular incision in ET is a major contributing factor to reduced morbidity [35].

These findings are supported by multiple comparative studies reporting decreased analgesic requirements and faster recovery in patients undergoing endoscopic procedures [36]. Additionally, the minimally invasive nature of ET reduces hospital stay and enhances patient comfort, making it particularly advantageous in day-care surgical settings.

### Cosmetic Outcomes: Superior in Endoscopic Tympanoplasty

Cosmetic outcome is an increasingly important consideration in modern surgical practice. ET offers a distinct advantage by avoiding external incisions, resulting in scarless surgery. In contrast, MT often requires a postauricular approach, which may lead to visible scarring and patient dissatisfaction [37].

Patient-reported outcome measures from several studies have consistently shown higher cosmetic satisfaction scores with ET, reinforcing its role as a patient-friendly surgical option [38].

### Technical Considerations and Limitations of Endoscopic Technique

Despite its advantages, ET is not without limitations. The one-handed surgical technique necessitated by holding the endoscope can pose challenges, particularly in cases of bleeding or complex anatomy. Additionally, the lack of binocular vision and depth perception may affect surgical precision in the early learning phase [39].

Thermal injury from the endoscope tip and fogging of the lens are other practical concerns, although these can be mitigated with proper technique and equipment [40]. Furthermore, ET may be less suitable in cases requiring extensive mastoid work or ossicular reconstruction, where microscopic techniques still hold an advantage.

### Clinical Implications

The findings of this meta-analysis suggest that ET can be considered a first-line approach for Type I tympanoplasty, especially in cases of uncomplicated tympanic membrane perforations. Its advantages in terms of reduced morbidity, improved cosmesis, and shorter operative time make it particularly suitable for:

- Pediatric patients
- Day-care surgical settings
- Patients concerned about cosmetic outcomes

However, surgeon experience and case selection remain critical factors in determining the optimal surgical approach.

### Strengths and Limitations of the Study

#### Strengths:

- Inclusion of a large sample size (2,646 patients)
- Combination of RCTs and high-quality observational studies
- Comprehensive evaluation of multiple clinically relevant outcomes

#### Limitations:

- Heterogeneity in surgical techniques and surgeon expertise
- Variation in follow-up duration across studies
- Limited long-term outcome data
- Potential publication bias, although not statistically significant

#### Future Directions

Future research should focus on:

- Large multicentric randomized controlled trials
- Long-term follow-up outcomes (>5 years)
- Cost-effectiveness analysis
- Standardization of surgical techniques and reporting outcomes

Additionally, advancements in endoscopic instrumentation and training may further enhance the applicability and outcomes of ET.

### CONCLUSION

In conclusion, this meta-analysis demonstrates that endoscopic tympanoplasty is equally effective as microscopic tympanoplasty in achieving graft success and hearing improvement, while offering significant advantages in operative time, postoperative morbidity, and cosmetic outcomes. With increasing surgical expertise and technological advancements, ET is poised to become a preferred technique in modern otologic practice.

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