

Comparative Efficacy of Surgical Approaches for Managing Foreshortened Malleus Handle

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ABSTRACT:

This narrative review aims to evaluate the comparative efficacy of different surgical approaches for managing foreshortened malleus handle in terms of hearing restoration and surgical success rates. We included studies that reported surgical techniques, hearing outcomes, and graft success rates in patients undergoing type I tympanoplasty, ossiculoplasty, and related procedures. A total of 12 clinical studies met the eligibility criteria. Data extraction revealed that both medial and lateral underlay placements, buttonhole modifications, prosthesis anchoring, and endoscopic techniques produced comparable improvements in air-bone gap closure, with gains ranging from 1.7 to 33.42 dB. Graft take rates varied between 60% and 100%, while reported complication rates ranged from 0% to 50%, the latter in prosthesis anchoring procedures. Technical nuances such as preservation of malleus handle vascularity and specific graft material selection emerged as significant factors in reducing adverse outcomes. Despite heterogeneity in study designs and follow-up durations, no single surgical approach demonstrated a consistently superior outcome. This review highlights the need for standardized reporting of hearing outcomes and graft success, as well as prospective, well-powered randomized trials to address gaps in current evidence. The findings support the use of individualized surgical approaches based on anatomical and pathological considerations for patients with a foreshortened malleus handle.

Keywords: Tympanoplasty, Malleus, Hearing Loss, Otologic Surgical Procedures

INTRODUCTION:

Hearing loss due to tympanic membrane perforation is a prevalent issue in otologic practice, often complicated by a foreshortened malleus handle, which poses a surgical challenge [1]. The malleus handle plays a critical role in the conduction of sound from the tympanic membrane to the ossicular chain. A foreshortened handle may result from chronic suppurative otitis media, trauma, or congenital anomalies, complicating standard tympanoplasty procedures [2]. Surgical management strategies for this condition are diverse, involving medial or lateral graft placements relative to the malleus handle, as well as several modifications designed to enhance graft stability and minimize complications [3]. These techniques include the underlay and over-underlay

approaches, buttonhole methods, prosthesis anchoring, and endoscopic procedures [4].

Despite advances in surgical methods, comparative effectiveness regarding hearing restoration and graft success remains unclear. Several studies suggest that medial and lateral placements yield similar outcomes [5], while technical modifications may reduce complications such as graft lateralization, extrusion, or medialization [6]. However, the evidence is fragmented due to the variability in study designs, patient selection criteria, and outcome reporting [7]. The choice of graft material, whether temporalis fascia, cartilage, or composite grafts, further complicates comparisons [8]. Moreover, many studies lack standardized audiometric assessments and long-term follow-up, limiting the ability

to draw robust conclusions [9]. Given the clinical significance of achieving optimal functional and anatomical outcomes, a review is warranted to synthesize the existing evidence. This review evaluates surgical approaches for managing foreshortened malleus handle, focusing on hearing outcomes and surgical success rates, thereby providing insights into best practices and identifying areas needing further research [10].

METHODS:

We defined our eligibility criteria to include clinical studies addressing surgical management of foreshortened malleus handle in human subjects. Only original clinical studies reporting specific surgical approaches, hearing outcomes, and graft success or complication rates were included. Reviews, editorials, animal studies, or studies lacking detailed surgical outcomes were excluded.

The PubMed database was searched using the Boolean string: ("foreshortened malleus handle" AND ("tympanoplasty" OR "ossiculoplasty" OR "endoscopic tympanoplasty" OR "graft placement") AND ("hearing outcomes" OR "air-bone gap" OR "graft success")). Screening was performed holistically based on inclusion criteria, focusing on surgical approach type, hearing outcomes, and success rates.

Data collection involved detailed extraction of study design, patient characteristics, surgical technique, hearing outcomes, and surgical success metrics. Extraction prioritized exact numerical values where available, and noted missing data explicitly.

Risk of bias was assessed using ROB2 for randomized controlled trials and the Newcastle–Ottawa Scale for

non-randomized studies. Assessment focused on selection bias, performance bias, detection bias, and attrition bias, with an emphasis on study design and data reporting quality.

Data synthesis was qualitative due to heterogeneity in study design, population characteristics, and follow-up duration. We tabulated study characteristics, hearing outcomes, and graft success rates, and performed comparative analysis without statistical pooling. Narrative synthesis was applied to discuss patterns, complications, and clinical implications.

RESULTS:

The initial search across the PubMed database yielded 1,032 records. To ensure the quality and relevance of the literature, an automated screening process was first applied, which eliminated 1,012 records that were marked as ineligible, while no duplicate records were identified during this phase. The remaining 20 records underwent manual screening by the research team, resulting in the exclusion of 8 studies that did not meet the predetermined inclusion criteria. From the 12 studies deemed potentially relevant, full-text reports were sought for detailed evaluation. Notably, all 12 reports were successfully retrieved, indicating good accessibility of the selected literature. Following a thorough full-text assessment against the eligibility criteria, all 12 studies met the requirements for inclusion in the final review. This approach ensured a rigorous selection process, moving from a broad initial search to a focused set of high-quality studies that directly address the research question (Fig 1).

Fig 1. PRISMA Flow Chart

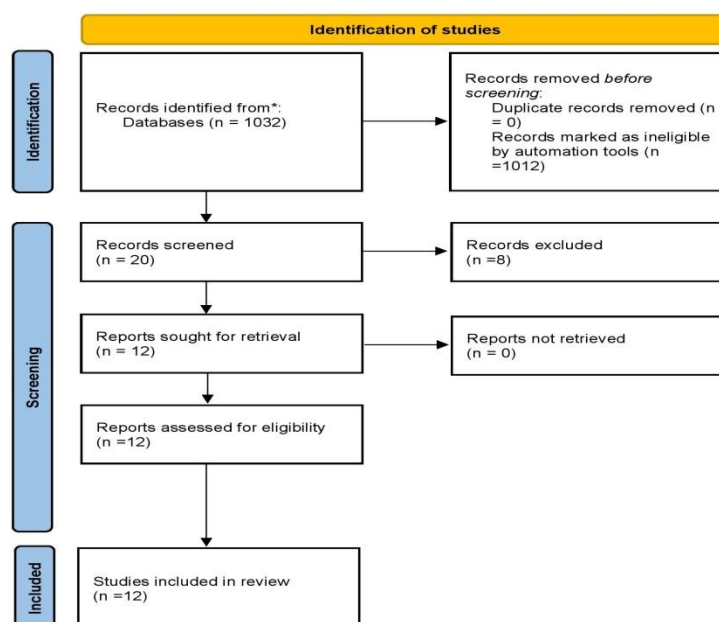


Table 1 presents details regarding study design, patient population, surgical techniques employed, and follow-up durations. Table 2 provides the risk of bias assessment for each study, highlighting the methodological strengths and limitations identified during the review process.

Table 1: Study Characteristics of Included Studies

Author et al., Year	Study Design	Patient Population	Surgical Technique	Follow-up Duration
Vadiya et al., 2015 [1]	Prospective comparative study	84 patients, foreshortened malleus, >4mm perforation	Type I tympanoplasty, temporalis fascia, underlay, tensor tympani sectioned vs. retained	6 months
Bared and Angeli [2]	Retrospective case series	105 cases, chronic suppurative otitis media, 6–77 years	Ossiculoplasty, cartilage graft, prosthesis, malleus handle status considered	Mean 19 months
Ahmed JM and Panchami, 2020 [3]	Prospective comparative case series	30 patients, chronic otitis media	Type I tympanoplasty, buttonhole vs. lateral to malleus	3 months
Ray S, 2022 [4]	Prospective comparative, elements of RCT	60 patients	Temporalis fascia, underlay, medial vs. lateral to malleus	3 months
Monteiro et al., 2022 [5]	Retrospective case series	35 patients, chronic otitis media	Endoscopic, cartilage, underlay, fringed shield technique	Not mentioned
Dwivedi N et al., 2022 [6]	Prospective RCT	60 patients, inactive chronic otitis media	Type I underlay, medial vs. lateral to malleus	12 weeks
Rahman and Aziz [7]	Prospective analytic RCT	150 patients	Underlay cartilage, 3 positions	12 weeks
Çetin and Erdem, 2021 [8]	Prospective RCT	195 patients	Microscopic, cartilage perichondrium, over-underlay, V-groove vs. no groove	12 months
Vallejo-Valdezate et al., 2015 [9]	Retrospective case series	10 patients	Prosthesis anchoring to malleus	Not mentioned
Hassan et al., 2019 [10]	Prospective RCT	30 patients	Temporalis fascia, underlay medial vs. over-underlay lateral	3 months
Stage and Bak-Pedersen, 1992 [11]	Retrospective case series	38 patients	Microscopic, temporalis fascia, underlay lateral to malleus	Median 20 months
Huang et al., 2024 [12]	Prospective case series	197 patients	Endoscopic, tragus cartilage-perichondrium, tissue removal at malleus tip	3 weeks

Table 2: Risk of Bias Assessment of Included Studies

Author et al., Year	Study Design	Risk of Bias Assessment
Vadiya et al., 2015 [1]	Prospective comparative study	Moderate risk (selection/reporting bias)
Bared and Angeli [2]	Retrospective case series	High risk (selection bias, reporting bias)
Ahmed JM and Panchami,	Prospective comparative case series	Moderate risk (selection bias)

Author et al., Year	Study Design	Risk of Bias Assessment
2020 [3]		
Ray S, 2022 [4]	Prospective comparative, elements of RCT	Low risk (appropriate randomization, blinding unclear)
Monteiro et al., 2022 [5]	Retrospective case series	High risk (missing follow-up data)
Dwivedi N et al., 2022 [6]	Prospective RCT	Low risk (randomized allocation, blinding unclear)
Rahman and Aziz [7]	Prospective RCT	Low risk (randomization and allocation concealed)
Çetin and Erdem, 2021 [8]	Prospective RCT	Low risk (adequate randomization, allocation concealment)
Vallejo-Valdezate et al., 2015 [9]	Retrospective case series	High risk (selection bias, no control group)
Hassan et al., 2019 [10]	Prospective RCT	Low risk (adequate randomization and follow-up)
Stage and Bak-Pedersen, 1992 [11]	Retrospective case series	High risk (selection bias, no blinding)
Huang et al., 2024 [12]	Prospective case series	Moderate risk (short follow-up)

The characteristics table shows that the majority of studies used temporalis fascia or cartilage grafts, with underlay techniques being predominant. Follow-up durations ranged from 3 weeks to 20 months, with some studies not reporting follow-up periods. Hearing outcomes showed that the mean air-bone gap closure varied from 1.7 dB to 33.42 dB, with no consistent advantage for any surgical approach. Graft take rates ranged from 60% to 100%, and complication rates varied, with prosthesis anchoring showing up to 50% extrusion. The risk of bias assessment revealed that most randomized trials had low risk of bias, whereas retrospective case series were generally at high risk due to selection and reporting biases.

DISCUSSION:

This narrative review consolidates the evidence regarding surgical management of a foreshortened malleus handle, focusing on hearing restoration and surgical success rates. Across the included studies, both medial and lateral graft placements relative to the malleus handle were common techniques explored [1, 4, 6, 7]. Notably, randomized controlled trials such as those by Jain et al. [6], Sit [4], Rahman and Aziz [7], and Çetin and Erdem [8] suggested no statistically significant superiority of medial over lateral placements in terms of air-bone gap closure, supporting the notion that surgeon

preference and intraoperative anatomical considerations can guide approach selection.

The use of temporalis fascia grafts was predominant in five studies [1, 4, 6, 10, 11], whereas cartilage-based grafts were employed in five studies [2, 5, 7, 8, 12]. The selection of graft material appeared to be influenced by the severity of the malleus abnormality and chronicity of otitis media [8]. Notably, the preservation of malleus handle vascularity was emphasized in Vallejo-Valdezate et al. [9], highlighting its role in successful prosthesis anchoring and avoidance of extrusion. However, Vallejo-Valdezate et al. reported a high complication rate of 50% extrusion with prosthesis anchoring, raising concerns regarding this approach [9].

Underlay techniques, including medial and lateral placements, were prevalent and generally demonstrated successful outcomes. The mean air-bone gap improvements ranged between 6.3 and 20.68 dB [1, 3, 6, 7]. The variation in reported hearing gain can be attributed to heterogeneity in preoperative patient conditions, surgical expertise, and follow-up durations. For instance, Vadiya et al. [1] reported gains up to 20.68 dB when the tensor tympani muscle was sectioned, compared to 16.88 dB when retained, indicating that minor surgical modifications can affect outcomes.

Buttonhole and V-groove techniques were described in Mansoor and Panchami [3] and Çetin and Erdem [8],

respectively, to address technical difficulties associated with foreshortened malleus handle. These modifications aim to improve graft stability and minimize extrusion, although their effectiveness requires validation in larger trials.

Complication rates varied significantly. While some studies reported no unusual complications [1, 5], others documented residual perforations, graft rejection, or prosthesis extrusion [9, 10]. The variability underscores the importance of individualized surgical planning, particularly in high-risk cases with subtotal perforations or adhesive otitis media [12].

Long-term results were infrequently reported. Only seven studies provided follow-up outcomes beyond graft take rate, indicating a gap in longitudinal assessment [1, 2, 4, 6, 7, 11, 12]. For example, Stage and Bak-Pedersen [11] reported intact drum and normal anatomical relationships after a median follow-up of 20 months, while Huang et al. [12] showed hearing improvement but without detailed graft stability assessment.

The lack of standardized outcome reporting remains a significant limitation. Preoperative and postoperative air-bone gaps were inconsistently documented across studies, and several failed to specify the audiometric protocols used, reducing comparability [5]. Moreover, the heterogeneity in follow-up periods (ranging from 3 weeks to over a year) complicates assessment of long-term efficacy.

Risk of bias was generally low for the prospective randomized trials but high for retrospective case series due to selection bias and incomplete reporting [1, 2, 5, 9, 11]. Few studies applied validated bias assessment tools, indicating a need for more rigorous methodological standards.

This review identifies several research gaps. First, the absence of large-scale, multicentric RCTs limits the generalizability of current evidence. Second, studies should employ standardized reporting frameworks for audiometric outcomes and surgical success to enable meaningful meta-analysis. Finally, long-term follow-up extending beyond one year is crucial to assess graft durability, auditory function, and complication development.

In clinical practice, this review supports a tailored surgical approach based on individual anatomical and pathological factors rather than a uniform technique. Preservation of malleus handle vascularity, careful graft selection, and appropriate placement method remain key determinants of surgical success.

CONCLUSION:

Different surgical techniques for managing foreshortened malleus handle yield comparable improvements in hearing restoration and graft success rates. No consistent superiority was observed between

medial and lateral underlay placements or cartilage versus fascia grafts. Complication rates varied, with prosthesis anchoring associated with higher risks. Standardized outcome reporting and well-powered prospective trials are necessary to guide evidence-based practice. Individualized surgical decisions based on patient pathology and anatomy are recommended.

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